European
Safe
Logistics
Association

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Informative Guidance:
Minimum Requirement for kxg acceleration level
EUMOS 40509 Test Method for Load Unit Rigidity

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1. Scope

This guidance aims at assisting packaging and testing engineers in understanding the **minimum requirements for the kxg acceleration level that a load unit must withstand individually when subjected to the EUMOS 40509 test**. This is particularly relevant when the load unit is being loaded and transported in a vehicle or container.

A **load unit** in the context of this informative guidance, should be considered as an indivisible piece of cargo in the sense that the complete load unit is protected and/or stabilized by transport packaging.

2. Introduction

In Anex III, Point 1, of the DIRECTIVE 2014/47/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL with title “on the technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Union”, informs that cargo securing shall withstand the following forces resulting from accelerations/decelerations of the vehicle (from now accelerations in general).

- 0.8g in forward direction, it means the acceleration when braking
- 0.5g backward, it means the acceleration when speeding
- 0.5g in both transversal directions, it means centrifugal acceleration when turning or driving in curves.

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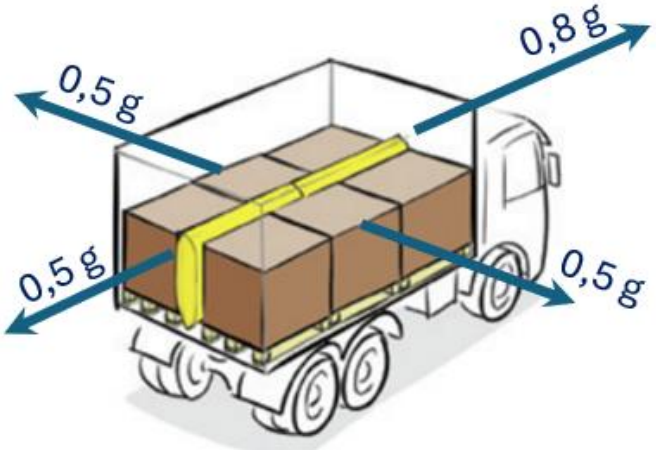

Other sources, as listed below, concur that the levels of acceleration occurring during vehicle transportation match those previously described:

- The National Safety Code (NSC) Standard 10 for Cargo Securement in Canada, 2013.
- The Load Restraint Guide from the National Transport Commission (NTC) in Australia, 2018.
- The Cargo Securement Rules from the Federal Motor Carrier Safety Administration (FMCSA) in USA, 2004.
- Informative material related to the IMO/ILO/UNECE code of practice for packing of cargo transport units (CTU code)
    - Best Practice Guidelines on Cargo Securing for Road Transport (European Commission), 2014 edition
    - International Guidelines on Safe Load Securing for Road Transport (IRU), 2014

It is important to know how to proceed when our load unit is not able by itself to withstand those acceleration levels.

In Annex III, Point 3 of Directive 2014/47/EU informs us that the strength of certain vehicle components, such headboard, sideboard, endboards, stanchions or lashing points, shall be taking into account if they are going to be used for cargo securing. And in Point 4 that one or more or a combination of the following restraining methods may be used (locking, blocking local or overall, direct lashing, top-over lashing).

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This could result in walls locking part of the load with their strength. Therefore, the load unit should not require as much rigidity for transportation.

In this case, the required force g could be estimated based on the strength of vehicles or containers.

The Best Practice Guidelines on Cargo Securing for Road Transport (European Commission) 2014 edition foresees that - if there is no risk of a cargo sliding - the cargo can be transported without the use of lashing straps. In addition, where possible blocking should be used as a method to secure the cargo. This involves positioning the cargo, or parts of the cargo directly to the headboard, sideboards, stanchions, supports, walls or parts of the cargo to stop it from moving. In case of global blocking, the sum of void spaces in any horizontal direction should not exceed 150 mm. However, void spaces should be further minimized, as far as possible.

2.1. Factors taken into account

The minimum requirements for the kxg acceleration level that a load unit must withstand individually when subjected to the EUMOS 40509 test will depend on the following factors:

- The position of the load unit inside the means of transport with respect to the forward direction of the means of transport
    - Length direction.
    - Width direction.
- The means of transport involved in the entire distribution
    - Uni-modal transportation
        - Road transportation.
    - Multi-modal transportation
        - Road + Rail transportation.
        - Road + Sea transportation.
        - Road + Rail + Sea transportation.
- The type of vehicle/container
    - Certified vehicle EN12642-XL

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- Non-Certified vehicle/container
- ISO Freight container

- The stowage conditions inside the vehicle/container:
  - Presence of void spaces in any horizontal direction to back doors or walls when the complete load is formed by a compact row of load units
  - Complete load formed by non-compact rows of load units, with spaces on the sides
  - Presence of empty space to the headboard
- If the load units present underhang.

2.2. Strength of Vehicle/Container

The strength of certain vehicle components, such as headboard, sideboard, endboards, stanchions or lashing points, shall be taken into account if they are going to be used for cargo securing.

This informative guidance considers the following type of vehicles/containers:

- Certified vehicle EN12642-XL: EN 12642-XL certification is a guarantee that the bodywork design of the box trailer of a vehicle has been tested and meets a minimum structural strength according to that standard.
- Non-Certified vehicle/container: when the box trailer is not EN 12642-XL certified or the freight container is not ISO 1496-1.
- ISO Freight container: related to an intermodal freight container ISO 1496-1.

Depending on the type of vehicle/container, the **side walls** are able to take the following percentage of payload uniformly distributed over the full length and height:

- Certified vehicle EN12642-XL: 40%
- Non-Certified vehicle/container: 0 %
- ISO Freight container: 60%

Depending on the type of vehicle/container, the **headboard wall** is able to take the following percentage of payload uniformly distributed over the full width and height:

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- Certified vehicle EN12642-XL: 50%
- Non-Certified vehicle/container: 0 %
- ISO Freight container: 40%

Depending on the type of vehicle/container, the **rear wall** is able to take the following percentage of payload uniformly distributed over the full width and height:

- Certified vehicle EN12642-XL: 30%
- Non-Certified vehicle/container: 0 %
- ISO Freight container: 40%

2.3. Accelerations from Modes of Transportation

The calculation of the correct forces is obtained from particular accelerations of the transportation mode in question or the combination of the modes used. This informative guidance considers the following modes of transportation:

- Uni-modal transportation
  - Road transportation: involves the movement of cargo via roads using vehicles. This includes the handling manoeuvres lo load and unload the vehicle.
- Multi-modal transportation
  - Road + Rail transportation: involves the movement of cargo using two different modes of transport, in this case road and rail.
  - Road + Sea transportation: involves the movement of cargo using two different modes of transport, in this case road and sea.
  - Road + Rail + Sea transportation: involves the movement of cargo using three different modes of transport, in this case road, rail and sea.

a) The road transportation of cargo is subject to the following horizontal accelerations:

- Longitudinal direction:
  - Forward: 0.8 g
  - Backward: 0.5 g

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- Transverse or lateral direction: 0.5 g

b) The **rail transportation** of cargo is subject to the following horizontal accelerations:

- Longitudinal direction: 1.0 g
- Transverse or lateral direction: 0.5 g

c) The **maritime transportation** of cargo is subject to the following horizontal accelerations:

- Maritime Area – A:
  - Longitudinal direction: 0.3 g
  - Transverse or lateral direction: 0.5 g
- Maritime Area – B:
  - Longitudinal direction: 0.3 g
  - Transverse or lateral direction: 0.7 g
- Maritime Area – C:
  - Longitudinal direction: 0.4 g
  - Transverse or lateral direction: 0.8 g

The **maritime area (A)** includes:

- Baltic Sea (including Kattegat) / Mediterranean Sea / Black Sea / Red Sea / Persian Gulf
- Coastal or island-to-island travel in the following regions:
  - Central Atlantic Ocean (between 30°N and 35°S)
  - Central Indian Ocean (up to 35°S)
  - Central Pacific Ocean (between 30°N and 35°S)

The **maritime area (B)** includes:

- North Sea / Skagerrak / English Channel / Sea of Japan / Sea of Okhotsk
- Coastal or island-to-island travel in the following regions:
  - Southern Central Atlantic Ocean (between 35°S and 40°S)
  - Southern Central Indian Ocean (between 35°S and 40°S)
  - Southern Central Pacific Ocean (between 35°S and 45°S)

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The **maritime area (C)** includes the zones not defined in areas A and B.

When a combination of transportation modes is involved in the distribution cycle, the acceleration level to take into consideration shall be the maximum value from the transportation modes involved.

The longitudinal and transverse accelerations for handling manoeuvres are considered in this informative guidance at 0.2 g.

When we talk about longitudinal acceleration, we refer to the acceleration forces in the direction of vehicle motion, either during acceleration or deceleration. For instance, in road transportation, when the vehicle accelerates, these forces act in the opposite direction to its forward motion, while during braking, they are aligned with its direction.

When we talk about transverse or lateral acceleration, we refer to the acceleration forces in lateral direction or sideways to the sides of the vehicle. For instance, in road transportation, these forces can arise during manoeuvres, turns or lane changes.

2.4. Stowage Conditions inside the Vehicle/Container

If there is no risk of the cargo sliding, it can be transported without the use of lashing straps.

A **load unit** in the context of this informative guidance, should be considered as an indivisible piece of cargo in the sense that the complete load unit is protected and/or stabilized by transport packaging. The function of the **transport packaging** is to unitise the complete load unit using banding, strapping, gluing, stretch wrapping and shrink wrapping.

When a single load unit or a combination of load units of the same or different type are placed in the vehicle/container, blocking should be used as method to secure the cargo where possible. This involves positioning the cargo, or parts of the cargo directly to the headboard, sideboards, stanchions, supports, walls or parts of the cargo to stop it from moving. In case of global blocking, the sum of void spaces in any horizontal direction should not exceed 15 cm. However, void spaces should be further minimized, as far as possible.

Depending whether the cargo is or is not formed by compact rows of load units, whether there is or is not any empty space to the headboard, whether there is more or less than 150 mm of total empty space to

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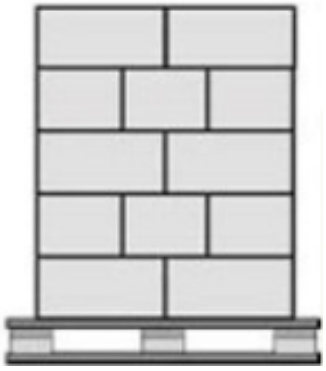
the back doors or walls, or whether the load unit presents or does not present underhang, the acceleration levels from the transportation modes can be reduced or not.

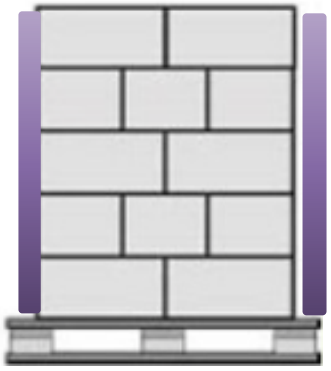
The best approach to minimize the kxg level of acceleration that the load unit must withstand individually when subjected to the EUMOS 40509 test, is to have inside the vehicle/container compact rows of load units with no underhang, with no empty space to the headboard and with less than 150 mm of total empty space to back doors or walls.

Underhang, empty space to the headboard and empty space to back door or walls can be solved by filling the void space with non-deformable filler materials.

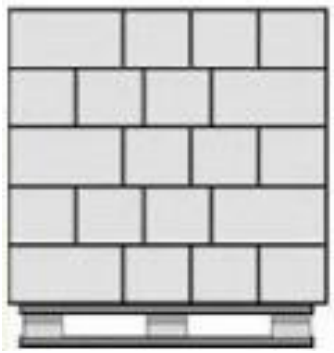
Underhang in the context of this informative guidance, refers to the void space inside the pallets' boundaries with respect to the load unit.



Underhang



Underhang + Filler



No Underhang

3. Minimum requirements for the kxg acceleration test level

The following tables define the minimum requirements for the kxg acceleration level that a load unit must withstand individually when subjected to the EUMOS 40509 test. The values will depend on the stowage conditions inside the vehicle/container, the type of vehicle/container and the transportation mode used.

If the position of the load unit inside the means of transport, with respect to the forward direction of the means of transport is not known, the minimum requirement for the kxg acceleration test level for length direction and width direction must be the maximum value between latitudinal and longitudinal values from the corresponding cell and table.

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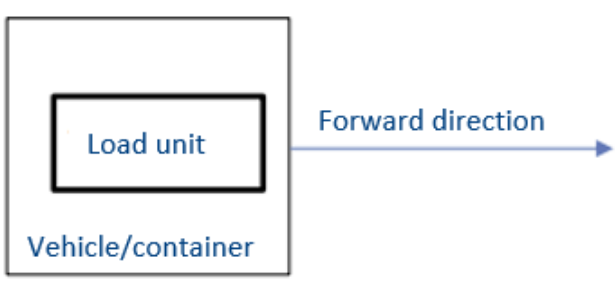
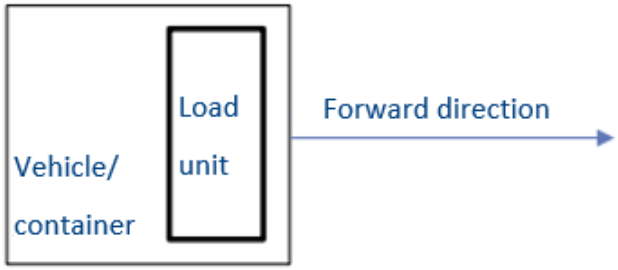
On the other hand, if that position is known, the minimum requirement for the kxg acceleration test level for length direction and width direction must be chosen according to the position inside the means of transport:

- If the length direction coincides with the direction of the vehicle motion, the longitudinal acceleration value must be chosen for the kxg acceleration test level for the length direction of the load unit and the latitudinal acceleration value must be chosen for the width direction of the load unit.
- If width direction coincides with the direction of the vehicle motion, the longitudinal acceleration value must be chosen for the kxg acceleration test level for the width direction of the load unit and the latitudinal acceleration value must be chosen for the width direction of the load unit.



Length direction



Width direction

Depending on the slenderness of the load unit, its structural stiffness and the acceleration test level, the load unit when is subjected to the EUMOS 40509 test can tip over or tilt and touch the front wall or the rear wall. If this case occurs the load unit cannot be placed on the platform of the vehicle/container without blocking to avoid the tilting and tip over during transportation.

Slenderness in the context of this informative guidance, refers to the ratio between height and width of a load unit measured from bottom to height and width of the centre of gravity.

Structural stiffness in the context of this informative guidance, refers to the quality of the load unit to present a very low elastic deformation during test.

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Road Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.4 g	**Lat 0.2 g Long 0.3 g**	**Lat 0.5 g Long 0.5 g**	**Lat 0.5 g Long 0.5 g**	**Lat 0.5 g Long 0.8 g**

Road + Rail Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.6 g	**Lat 0.2 g Long 0.7 g**	**Lat 0.5 g Long 0.6 g**	**Lat 0.5 g Long 0.7 g**	**Lat 0.5 g Long 1.0 g**

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Road + Sea (Zone A) Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.4 g	**Lat 0.2 g Long 0.5 g**	**Lat 0.5 g Long 0.4 g**	**Lat 0.5 g Long 0.5 g**	**Lat 0.5 g Long 0.8 g**

Road + Sea (Zone B) Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.4 g	**Lat 0.3 g Long 0.5 g**	**Lat 0.7 g Long 0.4 g**	**Lat 0.7 g Long 0.5 g**	**Lat 0.7 g Long 0.8 g**

Road + Sea (Zone C) Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.4 g	**Lat 0.4 g Long 0.5 g**	**Lat 0.8 g Long 0.4 g**	**Lat 0.8 g Long 0.5 g**	**Lat 0.8 g Long 0.8 g**

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Road + Rail + Sea (Zone A) Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.6 g	**Lat 0.2 g Long 0.7 g**	**Lat 0.5 g Long 0.6 g**	**Lat 0.5 g Long 0.7 g**	**Lat 0.5 g Long 1.0 g**

Road + Rail + Sea (Zone B) Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.6 g	**Lat 0.3 g Long 0.7 g**	**Lat 0.7 g Long 0.6 g**	**Lat 0.7 g Long 0.7 g**	**Lat 0.7 g Long 1.0 g**

Road + Rail + Sea (Zone C) Transportation				
Compact rows of load units (no underhang and not empty space to headboard)				Non-compact rows of load units, with spaces on the sides or Compact rows of load units (with underhang or empty space to headboard) or Non-Certified Vehicle / Container
With less or equal 150 mm of total empty space to back doors or side walls		With more than 150 mm of total empty space to back doors or side walls		
Freight Container	Certified Vehicle EN12642-XL	ISO Freight Container	Certified Vehicle EN12642-XL	
Lat 0.2 g Long 0.6 g	**Lat 0.4 g Long 0.7 g**	**Lat 0.8 g Long 0.6 g**	**Lat 0.8 g Long 0.7 g**	**Lat 0.8 g Long 1.0 g**

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4. References

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EN 12195-1:2010 – Load restraint assemblies on road vehicles - safety - part 1: calculation of lashing forces.

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