



International  
Standard

**ISO 10896-8**

**Rough-terrain trucks — Safety  
requirements and verification —**

Part 8:  
**Requirements for trucks designed  
for towing**

*Chariots tout-terrain — Exigences de sécurité et vérification —*

*Partie 8: Exigences pour les chariots conçus pour tracter*

**First edition  
2024-10**

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Published in Switzerland

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 4, *Rough-terrain trucks*.

A list of all parts in the ISO 10896 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate in the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or type-B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

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# Rough-terrain trucks — Safety requirements and verification —

## Part 8: Requirements for trucks designed for towing

### 1 Scope

This document specifies safety requirements and verification for rough-terrain variable-reach trucks and slewing rough-terrain variable-reach trucks as defined in ISO 10896-1 and ISO 10896-2 (hereafter referred to as “trucks”) designed for towing trailers or towed equipment or both (hereafter referred to as “towed vehicles”) with a maximum design speed less than or equal to 40 km/h, taking into account the intended use as well as the reasonably foreseeable misuse.

NOTE Local regulations can apply when trucks are used to tow towed vehicles on public roads.

The significant hazards dealt with in this document are mechanical hazards (see ISO 12100:2010, Table B.1) due to:

- acceleration, deceleration;
- instability;
- kinetic energy;
- machinery mobility;
- stored energy.

This document is not applicable to trucks intended to tow a towed vehicle equipped with a:

- a) complex electronic control system for braking or electronically-controlled braking system (EBS);
- b) braking system where the braking force applied to one wheel can be different from the braking force applied to the other wheel of the same axle (differential braking system);
- c) braking system where the energy source that provides the energy required to actuate the brakes is a vacuum pump (vacuum braking system);
- d) part of a service braking system which automatically controls the degree of slip, in the direction of rotation of the wheel, on one or more wheels of the towed vehicle or truck during braking (anti-lock braking system or ABS);
- e) additional braking system having the capability to provide and to maintain a braking effect over a long period of time without a significant reduction in performance, including the control device which can comprise a single device or a combination of several devices each of which can have its own control (endurance braking system).

This document does not provide requirements for the towed vehicles themselves.

This document is not applicable to trucks manufactured before the date of its publication.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5053-1, *Industrial trucks — Vocabulary — Part 1: Types of industrial trucks*

ISO 5676, *Tractors and machinery for agriculture and forestry — Hydraulic coupling — Braking circuit*

ISO 7638-1, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — Part 1: Connectors for braking systems and running gear of vehicles with 24 V nominal supply voltage*

ISO 7638-2, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — Part 2: Connectors for braking systems and running gear of vehicles with 12 V nominal supply voltage*

ISO 10896-1, *Rough-terrain trucks — Safety requirements and verification — Part 1: Variable-reach trucks*

ISO 10896-2, *Rough-terrain trucks — Safety requirements and verification — Part 2: Slewing trucks*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 16028, *Hydraulic fluid power — Dimensions and requirements of quick-attention couplings, flush-face type*

ISO 24347, *Agricultural vehicles — Mechanical connections between towed and towing vehicles — Dimensions of ball coupling device (80 mm)*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 10896-1, ISO 10896-2, ISO 5053-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1

#### **towed vehicle**

vehicle without powered traction that is towed by a truck

### 3.2

#### **trailer**

*towed vehicle* (3.1), intended mainly to carry loads or to process materials, where the ratio of the *technically permissible maximum laden mass* (3.11) to the unladen mass is equal to or greater than 3,0

### 3.3

#### **towed equipment**

*towed vehicle* (3.1) that permanently incorporates a piece of equipment or is designed to process materials, which can include a load platform to store temporarily any materials produced or needed during work, and where the ratio of the *technically permissible maximum laden mass* (3.11) to the unladen mass is less than 3,0

### 3.4

#### **mechanical coupling**

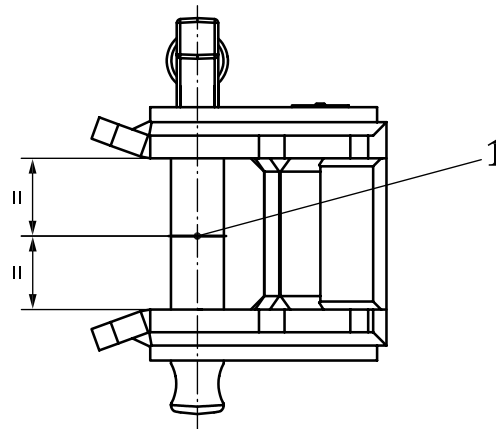
components of the truck intended to provide mechanical connection with a *towed vehicle* (3.1) for towing them on road or on unimproved terrain with the purpose of transport or work

### 3.5

#### reference centre of the mechanical coupling on truck

point on the axis of the pin, piton or hook at the level of contact with the ring, or the centre of the ball

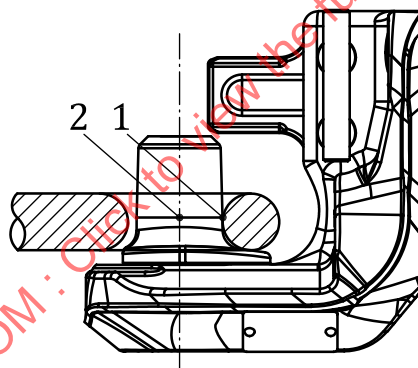
Note 1 to entry: See [Figure 1](#) and [Figure 2](#).



#### Key

- 1 reference centre of mechanical coupling on truck
- = distance is equal above and below point 1

**Figure 1 — Reference centre of mechanical coupling on truck in the case of a fork**



#### Key

- 1 contact with the ring
- 2 reference centre of mechanical coupling on truck

**Figure 2 — Reference centre of mechanical coupling on truck, excluding fork shape**

### 3.6

#### height above the ground of the coupling device

distance between the horizontal plane through the reference centre of the *mechanical coupling* ([3.4](#)) on truck and the horizontal plane on which the wheels of the truck are resting

### 3.7

#### vertical load on the coupling point

load transmitted, under static conditions on the reference centre of the *mechanical coupling* ([3.4](#))

### 3.8

#### graduated braking

braking which during either the application or the releasing of the brakes, within the normal range of operation of the system, has all the following characteristics:

- a) the operator can, at any time, increase or reduce the braking force through action of the control device;
- b) the braking force acts in the same direction as the action on the control device (monotonic function);
- c) it is easily possible to make a sufficiently precise adjustment to the braking force

### 3.9

#### inertia braking

braking by utilizing the forces generated by the *towed vehicle* (3.1) moving up on the truck

### 3.10

#### laden truck

truck or *towed vehicle* (3.1) loaded at its *technically permissible maximum laden mass* (3.11)

### 3.11

#### technically permissible maximum laden mass

maximum mass allocated to a *laden truck* (3.10) or *towed vehicle* (3.1) on the basis of its construction features and its design performances

### 3.12

#### technically permissible mass per axle

maximum load on the axle limited by the axle construction or tyres rated at the maximum specified towing speed

### 3.13

#### towed vehicle category

classification of a *towed vehicle* (3.1) based on the sum of the *technically permissible masses per axle* (3.13) according to [Table 1](#)

**Table 1 — Towed vehicle categories**

| Category | Technically permissible masses                                                                                          |
|----------|-------------------------------------------------------------------------------------------------------------------------|
| TR1      | trailers of which the sum of the technically permissible masses per axle does not exceed 1 500 kg                       |
| TR2      | trailers of which the sum of the technically permissible masses per axle exceeds 1 500 kg but does not exceed 3 500 kg  |
| TR3      | trailers of which the sum of the technically permissible masses per axle exceeds 3 500 kg but does not exceed 21 000 kg |
| TR4      | trailers of which the sum of the technically permissible masses per axle exceeds 21 000 kg                              |
| TE1      | towed equipment of which the sum of the technically permissible masses per axle does not exceed 3 500 kg                |
| TE2      | towed equipment of which the sum of the technically permissible masses per axle exceeds 3 500 kg                        |

## 4 Safety requirements and/or protective/risk reduction measures

### 4.1 Mechanical couplings

#### 4.1.1 General

Trucks shall comply with the safety requirements and/or protective/risk reduction measures of this clause. In addition, trucks shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

The mechanical coupling components on the truck shall conform to the dimensional and strength requirements in [4.1.2.1](#) and [4.1.2.2](#) and the requirements for the vertical load on the coupling point in [4.1.2.3](#).

All the couplings and their locking means shall be so designed that under normal operating conditions no unintentional de-coupling is possible.

The mechanical coupling components may be designed to function automatically or non-automatically.

In automatic coupling components, the locked position shall be secured by two independently functioning safety devices. However, the two safety devices may be released using the same control device.

## 4.1.2 Design

### 4.1.2.1 Dimensions

The dimensions of the mechanical coupling on the truck should conform to the relevant ISO document, as specified in [Annex A](#), [Table A.1](#).

### 4.1.2.2 Strength

The strength of the mechanical couplings shall be verified by a dynamic test under the conditions set out in [5.1.1](#) or a static test under the conditions set out in [5.1.2](#).

### 4.1.2.3 Vertical load on the coupling point, $S$

The truck manufacturer shall specify the maximum permitted vertical load at the coupling point on the truck.

The maximum permitted vertical load shall be such that the mass transmitted to the road by the wheels on the forward (steering) axle shall not be less than 20 % of the unladen mass of that truck, without exceeding the technically permissible mass per axle of the rear (other) axle.

The maximum permitted vertical load marked at the coupling point on the truck shall not exceed 3 000 kg, except for in the case of ball coupling conforming to ISO 24347, where the maximum value shall not exceed 4 000 kg.

### 4.1.2.4 Height above the ground of the coupling device, $h$

Mechanical couplings installed on trucks with a technically permissible maximum laden mass exceeding 2,5 tonnes shall provide for a height above the ground of the coupling device,  $h$ , satisfying [Formula \(1\)](#):

$$h \leq [(m_a - 0,2 \cdot m_t) \cdot l - (S \cdot c)] / [0,6 \cdot (0,8 \cdot m_t + S)] \quad (1)$$

where

$m_t$  is the mass of the truck, in kg;

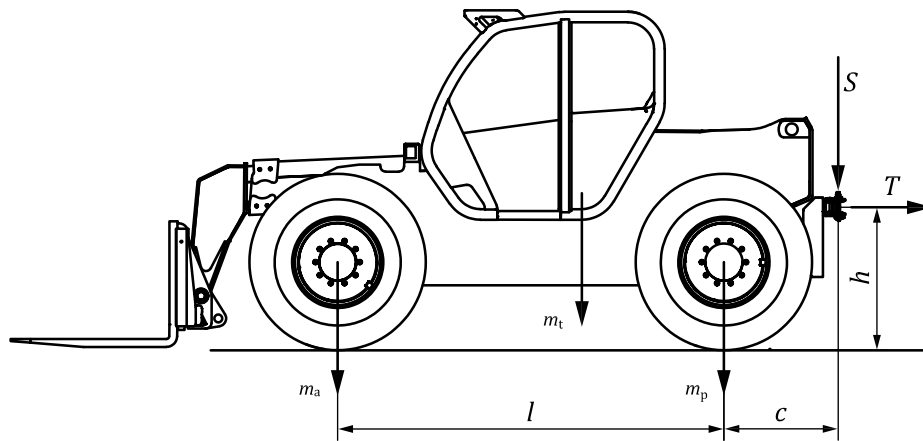
$m_a$  is the mass on the front axle of the unladen truck, in kg;

$l$  is the truck wheelbase length, in mm;

$S$  is the vertical load on the coupling point, in kg;

$c$  is the distance between the reference centre of the mechanical coupling and the vertical plane passing through the axle of the rear wheels of the truck, in mm.

See [Figure 3](#) for an illustration of [Formula \(1\)](#).



**Key**

- $m_a$  mass on the front axle of the unladen truck
- $m_p$  mass on the rear axle of the unladen truck
- $m_t$  mass of the truck
- $l$  truck wheelbase length
- $c$  distance between the reference centre of the mechanical coupling and the vertical plane passing through the axle of the rear wheels of the truck
- $h$  height above the ground of the coupling device
- $T$  towable mass
- $S$  vertical load on the coupling point

**Figure 3 — Height above the ground of the coupling device,  $h$**

## 4.2 Braking systems for towing

### 4.2.1 Required service braking systems for towed vehicle categories

Trucks do not need to be fitted with hydraulic or pneumatic brake connections if they are intended to tow trailers of category TR1, or trailers of category TR2 that are fitted with inertia brakes, or towed equipment of category TE1.

Trucks shall be equipped with hydraulic or pneumatic brake connections if they are intended to tow trailers of category TR2 that are fitted with hydraulic or pneumatic brakes.

Trucks shall be equipped with hydraulic or pneumatic brake connections if they are intended to tow trailers of category TR3, trailers of category TR4 or towed equipment of category TE2.

By way of derogation concerning trailers of category TR3 and towed equipment of category TE2, trucks may be intended to tow trailers of category TR3 and towed equipment of category TE2 with a maximum mass not exceeding 8 000 kg if towed vehicles are equipped with an inertia braking system and conform to one of the following:

- a) design speed does not exceed 30 km/h when the brakes do not act on all wheels;
- b) design speed does not exceed 40 km/h when the brakes act on all wheels.

A truck designed to tow trailers of category TR2 when not equipped with a service braking of the inertia type, trailers of category TR3, trailers of category TR4 or towed equipment of category TE2 shall satisfy the following requirements.

- a) An actuation of the service braking system of the truck shall generate a braking command on the towed vehicle when the engine is running.

- b) When the service braking system of the truck is actuated with the engine running there shall also be a graduated braking command on the towed vehicle.

NOTE When the engine is not running, a braking command on the towed vehicle is not required.

## 4.2.2 Requirements on connections for trucks so equipped

### 4.2.2.1 General

The flexible hydraulic/pneumatic hoses and electrical cables connecting the truck and towed vehicles shall not be part of the truck.

### 4.2.2.2 Requirements applying to hydraulic connections of the single-line type

The connector shall conform to ISO 5676. The probe part of the connector shall be on the truck.

With the engine running and the control device of the service braking system of the truck fully applied, a pressure between 10 000 kPa and 15 000 kPa shall be generated on the control line.

With the engine running and no brake control device on the truck applied (driving or stand-by condition), the pressure supplied at the coupling head of the control line shall be  $0^{+200}$  kPa.

The compatibility requirements according to [4.2.4](#) do not apply.

If the truck is equipped with the connection types referred to in [4.2.2.3](#) (hydraulic connection of the 2-line type between trucks and towed vehicles), in order to avoid duplication, the probe part of the connector described in [4.2.2.3 a\)](#) may be used, provided that the generated pressure fulfils the control line requirements of [4.2.2.3](#).

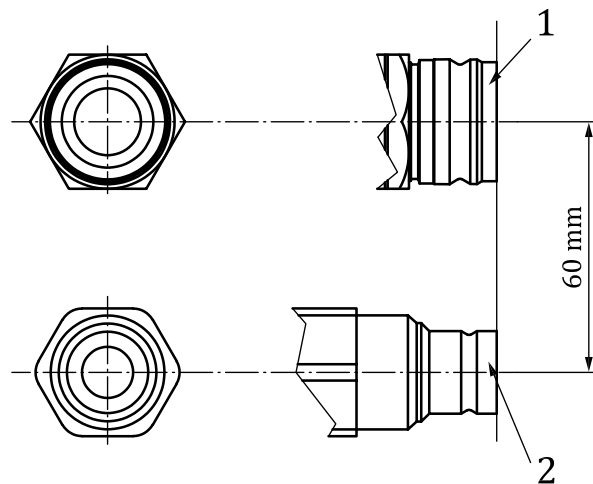
Detection of connected lines shall be carried out by automatic means.

### 4.2.2.3 Requirements applying to hydraulic braking systems of the 2-line type

A hydraulic connection of the 2-line type between truck and towed vehicle shall be provided according to the following.

- a) Hydraulic control line: with the probe part of the connector on the truck and the receptacle part of the connector on the towed vehicle. The connectors shall conform to ISO 5676.
- b) Hydraulic supplementary line: with the probe part of the connector on the truck and the receptacle part of the connector on the towed vehicle. The connectors shall conform to ISO 16028, size 10.

The positioning of the connectors as specified in a) and b) shall be arranged on the truck as illustrated in [Figure 4](#).



**Key**

- 1 probe coupling in accordance with ISO 5676
- 2 probe coupling in accordance with ISO 16028

**Figure 4 — Positioning of the connectors on the truck**

With the engine running and the parking braking system of the truck fully applied:

- a) a pressure of  $0^{+100}$  kPa shall be present on the supplementary line; and/or
- b) a pressure between 11 500 kPa and 15 000 kPa shall be supplied on the control line.

With the engine running and the parking braking system of the truck fully released, a pressure of at least 1 500 kPa but not exceeding 3 500 kPa shall be present on the supplementary line.

With the engine running and no brake control on the truck applied (driving or stand-by condition), the pressure supplied at the coupling head of the control line shall be  $0^{+200}$  kPa.

With the engine running and the service brake control device on the truck fully actuated, a pressure between 11 500 kPa and 15 000 kPa shall be generated in the control line.

#### 4.2.2.4 Requirements applying to compressed-air braking systems of the 2-line type

The connections of the compressed-air braking systems between trucks and towed vehicles shall be provided according to the following:

- a) one pneumatic supply line; and
- b) one pneumatic control line.

NOTE For pneumatic connections, see ISO 1728.

#### 4.2.3 Additional requirements for braking systems for trucks so equipped

##### 4.2.3.1 Additional requirements for trucks designed to tow towed vehicles with hydraulic braking systems

The pressure supplied at both coupling heads with the engine not running shall be 0 kPa.

A device may be fitted on the truck so that the hydraulic connecting lines can be connected and disconnected even when the engine is running and the parking braking system is applied. This device shall be so designed and constructed that the pressure in the connecting lines is positively restored to the rest position not

later than when the control (e.g. push button) of this device is automatically released (e.g. valve returns automatically into the normal operation position).

Trucks intended to tow towed vehicles using energy stored in a hydraulic energy storage device for the service braking system, parking braking system or automatic braking system shall be able to indicate the low level of stored energy on the towed vehicle by a separate warning signal. In this case, a 5-pin or 7-pin electrical connector conforming to ISO 7638-1 or ISO 7638-2 shall be provided. The warning signal shall be sent via pin 5 of the electrical connector.

#### 4.2.3.2 Additional requirements for trucks designed to tow towed vehicles with compressed-air braking systems

In the event of a failure (e.g. breakage) in one of the pneumatic connecting lines, it shall be possible for the driver, fully or partially, to actuate the brakes of the towed vehicle by means either of the service braking control device or of the secondary braking control device or of the parking braking control device, unless the failure automatically causes the towed vehicle to be braked.

This braking shall be considered to be met when the following conditions are fulfilled.

- a) When the brake control device designated among those mentioned above is fully actuated, the pressure in the supply line shall fall to 150 kPa within the following 2 s. In addition, when the brake control device is released, the supply line shall be re-pressurized.
- b) When the supply line is evacuated at the rate of at least 100 kPa/s, the automatic braking of the towed vehicle shall start to operate before the pressure in the supply line falls to 200 kPa.

In the case of a pneumatic service braking system comprising two or more independent sections, any leakage between those sections at or downstream of the control device shall be continuously vented to atmosphere.

#### 4.2.3.3 Additional requirements for the parking brake system

If the requirement for the parking brake system in [5.2.1.2](#) is applied, the following shall be fulfilled.

- a) In the case of compressed-air braking system: a control line pressure of at least 650 kPa shall be transmitted when a single control device is fully activated which also applies the truck parking braking system. This shall also be ensured when the ignition/start switch has been switched off and/or the key has been removed.
- b) In the case of hydraulic braking system: when a single control device is fully activated, a pressure of  $0^{+100}$  kPa shall be generated on the supplementary line.

#### 4.2.4 Compatibility requirements

##### 4.2.4.1 General

Trucks with a maximum design speed exceeding 30 km/h approved to tow trailers of category TR2 when not equipped with a service braking of the inertia type, trailers of category TR3, trailers of category TR4 and towed equipment of category TE2 shall fulfil the requirements given in [4.2.4.2](#).

If a device is used to fulfil the compatibility requirements given in [4.2.4.2](#), this shall operate automatically.

Conformance with the compatibility requirements shall be demonstrated by calculation.

##### 4.2.4.2 Requirements relating to the braking rate, $T_M/F_M$ , and the pressure, $p_m$

The requirements relating to the diagram in [Figure 5](#) shall be applied to trucks with pneumatic or hydraulic control lines in accordance with [4.2.2](#).

The permissible relationship between the braking rate,  $T_M/F_M$ , and the pressure,  $p_m$ , shall lie within the areas shown on the diagram in [Figure 5](#) for all pressures between 20 kPa and 750 kPa (in the case of compressed air braking system) and 350 kPa and 13 300 kPa (in the case of hydraulic braking system).

In all cases, the reference value (abscissa of the diagram) will be the value of the transmitted pressure or electrical signal respectively in the control line.

- a) For trucks equipped with one hydraulic control line and one hydraulic supplementary line, this value shall be the actual hydraulic pressure in the control line,  $p_m$ .
- b) For trucks equipped with one pneumatic supply line and one pneumatic control line, this value will be the actual pneumatic pressure in the control line,  $p_m$ .

#### 4.2.4.3 Validation of the development of braking force

It shall be checked that the development of braking on each axle shall be within the following pressure ranges.

- a) Laden truck:

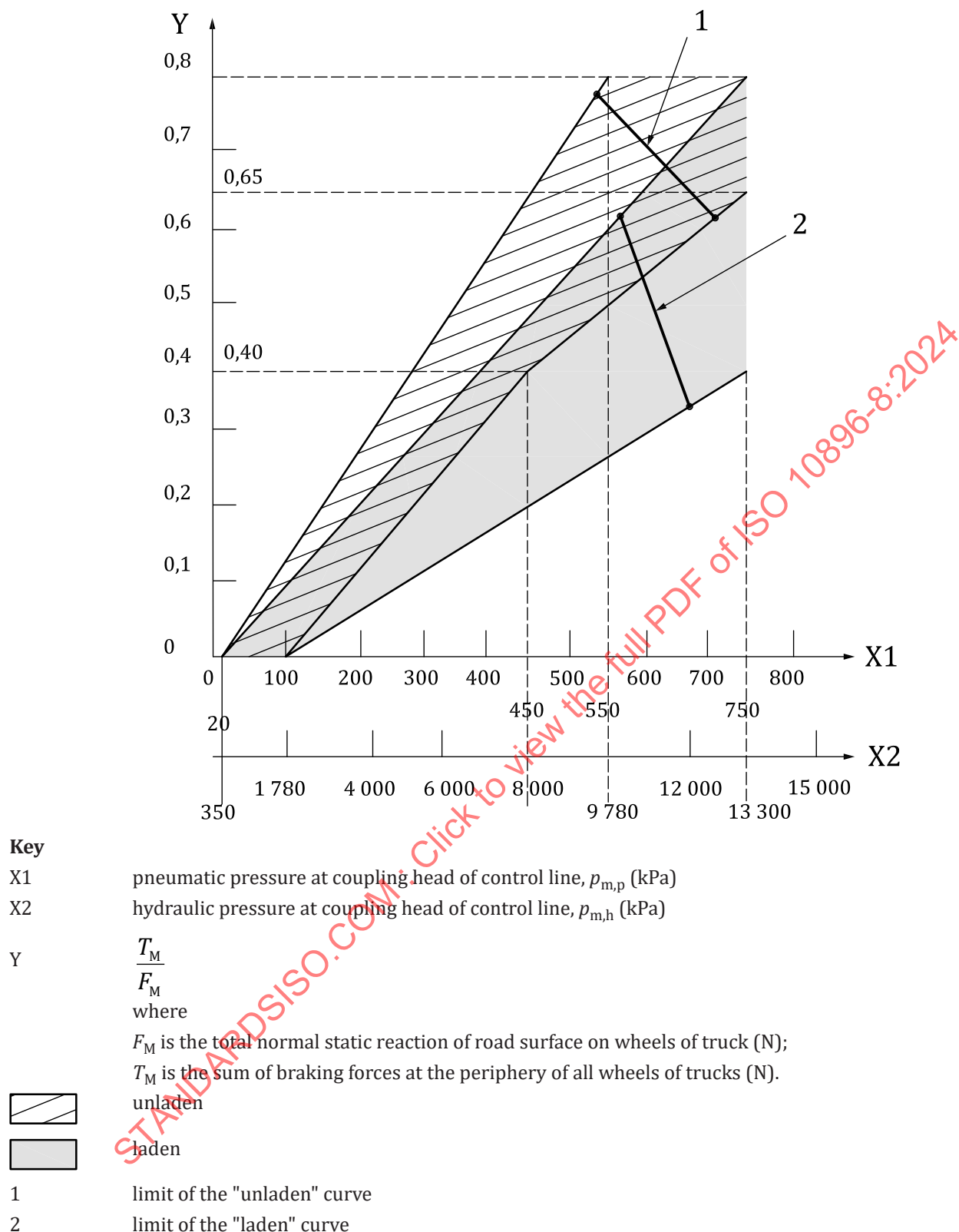
At least one axle shall start to develop a braking force when the pressure at the coupling head is within the pressure range 20 kPa to 100 kPa (pneumatic braking systems) and 350 kPa to 1 800 kPa (hydraulic braking systems) respectively or the equivalent digital demand value.

The other axle shall start to develop a braking force when the coupling head is at a pressure  $\leq 120$  kPa (pneumatic braking systems) and 2 100 kPa (hydraulic braking systems) respectively or the equivalent digital demand value.

- b) Unladen truck:

At least one axle shall start to develop a braking force when the pressure at the coupling head is within the pressure range 20 kPa to 100 kPa (pneumatic braking systems) and 350 kPa to 1 800 kPa (hydraulic braking systems) respectively or equivalent digital demand value.

To verify the requirements above, with the wheels of the axles raised and free to rotate, apply an increasing brake demand and measure the coupling head pressure corresponding to when the wheel(s) can no longer be rotated by hand.



## 5 Verification of the safety requirements and/or protective/risk reduction measures

### 5.1 Mechanical couplings

#### 5.1.1 Dynamic test method

##### 5.1.1.1 Test procedure

This method describes the fatigue test to be used on the complete mechanical coupling device fitted with all the parts needed for mounting and testing on a test bed.

The strength of the mechanical coupling shall be established by alternating traction forces.

These applied alternating forces shall be as close as possible to sinusoidal (alternating and/or rising) with a load cycle depending on the material involved.

No fracture to the component shall occur during the test.

##### 5.1.1.2 Test criteria

The horizontal force components in the longitudinal axis of the truck together with the vertical force components shall form the basis of the test loads.

In so far as they are of secondary importance, horizontal force components at right angles to the longitudinal axis of the truck, as well as movements, may not be taken into consideration.

The horizontal force components in the longitudinal axis of the truck shall be represented by a mathematically established representative force, the value  $D$ , in kN.

[Formula \(2\)](#) shall be applied to the mechanical coupling

$$D = g \cdot (T \cdot R) / (T + R) \quad (2)$$

where

$T$  is the technically permissible maximum laden mass of the truck, in tonnes;

$R$  is the technically permissible maximum laden mass of the towed vehicle, in tonnes;

$g = 9,81 \text{ m/s}^2$ .

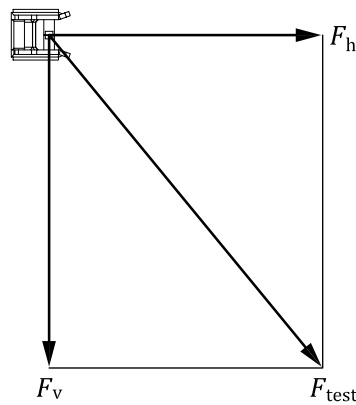
The technically permissible loads shall be given by the manufacturer.

##### 5.1.1.3 Test procedure requirements

###### 5.1.1.3.1 General

The alternating test force shall be applied to the mechanical couplings at an angle formed by the position of the vertical test load,  $F_v$ , in relation to the horizontal test load,  $F_h$ , in the direction of the median longitudinal plane.

The test force shall be applied at the usual point of contact between the mechanical coupling on the truck and the corresponding one on the towed vehicle.



**Key**

- $F_v$  vertical test load
- $F_h$  horizontal test load
- $F_{test}$  test force

**Figure 6 — Application of test force**

The play between the mechanical coupling on the truck and the corresponding one on the towed vehicle shall be kept to a minimum.

For ball type coupling, the test force shall be applied in an alternating manner around the zero point. With an alternating test force, the resulting load is equal to zero.

For any other coupling type, the test force shall be applied on a rising basis in the direction of traction or pressure, whichever is the greater. For this test, the maximum test force shall be equal to the upper (highest) force, and the lower (smallest) force should not exceed 5 % of the upper force.

Care should be taken in the alternating force test to ensure that by suitable mounting of the test apparatus and choice of power conduction system no additional moments or forces arising at right angles to the test force are introduced. The angular error for the direction of force in the alternating force test should not exceed  $\pm 1,5^\circ$ . For the rising force test, the angle is set in the upper load position.

The test frequency shall not exceed 30 Hz.

For components made of steel or steel casting, the load test shall be at least 300 000 cycles.

The subsequent non-destructive examination shall be carried out by a method other than simple visual inspection, for example a dye penetration method or a similar method.

If springs and/or dampers are incorporated into the coupling parts, they shall not be removed during the test but may be replaced if, during the test, they are subject to strain under conditions which would not be obtained during normal operation (e.g. heat action) and become damaged. Their behaviour before, during and after the test shall be described in the test report.

#### 5.1.1.3.2 Test forces

The test force,  $F_{\text{test}}$ , shall consist in geometrical terms of the horizontal and vertical test components as shown in [Formula \(3\)](#):

$$F_{\text{test}} = \sqrt{(F_h)^2 + (F_v)^2} \quad (3)$$

where

- $F_h$  =  $\pm 0,6 \cdot D$  (kN) in the case of alternating force, or  
 =  $1,0 \cdot D$  (kN) in the case of rising force (traction or pressure);
- $F_v$  =  $g \cdot 1,5 \cdot S/1\,000$  (value expressed in kN);
- $S$  = static vertical load on the coupling point (value expressed in kg).  
 See [Figure 6](#).

#### 5.1.1.3.3 Load application

For components of the mechanical coupling on a truck, the load is applied using the components of one corresponding mechanical coupling on a towed vehicle as permitted by the combinations listed in [Table A.1](#).

### 5.1.2 Static test method

#### 5.1.2.1 Test specifications

##### 5.1.2.1.1 General

For verification of its construction characteristics, the mechanical coupling shall undergo static tests in accordance with the requirements listed in the following subclauses.

##### 5.1.2.1.2 Test preparation

The tests shall be carried out on a test bench, with the mechanical coupling and any structure used to mount it to the truck attached to a rigid structure by means of the same components used to mount it on the truck.

##### 5.1.2.1.3 Test instruments

The instruments used to record loads applied and movements shall have at least the following degree of accuracy:

- loads applied:  $\pm 1$  %;
- movements:  $\pm 0,01$  mm.

##### 5.1.2.1.4 Test procedure

The coupling shall undergo a vertical load test, as defined in [5.1.2.1.5](#), followed by a traction test, as defined in [5.1.2.1.6](#).

##### 5.1.2.1.5 Vertical load test

A load of three times the maximum permissible vertical force (in N, equal to  $g \cdot S$ ) recommended by the manufacturer is applied in a gradually increasing manner, starting from an initial load of 5 000 N, to the reference centre of the mechanical coupling on truck.

After the test, the permanent deformation of the coupling device shall not exceed 25 % of the maximum elastic deformation which occurred during the test. The check shall be carried out after removing the vertical force (in N, equal to  $g \cdot S$ ) and returning to the initial load of 5 000 N.

#### 5.1.2.1.6 Traction test

- a) The coupling device shall first be subjected to a pre-traction load not exceeding 15 % of the traction test load defined in 5.1.2.1.6 b).

This operation shall be repeated at least twice, starting with a zero load, which is gradually increased until the value prescribed in 5.1.2.1.6 a) is reached, and then decreased to 5 000 N. The settling load shall be maintained for at least 60 s.

- b) The data recorded for plotting the load/deformation curve under traction, or the graph of that curve provided by the printer linked to the traction machine, shall be based on the application of increasing loads only, starting from 5 000 N, in relation to the reference centre of the mechanical coupling on truck.

There shall be no breaks for values up to and including the traction test load, which is established as 1,5 times the technically permissible trailer mass. In addition, the load/deformation curve shall show a smooth progression, without irregularities, in the interval between 5 000 N and 1/3 of the maximum traction load.

- c) After the test, the permanent deformation of the coupling device shall not exceed 25 % of the maximum elastic deformation which occurred during the test. The check shall be carried out after returning to the initial load of 5 000 N.

## 5.2 Braking systems

### 5.2.1 Performance of braking systems

#### 5.2.1.1 Service braking systems

##### 5.2.1.1.1 Mean fully developed deceleration of the combination

In the case of a truck designed to tow an unbraked towed vehicle, the minimum combination performance required in 5.2.1.1.2 shall be attained with the unbraked towed vehicle coupled to the truck and with the unbraked towed vehicle laden to the maximum mass declared by the truck manufacturer.

The combination performance shall be verified by calculations referring to the maximum braking performance actually achieved by the truck alone during the mean fully developed deceleration (MFDD) braking test (5.2.2) with the engine disconnected for the laden and unladen truck using Formula (4) (no practical tests with a coupled unbraked towed vehicle are required):

$$d_{M+R} = d_M \cdot m_M / (m_M + m_R) \quad (4)$$

where

$d_{M+R}$  is the calculated mean fully developed deceleration of the truck when coupled to an unbraked towed vehicle, in  $m/s^2$ ;

$d_M$  is the maximum mean fully developed deceleration of the truck alone achieved during the “MFDD braking test” in 5.2.2 with engine disconnected, in  $m/s^2$ ;

$m_M$  is the technically permissible maximum operating mass of the truck, in kg;

$m_R$  is the maximum laden mass of the unbraked towed vehicle as declared by the truck manufacturer, in kg.

#### 5.2.1.1.2 Required minimum combination performance

For the laden and unladen conditions, the minimum combination performance shall be:

- not less than  $4,5 \text{ m/s}^2$  in the case of trucks with maximum design speed,  $v_{\text{max}} > 30 \text{ km/h}$ ;
- not less than  $3,2 \text{ m/s}^2$  in the case of trucks with maximum design speed,  $v_{\text{max}} \leq 30 \text{ km/h}$ .

At the discretion of the truck manufacturer, an additional MFDD braking test (5.2.2) may be carried out for a partial laden truck mass declared by the manufacturer in order to define the maximum permitted unbraked towed vehicle mass fulfilling the required minimum combination performance for such combination mass.

The measured values " $d_M$ " for the above-mentioned load conditions and the corresponding calculated values " $d_{M+R}$ " shall be recorded in the test report.

The maximum declared mass for the unbraked towed vehicle shall not exceed 3 500 kg.

#### 5.2.1.2 Parking braking system

##### 5.2.1.2.1

On trucks designed to tow towed vehicles, the parking braking system of the truck shall be capable of holding the combination, at the maximum permissible mass as specified by the truck manufacturer, stationary on a 12 % up and down gradient.

##### 5.2.1.2.2

The requirement of 5.2.1.2.1 is considered to be fulfilled when the following conditions are met.

a) In the case of a towed vehicle with service brake:

Even with the truck engine not running, the combination at the maximum permissible mass shall remain stationary on the prescribed gradient when the activation of a single control device by the operator, from the operator seat, has applied the truck parking braking system and the towed vehicle service braking system.

b) In the case of an unbraked or inertia-braked towed vehicle:

The parking braking system of the truck shall hold stationary on the prescribed gradient the truck connected to an unbraked or inertia-braked towed vehicle having a mass equal to the highest combination mass.

This combination mass shall be determined as follows:

- in the case of unbraked towed vehicle:  $m_M + m_R$  according to 5.2.1.1.1;
- in the case of an inertia braked towed vehicle:  $m_M + m_R$  = combination mass (mass  $m_M$  + declared inertia-braked towed vehicle mass as specified by the manufacturer);

where  $m_M$  is the mass of the truck.

#### 5.2.2 Mean fully developed deceleration (MFDD) braking tests

The mean fully developed deceleration (MFDD) of a braking system shall be determined with brakes cold.

Throughout this test, the maximum design speed is considered to be in the forward direction of the truck travel, unless otherwise explicitly mentioned.

The initial truck speed,  $v_1$ , shall be the speed at the moment at which the operator begins to actuate the control device of the braking system. The initial speed shall not be less than 98 % of the maximum design speed.