
**Rough-terrain trucks — Visibility test
methods and their verification —**

Part 2:
**Slewing rough-terrain variable-reach
trucks**

*Chariots tout-terrain — Méthodes d'essai de la visibilité et leur
vérification —*

Partie 2: Chariots tout-terrain rotatifs à portée variable

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Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Basic dimensions	4
4.1 Light bulb spacing dimensions.....	4
4.2 Masking dimensions.....	4
4.3 Reference dimensions for the measurement.....	5
5 Test apparatus	5
5.1 Test load.....	5
5.2 Light source apparatus.....	5
5.3 Vertical test object.....	5
5.4 Observation mirror.....	5
6 Truck test configuration	6
6.1 Equipment of the truck.....	6
6.2 Openings.....	6
6.3 Position of the truck and load handling attachment.....	6
6.3.1 General.....	6
6.3.2 Test simulating manoeuvring.....	6
6.3.3 Test simulating travel.....	6
6.3.4 Test simulating pick-and-place.....	7
7 Measurement procedure	7
7.1 Test-surface marking and truck location on the test surface.....	7
7.2 Positioning of the test apparatus.....	8
7.3 Measurement of the masking.....	8
7.3.1 General.....	8
7.3.2 Measurement in travelling condition.....	8
7.3.3 Measurement in manoeuvring condition.....	9
7.3.4 Measurement in pick-and-place condition.....	11
7.4 Fork arm visibility.....	11
8 Calculation method and computer simulation	11
8.1 Calculation method.....	11
8.2 Computer simulation.....	12
9 Evaluation method and performance criteria	12
9.1 Visibility performance criteria on sector A.....	12
9.2 Visibility performance criteria for the RB.....	12
9.3 Visibility maskings that exceed the visibility performance criteria with direct view.....	13
9.4 Fork arm visibility criteria.....	13
10 Test reports	13
10.1 Truck details.....	13
10.2 Drawing.....	13
11 Information for use	13
Annex A (informative) Light bulb spacing dimensions	14
Annex B (informative) Performance criteria for indirect visibility devices	15
Annex C (informative) Procedure for the determination of maskings at the sector A or the RB	16
Annex D (informative) Examples of drawings for the test report	18

Bibliography 21

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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 documents 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).

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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.

This document was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 4, *Rough-terrain trucks*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 150 *Industrial Trucks – Safety*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 18063 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.

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 organisations, 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 at 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.”

Acknowledging that, at the time of publication, the requirements included in this document do not represent the state of the art, a transition period of 24 months is permitted after the date of publication, such that manufacturers can develop their products sufficiently to meet the requirements of this standard.

The purpose of this document is to address the operator's visibility in such a manner that the operator can see around the slewing rough-terrain variable-reach truck to enable proper, effective and safe operation that can be quantified in objective engineering terms. This document includes a test method that uses two lights placed at the location of the operator's eyes. The maskings due to the truck, its components and attachments and a standard test load are determined around the truck, starting at a boundary line 1 m away from the smallest rectangle that encompasses the truck out to the visibility test circle. The radius of the circle is 12 m. The method used does not capture all of the aspects of the operator's visibility but provides information to assist in determining the acceptability of visibility from the truck. Criteria are included in this document to provide guidance for designers as to the extent of visibility maskings that are acceptable.

Due to the truck's capability and the intended operation mode of the truck, the test method is divided into 4 tests representing the main utilisation:

- driving between 2 work sites, at high speed: visibility is checked in the front sector of the 12m boundary. Crab steering and 4-wheel steering are not permitted at high speed, so there is no need to check visibility at the sides of the truck, neither at the rear-side;
- pick-and-carry: manoeuvring and slewing at low speed on work site, with possible crab or 4-wheel steering, in both forward and backward direction. The risk is then in close proximity of the truck and visibility is checked at 1 m rectangular boundary all around the truck except for trucks with an operating mass greater than 20 tons or a maximum lift height above 20 m, where the distance is greater than 1 m to the front of the truck;

- pick-and-place: slewing the upper structure at low speed, the truck being on stabilisers (if any) in static position. The risk is in close proximity of the boom and/or the tail. The test can be performed in any position of the upper structure, and this document considers the worst case, i.e. when in forward aligned position. Therefore, visibility is checked at 1 m rectangular boundary except for trucks with an operating mass greater than 20 tons or a maximum lift height above 20 m, where the distance is greater than 1 m to the front of the truck;
- on forks: the market is now offering trucks with long reach (up to 40 m and more). Visibility to the forks is then of high importance to ensure visibility to the overall front size of the truck.

For the eye spacing, adjustments (up to the limits specified in [Tables 1](#) and [2](#)) can be made considering that the operator has the capability to turn their head and move their body torso side to side. The eye spacings used are less than the maximum permitted values based on the ergonomics of the operator. This is done to maintain the current state-of-the-art of trucks.

Standard test loads are carried on devices on the truck during the visibility tests. They are intended to be dimensionally representative of typical loads carried by slewing rough-terrain variable-reach trucks and are used to determine their masking effects and to define representative boom geometry of the truck in normal uses.

The established visibility performance criteria are based on the physical aspects of the human operators and ground personnel using various representative dimensions and the design of trucks that have provided acceptable visibility. To establish the visibility criteria, a combination of the eye spacings and masking widths are used. Multiple maskings in sectors are acceptable where there is adequate spacing between the individual maskings. Where the direct visibility is considered inadequate, additional devices for indirect visibility [mirrors or closed-circuit television cameras (CCTV)], can be used to achieve acceptable visibility. For the rectangular boundary (RB) additional devices for indirect visibility (mirrors or CCTV) are preferred. Other aids (see ISO 16001) can be used exceptionally.

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Rough-terrain trucks — Visibility test methods and their verification —

Part 2: Slewing rough-terrain variable-reach trucks

1 Scope

This document applies to slewing rough-terrain variable-reach trucks (hereinafter referred to as trucks) as defined in ISO 5053-1:2020, 3.22, that have a specific seated operator's position, on the left-hand side of the boom, or centre position (excluding operator position on the right side of the boom).

This document specifies a static test method for determining and evaluating the operator's visibility on a rectangular boundary close around the truck and on a 12 m visibility test circle. Performance requirements for visibility are specified in this document. A calculation method or computer simulation can also be used.

This document does not provide performance requirements for the additional means for indirect visibility.

This document also covers information to be provided by the manufacturer.

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 5053-1:2020, *Industrial trucks — Vocabulary — Part 1: Types of industrial trucks*

ISO 5353:1995, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point*

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

ISO 10896-2:2016, *Rough-terrain trucks — Safety requirements and verification — Part 2: Slewing trucks*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010, ISO 10896-2:2016, ISO 5053-1:2020 and the following apply.

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

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

3.1

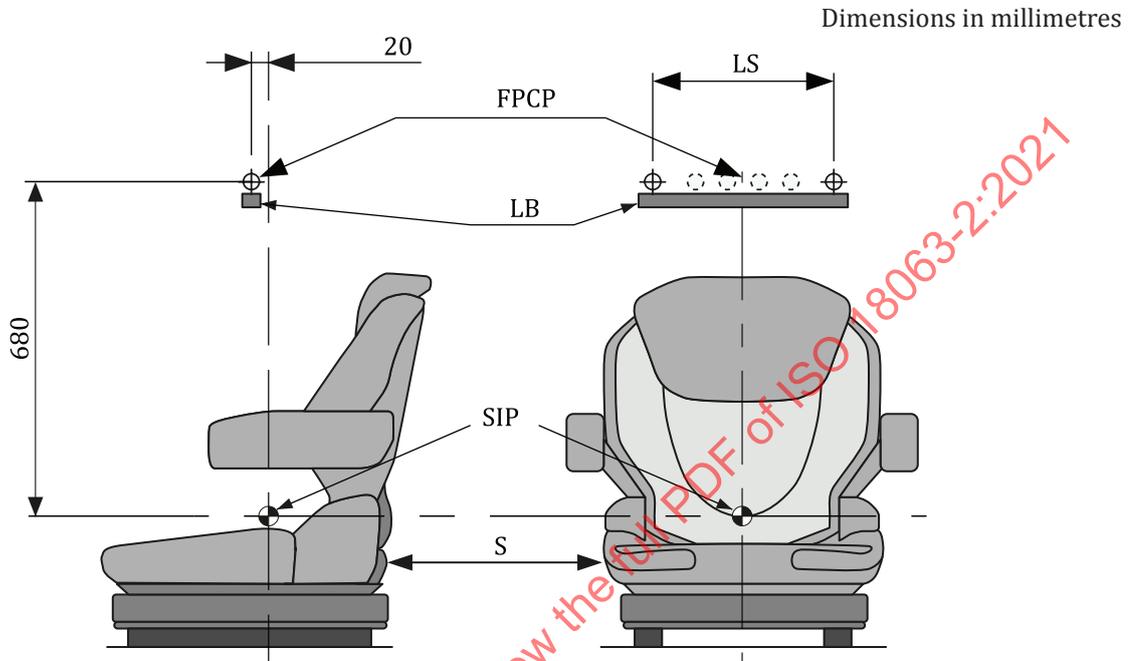
test surface

area of compacted earth or firm surface that forms the ground reference plane for the visibility measurements, with a gradient of no more than 3 % in any direction

**3.2
filament position centre-point
FPCP**

centre at the midpoint of the line between the light-bulb filaments, located 680 mm above and 20 mm in front of the seat index point (SIP) as described in ISO 5353:1995

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



- Key**
- FPCP filament position centre-point
 - LB light bar
 - LS light bulb spacing
 - SIP seat index point
 - S seat

Figure 1 — Light source apparatus

**3.3
visibility test circle
VTC**

circle with 12 m radius located on the ground reference plane with its centre vertically below the filament position centre point (3.2)

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

**3.4
rectangular boundary
RB**

line on the ground reference plane located at 1 m distance from the test machine boundary (3.5), except for trucks with an operating mass greater than 20 tons or a maximum lift height above 20 m, where the distance is greater than 1 m to the front of the machine

Note 1 to entry: See [Figure 2](#) and [Figure 6](#).

3.5
test machine boundary
TMB

outermost truck rectangular boundary, the truck being on wheels with stabilizers fully retracted and the upper structure in front aligned position, including forks and excluding mirrors and lighting devices

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

3.6
sector A

segment of the visibility test surface to the front of the truck, defined by a 9,5 m chord length for the 12 m radius that is perpendicular to the longitudinal plane passing through the *filament position centre point* ([3.2](#)) with the chord length bisected by the longitudinal plane

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

3.7
masking

shadow on *sector A* ([3.6](#)) or on the *rectangular boundary* ([3.4](#)) created because parts of the base truck and/or the *test load* ([3.9](#)) cover the light rays from both of the light bulb filaments

Note 1 to entry: Parts that can cause maskings include, e.g. rollover protective structures (ROPS), window and door frames, exhaust pipes, the engine hood and equipment, such as the boom, the test load

3.8
light source apparatus

test unit intended to simulate the position of the operator eyes, and the possible movements of his head

3.9
light bulb spacing

distance between the vertical centre axis of the considered light-bulb filaments

Note 1 to entry: Information about light bulb spacing can be found in [Annex A](#).

3.10
light bar

rigid support on which the light bulbs are fixed and aligned

3.11
visibility performance criteria

criteria for the design of trucks to enable an operator to see objects in the area around the truck during truck operation and specified as maximum allowed *maskings* ([3.4](#)) at the *sector A* ([3.6](#)) or at the *rectangular boundary* ([3.4](#))

3.12
test load

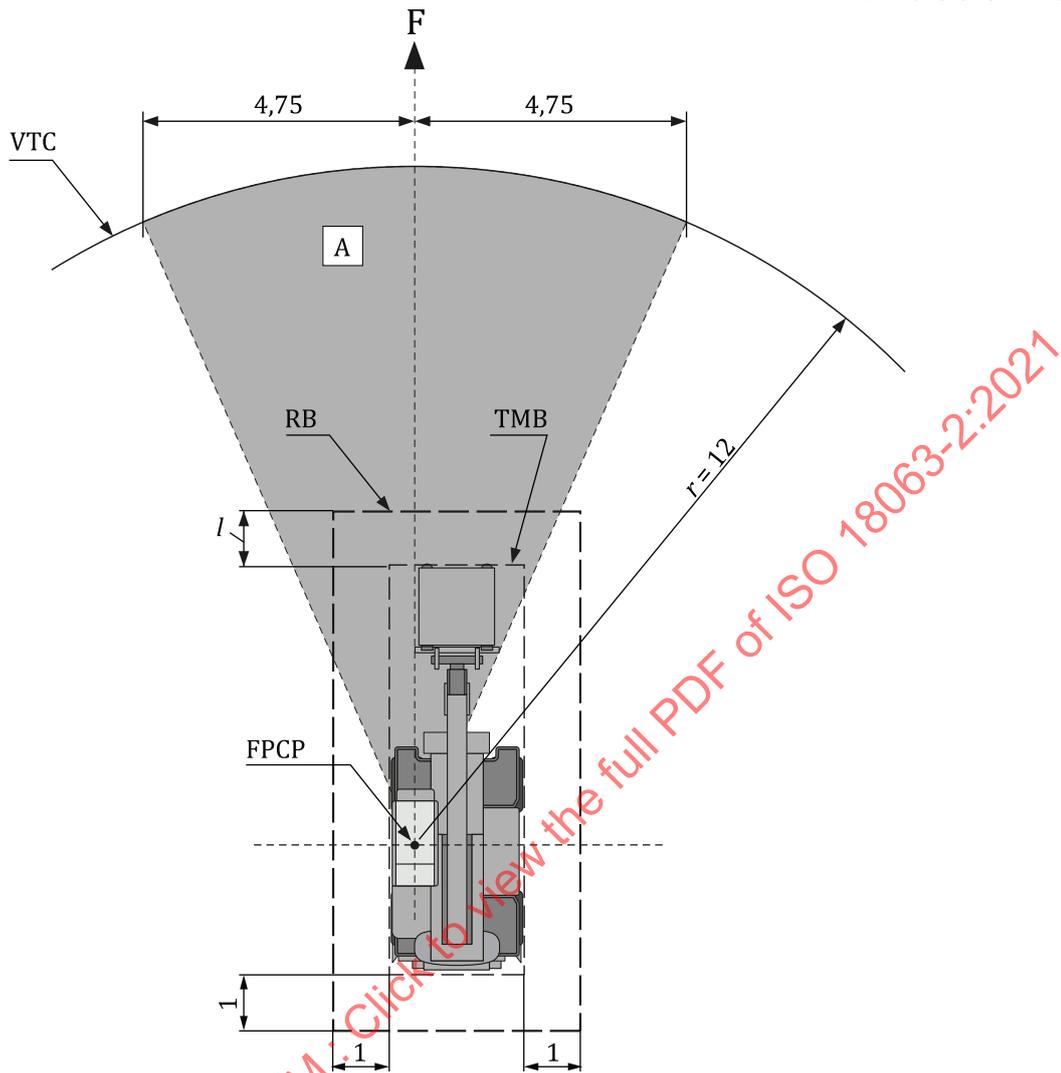
simulated load used for the purpose of visibility tests intended to be dimensionally representative of typical loads which might be carried by the truck in normal use

3.13
direct visibility

visibility by direct line to the light source

3.14
indirect visibility

visibility with the aid of mirrors or with other aids, e.g. close-circuit television (CCTV), fitted to the truck



Key

- | | | | |
|---|--|------|--------------------------------|
| F | forward direction | FPCP | filament position centre-point |
| A | sector A | RB | rectangular boundary |
| l | distance from the front of the test load to the rectangular boundary | TMB | test machine boundary |
| r | radius of the visibility test circle | VTC | visibility test circle |

Figure 2 — Visibility test circle and rectangular boundary

4 Basic dimensions

4.1 Light bulb spacing dimensions

The light bulb spacing shall conform to [Tables 2](#) and [3](#).

4.2 Masking dimensions

Maximum masking dimensions for each test are given in [Tables 2](#) and [3](#).

4.3 Reference dimensions for the measurement

This document specifies the following three reference dimensions for measurement:

- 1 m, the distance used in conjunction with the rectangular boundary line around the truck and test load to describe the near field (closest distance) around the truck;
- 1,5 m, the maximum height above the ground reference plane on which a visibility observation in the near field is made, based on the height of 5 % of the truck operators;
- 12 m, the radius of the visibility test circle on a horizontal surface measured from the filament position centre-point.

5 Test apparatus

5.1 Test load

A test load shall be available for the tests. It shall have the characteristics according to [Table 1](#).

Table 1 — Test load characteristics

Truck rated capacity kg	Test load dimensions (height × width × depth) (mm)
	Fork mounted test load
≤5 000	825 × 1 200 × 1 000 ^a
>5 000	1 200 × 1 200 × 1 200

^a Simulating an EN 13698-2:2003 pallet with 4 × 200 mm high EN 13545: 2002 pallet collars.

The test loads shall not permit transmission of light through their surfaces which can affect the visibility test results.

5.2 Light source apparatus

A light source apparatus shall be available for the tests. It shall be able to position a light bar horizontally with two lights (e.g. H5-type 60W or equivalent) mounted with the bulbs vertically. Each light bulb shall be horizontally movable on the light bar from 102,5 mm up to 202,5 mm on each side of the filament position centre-point. It shall be possible to rotate the light bar through 360° around the filament position centre point. The filament position centre point shall be located 680 mm above and 20 mm in front of the seat index point (SIP) as described by ISO 5353:1995 (see [Figure 1](#)).

5.3 Vertical test object

A vertical test object shall be available for the tests. It shall be 1,5 m high, 100 mm wide, used to evaluate the maskings on the rectangular boundary. It is considered as a two-dimensional object, without depth. It shall be maintained substantially perpendicular to the test surface throughout the tests.

5.4 Observation mirror

An observation mirror shall be available for the tests. It shall be used to detect the line-of-sight between the light source and the ground reference plane or vertical test object, in order to determine the maskings on sector A or on the rectangular boundary. It shall have a maximum size of 100 mm × 150 mm.

6 Truck test configuration

6.1 Equipment of the truck

The truck shall be equipped with standard fork arms according to the manufacturer's standard specification appropriate for the dimensions of the test load specified in [Table 1](#).

6.2 Openings

All truck openings, such as doors and windows, shall be closed.

6.3 Position of the truck and load handling attachment

6.3.1 General

The truck in forward aligned position shall be positioned on the test surface with the filament position centre point vertically above the visibility test circle centre point. The front side of the truck shall be directed to sector A.

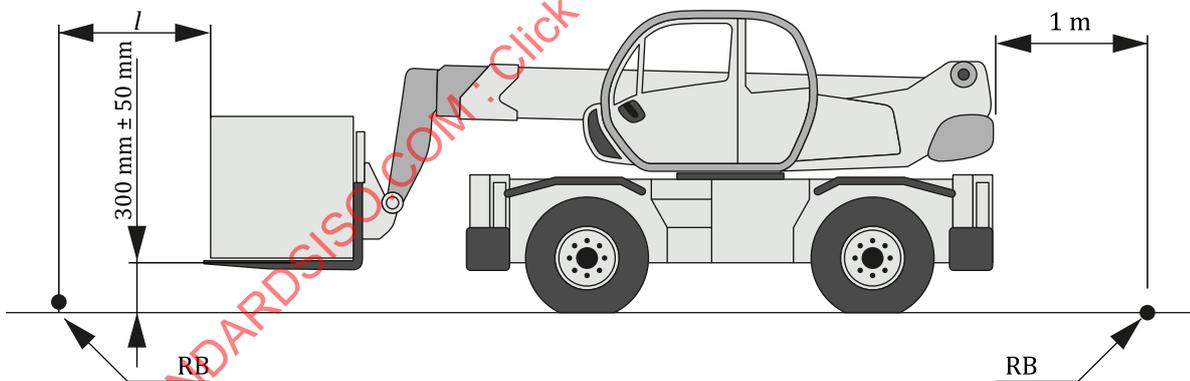
6.3.2 Test simulating manoeuvring

The truck shall be on tyres, and the upper structure in forward aligned position.

The test load shall be positioned centrally (laterally) and rearwards (longitudinally) on the forks.

The boom shall be fully retracted, and its height adjusted so that the upper face of the forks above and substantially parallel to the test surface is $300 \text{ mm} \pm 50 \text{ mm}$. A rearward tilt of $<5^\circ$ is acceptable (see [Figure 3](#)).

NOTE The test load can be lifted on a pallet.



Key

l distance from the front of the test load to the rectangular boundary

RB rectangular boundary

Figure 3 — Test simulating manoeuvring - Truck and load position

6.3.3 Test simulating travel

The truck shall be on tyres, and the upper structure in forward aligned position.

The boom shall be fully retracted, and its height adjusted so that the upper face of the forks above and substantially parallel to the test surface is $300 \text{ mm} \pm 50 \text{ mm}$. A rearward tilt of $<5^\circ$ is acceptable (see [Figure 4](#)).

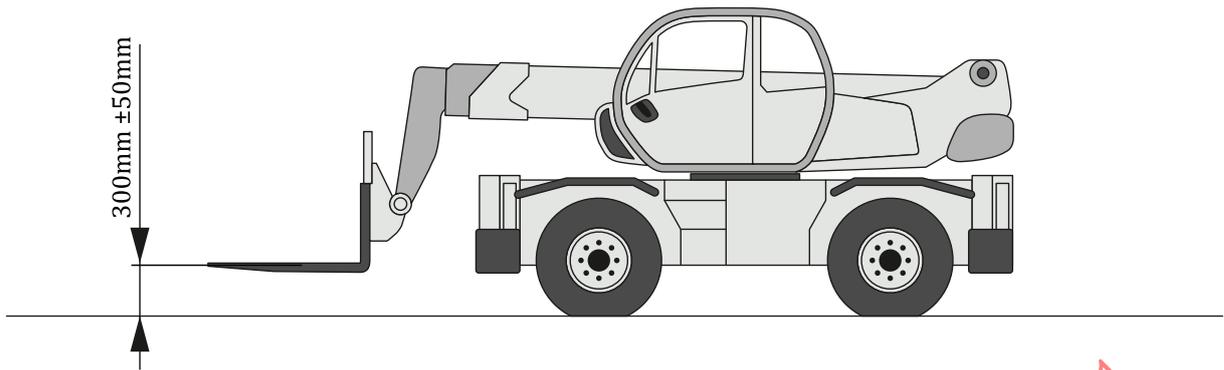


Figure 4 — Test simulating travel - truck position

6.3.4 Test simulating pick-and-place

The truck shall be on stabilisers fully deployed, and the upper structure in forward aligned position.

The boom shall be fully retracted, and the angle of the boom shall be adjusted as defined in 7.3.4 (see Figure 5).

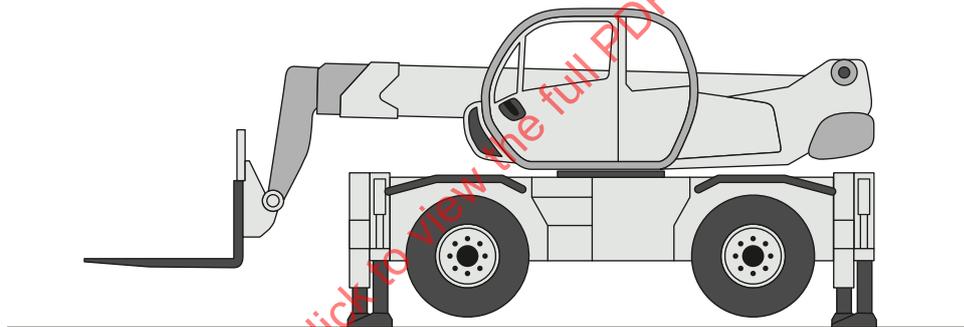


Figure 5 — Test simulating pick-and-place - truck position

7 Measurement procedure

7.1 Test-surface marking and truck location on the test surface

7.1.1 Mark a visibility test circle of 12 m radius on the test surface with the two centrelines as shown in Figure 2. Mark the centre-point of the visibility test circle to enable accurate alignment of the truck (see 6.3.1).

7.1.2 Mark where the sector A intersects the line of the circle on the test surface as shown in Figure 2.

7.1.3 Position the fork mounted load and adjust the boom and forks as defined in 6.3.2.

NOTE RB remains the same for all tests and is measured and set as illustrated in Figure 2 and Figure 3

7.1.4 Mark the test machine boundary (TMB) as shown in Figure 2.

7.1.5 Mark the rectangular boundary (RB) on the test surface at a distance of 1 m from the test machine boundary, as shown in [Figure 2](#).

For trucks with an operating mass greater than 20 t or a maximum lift height above 20 m, the distance of the rectangular boundary (RB) to the front of the machine shall be 2 m.

7.2 Positioning of the test apparatus

7.2.1 Mount the light source apparatus with the FPCP as described in [5.2](#).

7.2.2 For the sector being evaluated, the light bulb spacing shall be in accordance with [Table 2](#) and [Table 3](#) and shall be symmetrical to the FPCP. Where using 205 mm or 405 mm spacing, in order to minimize the masking effects, these do not need to be symmetrical to the FPCP, provided that each bulb is between 102,5 mm and 202,5 mm (in accordance with [Tables 2](#) and [3](#)) from the FPCP.

7.2.3 To take measurements, rotate the light bar so that the line between the two light sources is perpendicular to the line between the FPCP and the edge of the visibility masking component. This first point denotes the start of the masking. Continue to rotate the light bar to the next edge of the visibility masking component i.e. where the masking ceases to occur.

7.2.4 The light source may be moved toward the load centre by up to 300 mm and above/below 150 mm except for travelling condition.

7.3 Measurement of the masking

7.3.1 General

As a first step, all measurements shall be made considering the direct visibility.

A masking shall be evaluated with respect to the criteria defined in [Tables 2](#) and [3](#). If a masking lies on more than one RB side, each portion shall be assessed separately according to the RB side where it lies.

As a second step, additional devices like mirrors or CCTV may be incorporated in the measurements to conform to the visibility performance criteria if required. If when having incorporated additional devices a direct visibility masking is broken into two or more parts, the remaining masking portions shall be re-evaluated with respect of the relevant RB side in which the remaining masking lies (see [9.3](#)).

For defining the indirect visibility for mirrors, use the same measurement procedure as for direct visibility to measure and record the reflection of the light source in the mirrors to the rectangular boundary. Use the same light bulb spacing as specified in [7.3.3](#) for the rectangular boundary for the RB sides where the mirror is located.

The measurements shall be made for each of the test configurations specified in [6.3.2](#), [6.3.3](#) and [6.3.4](#)

Where a mirror is used to take measurements, the masking points on sector A and on RB shall be marked where the light source is cut off at the centre of the mirror.

7.3.2 Measurement in travelling condition

Visibility shall be measured at the VTC in sector A in normal travel mode without load as defined in [6.3.3](#). See [Figure 4](#).

Adjust the light bulb spacing as specified in [Table 2](#) for the relevant sector. Position the light source as described in [7.2.2](#) and [7.2.3](#).

Record the masking in sector A on the ground reference plane, so that the cord length of the masking on the visibility test circle can be determined.

When a truck has two or more vertical components that are near each other, a light bulb spacing less than the maximum specified for the sector may be used to determine the minimum masking (see also 7.2.2).

The requirements for a minimum spacing between two adjacent masking as specified in 9.1 shall be considered.

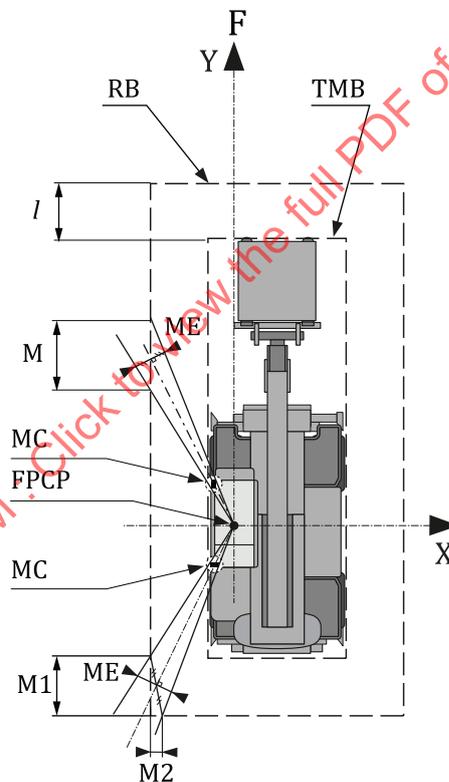
If a masking exists at the visibility test circle in sector A record the measurements.

Do not record masking that have a width of less than 100 mm.

NOTE The test can be carried out in a dark environment where the shadows of truck components can be directly noted on the visibility test circle, or a mirror located on the test surface or the vertical test object can be used to develop a line of sight to the filament to determine the point where masking occurs.

7.3.3 Measurement in manoeuvring condition

Visibility shall be measured at the RB in normal pick-and-carry mode with load as defined in 6.3.2 (see Figure 3).



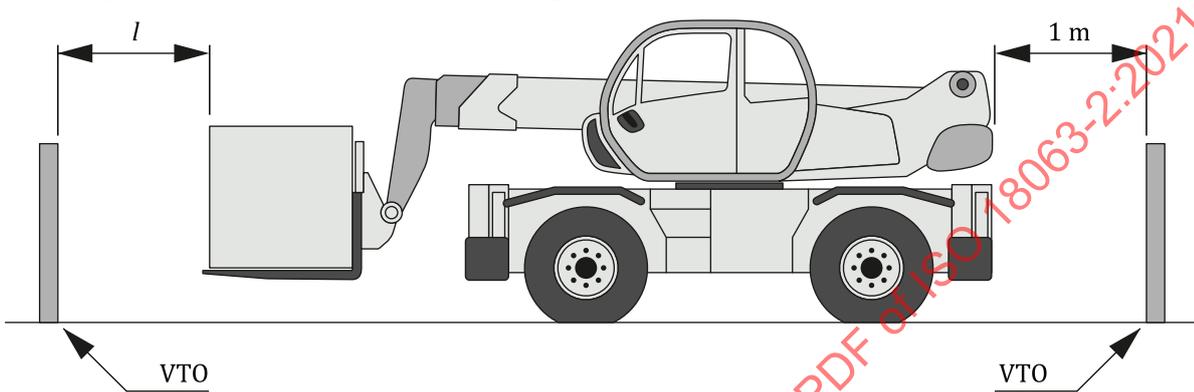
Key

F	forward direction	MC	masking component
FPCP	filament position centre point	ME	masking effective length perpendicular to light source
M	masking	RB	rectangular boundary
M1	masking on one side of the RB, adjacent to another masking M2 on another side of the RB	TMB	test machine boundary
M2	masking on one side of the RB, adjacent to another masking M1 on another side of the RB	l	distance from the front of the test load to the rectangular boundary

Figure 6 — Measurement at the rectangular boundary

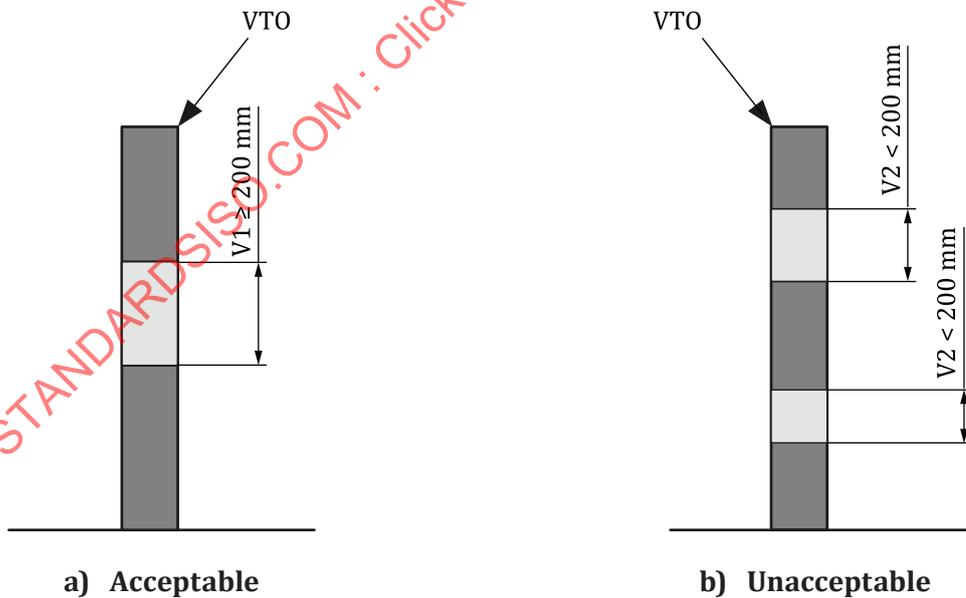
The measurement shall be made with light bulb spacing up to 405 mm on the RB perpendicular to the maskings for determination of the actual masking in the near field vision area. Use the vertical test object as specified in 5.3 and as illustrated in Figure 7 and Figure 8 check along the RB. Mark on the RB where the direct view to the light source is masked by truck parts. Record the maskings with their x and y coordinate. If the masking width, M , exceeds 300 mm on the RB, measure the width ME (masking effective length, see Figure 6) of the masking perpendicular to the light source; see Figure 6. Record ME as the width of the masking.

If the top of the surface of the vertical test object is masked, then the vertical test object may be considered visible if the observation mirror (or equivalent) can direct the light source for a continuous 200 mm height of the vertical test object (see Figure 8).



- Key**
 l distance from the front of the test load to the rectangular boundary
 VTO vertical test object

Figure 7 — Position of the VTO at the rectangular boundary



- Key**
 VTO vertical test object
 V1 visibility ≥ 200 mm anywhere on the VTO
 V2 visibility < 200 mm not adjacent

Figure 8 — Observation of the vertical test object

NOTE The visibility on the vertical test object below the 1,5 m height can be checked by using a mirror moved up and down the test object.

When a truck has two or more vertical components that are near each other, a light bulb spacing less than the maximum may be used to determine the minimum masking (see also [7.2.2](#)).

7.3.4 Measurement in pick-and-place condition

Visibility shall be measured at the RB, in normal pick-and-place mode with load as defined in [6.3.4](#) (see [Figure 5](#)).

Tests shall be first carried out with the boom angle at 45° to define visibility in pick-and-place condition.

NOTE A 45° boom angle is considered as typical condition for this mode.

As a second step, the range of angle of the boom to the horizontal plane for which the visibility is affected on the right side of the RB shall be determined.

The measurement shall be made with light bulb spacing up to 405 mm on the RB perpendicular to the maskings for determination of the actual masking in the near field vision area. If the vertical projection of the upper structure does not exceed from the chassis at the rear of the machine, then there is no risk of hitting obstacles when slewing, therefore no measurement is necessary on this side of the RB.

Use the vertical test object as specified in [5.3](#) and check along the rectangular boundary as illustrated in [Figure 6](#) and [Figure 7](#). Mark on the RB where the direct view to the light source is masked by truck parts. Record the maskings with their x and y coordinates. If the masking width, M , exceeds 300 mm on the RB, measure the width ME (masking effective length, see [Figure 6](#)) of the masking perpendicular to the light source. Record ME as the width of the masking.

If the top of the surface of the vertical test object is masked, then the vertical test object may be considered visible if the observation mirror (or equivalent) can direct the light source for a continuous 200 mm height of the vertical test object (see [Figure 8](#)).

If visual aids are added to fulfil these requirements, direct visibility shall not be affected by the presence of the visual aids according to [Table 2](#) and [Table 3](#).

7.4 Fork arm visibility

Use the machine configuration described in [6.3.3](#) (without test load), using standard specification forks as described by the manufacturer, and the light source apparatus with light bulb spacing of up to 405 mm. The forks shall be positioned as follow:

- the external edge of the fork arm is 450 mm from the longitudinal centre plane of the carriage;
- the fork arms are horizontal and up to 150 mm from the ground.

Move observation mirror (or equivalent) along upper face of fork to detect the light source. An observation mirror is not necessary if the fork arm is directly illuminated by the light source.

8 Calculation method and computer simulation

8.1 Calculation method

If calculation is used as an alternative method to the tests, it shall give equivalent results.

[Annex C](#) gives an example of calculation method for symmetrical eye spacing.

8.2 Computer simulation

Computer-simulation based on the principles specified in this document may be used to determine the visibility masking and provide results for the test report. The computer-simulation shall give equivalent results to the tests.

9 Evaluation method and performance criteria

9.1 Visibility performance criteria on sector A

The space between any two adjacent masking on sector A of the visibility test circle shall be equal to or greater than 700 mm. If this is not the case, the two masking and the space between them shall be combined to result in one reported masking.

The truck meets the requirements of this document if the measurement results show no masking or masking smaller than or equal to the performance criteria with direct view only, as specified in [Table 2](#).

Table 2 — Visibility performance criteria on visibility test circle

Test configuration	Sector
	A
Test in normal travel mode without load (see 6.3.3)	
All types of trucks	Maximum allowed light bulb spacing: 205 mm. Only one masking up to 1500 mm shall be allowed.

9.2 Visibility performance criteria for the RB

The truck meets the requirements of this document if the measurement results show no masking or masking smaller or equal to the acceptable masking as shown in [Table 3](#).

Table 3 — Visibility performance criteria on RB

Test configuration	Sides of the RB	
	Front side of RB	Sides of RB other than the front side
Manoeuvring condition with load (see 6.3.2)		
	Maximum allowed light bulb spacing: 405 mm No masking more than 500 mm. Only one masking greater than 300 mm and up to 500 mm shall be allowed and in this case the result shall be reported in the information for use.	Maximum allowed light bulb spacing: 405 mm No masking more than 300 mm. A gap of minimum 300 mm is required between 2 maskings
Pick-and-place condition without load (see 6.3.4)		
	Maximum allowed light bulb spacing: 405 mm No masking more than 300 mm when the boom angle is 45°. A gap of minimum 300 mm is required between 2 maskings. When the boom is at angles less than 45°, if maskings greater than 300 mm exist, the angle range shall be reported in the information for use [see Clause 11 , e)].	

9.3 Visibility maskings that exceed the visibility performance criteria with direct view

If the direct view does not conform to the performance criteria specified in 9.2 for the rectangular boundary the visibility provided by the following additional devices shall be provided:

- incorporate the indirect view provided by mirrors;
- incorporate the view provided by additional visual aids, e.g. CCTV.

The truck meets the requirements of this document if the visibility with the additional devices conforms to the performance criteria in Table 3 and in 9.2.

9.4 Fork arm visibility criteria

There shall be visibility to at least the full width of one fork tip.

10 Test reports

10.1 Truck details

The test reports shall include the following information:

- a) the business name and full address of the manufacturer and, where applicable, their authorized representative;
- b) the designation of the truck (model, commercial name);
- c) serial number;
- d) any other information that affects the visibility measurements;
- e) pictures (or illustration) of the truck configuration for the visibility test.

10.2 Drawing

For each test configuration, a drawing shall illustrate the test results including the maskings (dimensions in millimetres) on the sector A with the specific light bulb spacing (see Annex D). The distance between maskings and their positions shall be provided. Also, the masking without visibility aids at the RB line shall be provided.

11 Information for use

The manufacturer shall provide an instruction handbook in accordance with ISO 12100:2010, 6.4.5, which contains the following to minimize the residual visibility hazards:

- a) recommendation that the operator survey his/her field of vision when operating the truck;
- b) information regarding the position, setting, use and maintenance of mirrors or visual aids (CCTV), when provided;
- c) information that modifications of the truck can affect the operator's visibility;
- d) information that attachments can affect the operator's visibility;
- e) the boom angle range for which visibility is affected at the RB in pick-and-place condition.

Annex A (informative)

Light bulb spacing dimensions

The light bulb spacings are derived from the following operator physical characteristics:

- 205 mm, the light bulb spacing that represents the range of eye movement (considering body torso and head movement) of 50 % of operators as described in ISO 3411:2007 when looking to a 45° angle to the rear (135° clockwise or anti-clockwise from straight ahead position);
- 405 mm, the light bulb spacing that represents the range of eye movement (considering body torso and head movement) of 50 % operators as described in ISO 3411:2007 when looking to the front (90° clockwise and anti-clockwise from the straight-ahead position).

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Annex B (informative)

Performance criteria for indirect visibility devices

B.1 Performance criteria for mirrors

For indirect visibility to the rectangular boundary around the truck, mirrors should have at least a convex radius of curvature as follows:

- 200 mm radius for up to 2,5 m from filament position centre point;
- 300 mm radius for up to 3,5 m from filament position centre point;
- 400 mm radius for up to 5 m from filament position centre point.

B.2 Performance criteria for object detection systems (ODSs) and visibility aids (VAs)

The object detection systems (ODSs) and visibility aids (VAs) should conform to ISO 16001:2017.

Annex C (informative)

Procedure for the determination of maskings at the sector A or the RB

The specified simulation procedure provides an alternative to the test method.

For binocular vision with an eye spacing, d_1 , the masking, b_1 , expressed in millimetres, is given by [Formula \(C.1\)](#) (see also [Figure C.1](#)):

$$b_1 = \frac{(b_2 - d_1)}{d_2} \times r + d_1 \quad (\text{C.1})$$

where

- b_1 is the width of the masking tangent to the visibility test circle or masking effective length on the rectangular boundary, in millimetres;
- b_2 is the width of the component causing the maskings, measured horizontally, and perpendicular to the radius from the light-bulb filament position centre-point and the centre of the component, in millimetres;
- d_1 is the distance between the light-bulb filaments, used to represent binocular vision with this eye spacing, in millimetres;
- d_2 is the distance between the component causing the masking and the light-bulb filament, in millimetres;
- r is the radius from the light-bulb filament position centre-point on the test surface to the visibility test circle on the test surface or to the rectangular boundary, in millimetres.

NOTE [Formula \(C.1\)](#) is an approximate calculation of the masking and becomes less accurate as the length of the masking increases, but it provides acceptable accuracy for masking widths up to 5 m without verification by physical measurement.