INTERNATIONAL STANDARD

ISO 5006

First edition
2006-11-01

Earth-moving machinery — Operator's field of view — Test method and performance criteria

Engins de terrassement — Visibilité du conducteur — Méthode d'essai et critères de performance

Reference number
ISO 5006:2006(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5006 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety requirements and human factors*.

This first edition of ISO 5006 cancels and replaces ISO 5006-1:1991, ISO 5006-2:1993 and ISO 5006-3:1993, which have been technically revised.

Introduction

The purpose of this International Standard is to address operator's visibility in such a manner that the operator can see around the machine to enable proper, effective and safe operation that can be quantified in objective engineering terms. This International Standard includes a test method that uses two lights placed at the location of the operator's eyes. The maskings due to the machine, its components and attachments are determined around the machine, on a boundary line 1 m away from the smallest rectangle that encompasses the machine and on the visibility test circle. The radius of the circle is 12 m. The method used doesn't capture all of the aspects of operator's visibility, but provides information to assist in determining the acceptability of visibility from the machines. Criteria are included in this International Standard to provide guidance for designers as to the extent of visibility maskings that are acceptable.

Because of the operator's capability and the operation mode of the machines, the test method divides the area around the machine into six sectors: the front (sector A), to the front sides (sectors B and C), to the rear sides (sectors D and E), and to the rear (sector F).

For each of the sectors, the operator has physical characteristics that are considered. Besides the eye spacing of 65 mm (the nominal binocular eye spacing of the 50th percentile operator), additional adjustments can be made considering that the operator has the capability to turn the head and move the body torso side to side. This allows the range of eye spacing to be enlarged up to 405 mm for the sectors A, B and C. For the sectors D, E and F, the turning of the operator's head and the rotation of the body torso are restricted by the physical aspects for seated operator. Thus, the maximum achievable eye spacing is 205 mm for sectors D, E, and F. For certain machine types, 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 machines.

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 machines 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 1 m boundary (RB) additional devices for indirect visibility (mirrors or CCTV) are preferred. Other aids (see ISO 16001) can be used exceptionally.

Jobsite organization can be an additional effective measure to compensate for remaining visibility maskings.

Earth-moving machinery — Operator's field of view — Test method and performance criteria

1 Scope

This International Standard specifies a static test method for determining and evaluating the operator's visibility on a rectangular 1 m boundary close around the machine and on a 12 m visibility test circle.

This International Standard applies to the earth-moving machines listed in Table 1 and as defined in ISO 6165 that have a specific seated operator's position. For machines not listed in Table 1, including larger machines, derivative earth-moving machines and other types of earth-moving machines, the visibility test procedures can be used — see 10.4.

It applies to earth-moving machines for operation on work sites and for travelling on public roads.

This International Standard provides visibility performance criteria for machines up to a maximum operating mass (see ISO 6016) depending on the type of machine family (see Table 1).

2 Normative references

The following referenced documents are indispensable for the application 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 3411, *Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope*

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

ISO 6016, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 7135, *Earth-moving machinery — Hydraulic excavators — Terminology and commercial specifications*

ISO 16001, *Earth-moving machinery — Hazard detection systems and visual aids — Performance requirements and tests*[1)]

1) To be published.

3 Terms and definitions

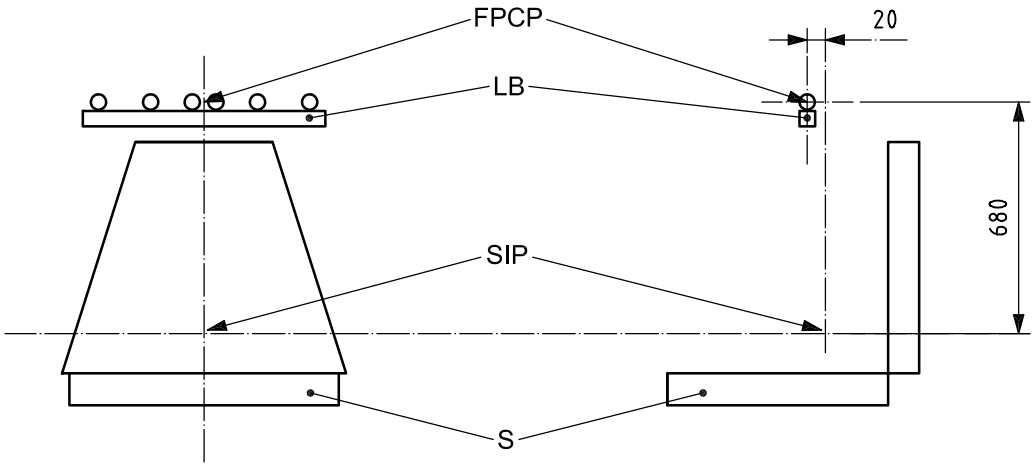
For the purposes of this document, the following terms and definitions apply.

3.1
test surface
area that forms the ground reference plane for the visibility measurements

3.2
filament position centre-point
centre at the midpoint of the line between the light-bulb filaments

See Figure 1.

Dimensions in millimetres



Key

LB	light bar
SIP	seat index point
S	seat
FPCP	filament position centre point

Figure 1 — Light source apparatus

3.3 Visibility test locations

3.3.1
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

See Figure 2.

3.3.2
rectangular 1 m boundary
RB
line on the ground reference plane located at 1 m distance from the outside rectangular boundary of the machine, except for articulated dumpers, where the distance is greater than 1 m to the front of the machine and graders where the distance to the rear of the machine is greater than 1 m

See Figure 2 and 8.3.3.

3.3.3
sector of vision A
segment of the visibility test surface to the front of the machine, 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 with the chord length bisected by the longitudinal plane

See Figure 2.

3.3.4
sectors of vision B and C
segments of the visibility test surface to the front of the machine outside sector A and bounded by the transverse plane through the filament position centre point

See Figure 2.

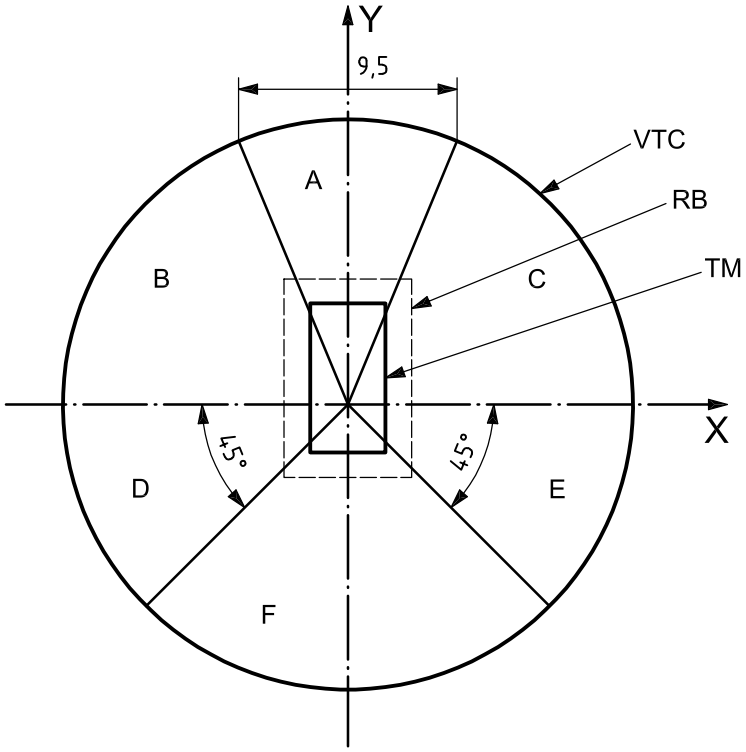
3.3.5
sectors of vision D and E
segments of the visibility test surface to the rear defined by an angle of 45° to both the right and left sides of the longitudinal plane passing through the filament position centre point

See Figure 2.

3.3.6
sector of vision F
segment of the visibility test circle to the rear between sectors D and E

See Figure 2.

Dimensions in metres



Key

VTC	visibility test circle
RB	rectangular 1 m boundary
TM	test machine
Y	forward direction of machine
A, B, C, D, E, F	sectors of vision

Figure 2 — Visibility test locations

3.4
masking
shadow on the 12 m visibility test circle or the vertical test object at the rectangular 1 m boundary created because parts of the base machine and/or its equipment block the light rays from both of the light bulb filaments

NOTE Parts that can cause maskings include, e.g. rollover protective structures (ROPS), window and door frames, exhaust pipes, the engine hood and equipment or attachment, such as bucket, boom.

3.5
light source apparatus
test unit with at least two light sources, 360° rotateable, with its rotation point at the filament position centre point

See Figure 1.

3.6
visibility performance criteria
criteria for the design of earth-moving machinery to enable an operator to see objects in the area around the machine during machine operation and travelling

NOTE These visibility performance criteria are specified as maximum allowed maskings at the 12 m visibility test circle or at the rectangular 1 m boundary.

3.7
jobsite organization
rules and procedures for the jobsite that coordinate machines and people working together

EXAMPLE Safety instructions, traffic patterns, restricted areas, operator and jobsite training, machine and vehicle marking (e.g. special warning lights, warning signs), restrictions on travelling in reverse, communication systems, etc.

3.8 Direct and indirect visibility

3.8.1
direct visibility
visibility by direct line of sight as determined by the light from the light source

3.8.2
indirect visibility
visibility with the aid of mirrors or with other visual aids, such as closed circuit TV (CCTV)

3.9
derivative earth-moving machine
machine modified or fitted with equipment and/or attachments that influence visibility as compared with the standard configuration of the machine

4 Basic dimensions

4.1 Light spacing dimensions

This International Standard specifies the following three light spacings:

a) 65 mm, the light spacing that represents the binocular eye spacing of 50 % seated earth-moving machinery operators (see ISO 3411);

b) 205 mm, the light spacing that represents the range of eye movement (considering body torso and head movement) of 50 % of earth-moving machine operators (see ISO 3411) when looking to a 45° angle to the rear (135° clockwise or anti-clockwise from straight ahead position);

c) 405 mm, the light spacing that represents the range of eye movement (considering body torso and head movement) of 50 % earth-moving machine operators (see ISO 3411) when looking to the front (90° clockwise and anti-clockwise from the straight ahead position).

4.2 Masking dimensions

This International Standard specifies a 300 mm masking dimension for the rectangular 1 m boundary line that represents approximately the chest depth of personnel working in the near field of earth-moving machinery.

4.3 Reference dimensions for the measurement

This International Standard specifies the following three reference dimensions for measurement:

a) 1 m, the distance used in conjunction with the rectangular 1 m boundary line around the earth-moving machinery to describe the near field (closest distance) around earth-moving machinery;

b) 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 earth-moving machinery operators.

c) 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 Light source apparatus, capable of positioning a light bar horizontally with two halogen light bulbs (or equivalent) mounted with the bulbs vertically. Each light bulb should be horizontally movable on the light bar from 32,5 mm up to 202,5 mm on each side of the light bar centre point. It shall be possible to rotate the light bar through 360° about the filament position centre point. The vertical centre point of the light bulb filaments shall be located 680 mm above and 20 mm in front of the seat index point (SIP) as defined by ISO 5353 (see Figure 1).

5.2 Vertical test object, 1,5 m high, with a suitable width (e.g. 150 mm), used to evaluate the maskings on the rectangular 1 m boundary.

5.3 Test surface, an area of compacted earth or paved surface with a gradient of no more than 3 % in any direction.

5.4 To determine the maskings on the visibility test circle or the rectangular 1 m boundary, a hand held **mirror** can be used to detect the line-of-sight between the light source and the ground reference plane or vertical test object. Other apparatus giving equivalent results is permitted.

6 Machine test configuration

6.1 The machine shall be equipped with attachment(s) and equipment according to the manufacturer's specification for operation on a work site and/or for travelling on public roads.

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

6.3 The machine shall be positioned on the test surface with the equipment and attachments located in the travel mode according to the manufacturer's specification — see examples in Annex A. The filament position centre point, as defined in 3.2, shall be vertically above the visibility test circle centre point. The front side of the machine shall be directed to sector A.

6.4 The earth-moving machinery operator's seat shall be positioned such that there is no restriction or influence on the light source, such as to prevent rotation of the light bar.

7 Performance criteria for additional devices

7.1 Performance criteria for mirrors

For indirect visibility to the visibility test circle, mirrors shall have a convex radius of curvature of 300 mm.

For indirect visibility to the rectangular 1 m boundary around the machine, mirrors shall 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.

NOTE Research to determine viewing distances as a function of mirror radius specifically for earth-moving machines is in progress.

7.2 Performance criteria for CCTV system

The CCTV system shall comply with ISO 16001.

8 Measurement procedure

8.1 Test-surface marking and machine location on the test surface

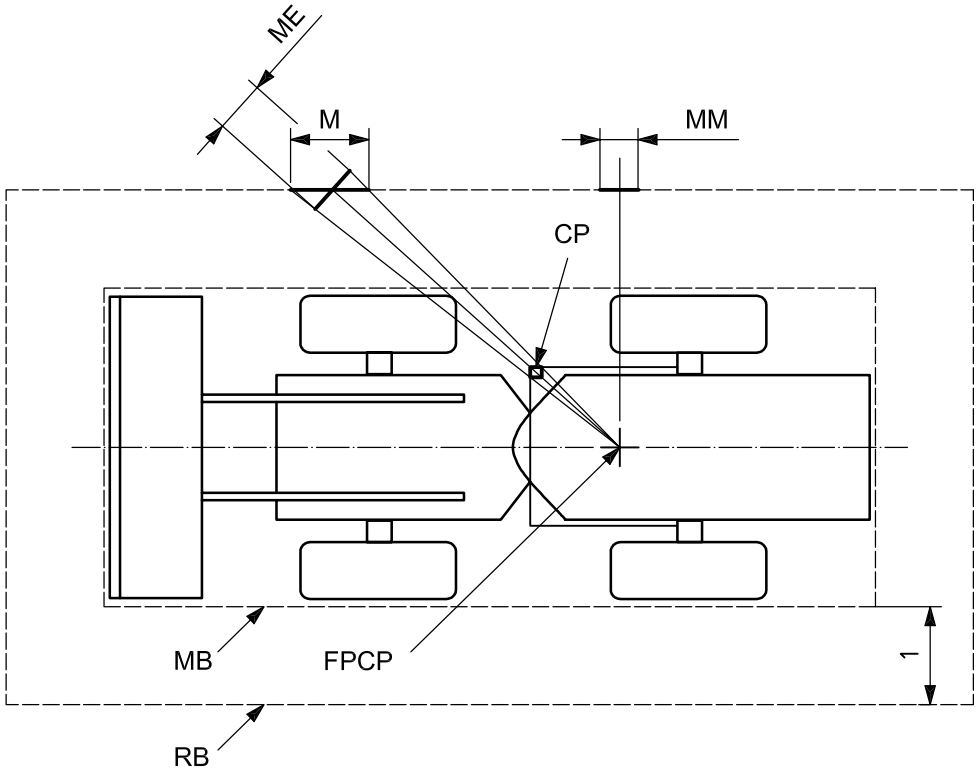
8.1.1 Mark a visibility test circle of 12 m radius on the test surface with the two centrelines as shown in Figure 2.

8.1.2 Mark the sectors A, B, C, D, E and F on the test surface as shown in Figure 2.

8.1.3 Position the machine on the test surface as defined in 6.3.

8.1.4 Mark the rectangular 1 m boundary on the test surface at a distance of 1 m from the smallest rectangle that can be placed around the vertical projection of the machine as shown in Figure 3. For excavators, the rectangular 1 m boundary is measured from the front of the most forward point of the base machine (see ISO 7135) or dozer blade if it is standard — see A.3.

Dimensions in metres



Key

MB	machine boundary
RB	rectangular 1 m boundary (1 m from all four sides except as noted in Table 1)
FPCP	filament position centre point
M	masking length on RB
ME	masking effective length perpendicular to light source
MM	maximum masking is 300 mm
CP	cab post

Figure 3 — Location and maskings on the rectangular 1 m boundary

8.2 Positioning of the test apparatus

8.2.1 Mount the light source with the light bulb filament centre point as defined in 5.1.

8.2.2 The light bulb spacing arrangement with a distance of 65 mm is symmetric to the centre of the light source apparatus. If the allowed light bulb spacings are used up to their maximum values 205/405 mm, the left and right light source can each be positioned in a way that the measurement on the 12 m visibility test circle or the rectangular 1 m boundary minimizes the maskings. During this procedure, it is not necessary that the two light sources be symmetric to the filament position centre point, as long as the maximum distance from the filament position centre point is 102,5 mm or 202,5 mm, as appropriate for the sector being evaluated.

NOTE For machine research and development purposes, the 65 mm light bulb spacing can be used to provide a more detailed evaluation of the maskings around a machine and is recommended for such work.

8.2.3 To take measurements, rotate the light bar so that the line between the two light sources is perpendicular to the line between the filament position centre point, as defined in 3.2, and the centre of the visibility masking component.

8.3 Measurement of the maskings

8.3.1 General

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

In a second step, additional devices like mirrors or CCTV may be incorporated in the measurements to comply with the visibility performance criteria if required.

For defining the indirect visibility for mirrors, use the same measurement procedure as for direct visibility (Clause 7) to measure and record the reflection of the light source in the mirrors to the visibility test circle and the rectangular 1 m boundary. Use the same light-bulb spacing as specified in 8.3.2 for the visibility test circle and in 8.3.3 for the rectangular 1 m boundary for the sectors where the mirror is located.

8.3.2 Measurement at the visibility test circle

Adjust the light-bulb spacing as specified in Table 1 for the relevant sector. Position the light source as defined in 8.2.2 and 8.2.3.

When a masking overlaps adjacent visibility sectors, the masking shall be evaluated in the visibility sector in which the greater part of the masking lies using the light-bulb spacing for each sector as specified in Table 1.

When a machine has two or more vertical components that are near each other, a light-bar spacing less than the maximum specified for the sector may be used to determine the minimum maskings (see also 8.2.2).

The requirements for a minimum spacing between two adjacent maskings as specified in 10.1 shall be considered.

Record the masking at the visibility test circle on the ground reference plane, so that the chord length of the masking on the visibility test circle can be determined.

It is not necessary to record maskings that have a width of less than 100 mm.

For maskings that are wider on the visibility test circle than they are within 1 m (inside and outside) of the visibility test circle (due to some machine component, such as a door latch, cup holder, grab handle), the average of the narrower masking widths at 1 m inside and outside the test circle may be used as the masking width.

NOTE The test can be carried out in a dark environment where the shadows of machine 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.

8.3.3 Measurement at the rectangular 1 m boundary

The measurement shall be made with a 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 5.2 and check along the rectangular 1 m boundary as illustrated in Figure 4. For the front of articulated dumpers and the rear of motor graders, the distance to the RB is specified in Table 1. Mark on the rectangular 1 m boundary where the direct view to the light source is masked by machine parts. Record the maskings with their x and y coordinates. If the masking width (M) exceeds 300 mm on the RB, measure the width of the masking perpendicular to the light source (ME); see Figure 3. Record ME as the width of the masking.

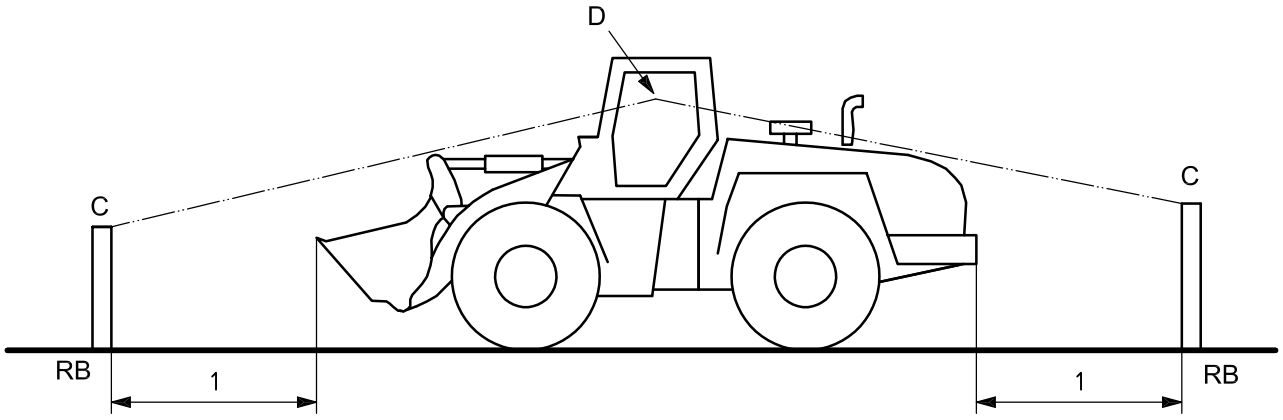
If the top of the vertical test object is masked, check if the vertical test object can be seen at least in a length of 200 mm. If seen, this point (position) on 1 m boundary is not counted for masking evaluation.

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

It is not necessary to record maskings that have a width of less than 200 mm.

When a machine has two or more vertical components that are near each other, a light-bar spacing less than the maximum may be used to determine the minimum maskings (see also 8.2.2).

Dimensions in metres



Key

RB rectangular 1 m boundary
C vertical test object
D light source

Figure 4 — Measurement at the rectangular 1 m boundary

9 Calculation method

9.1 Calculation procedure for the determination of maskings at the visibility test circle or the rectangular 1 m boundary

A calculation procedure can be used for determination of maskings at the visibility test circle or the rectangular 1 m boundary.

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

For binocular vision with an eye spacing, s, the masking, expressed in millimetres, is given by the equation (see also Figure 5):

$$x = \left(\frac{b-s}{a} \right) r + s$$

where

a is the distance between the component causing the masking and the light-bulb filament, in millimetres;

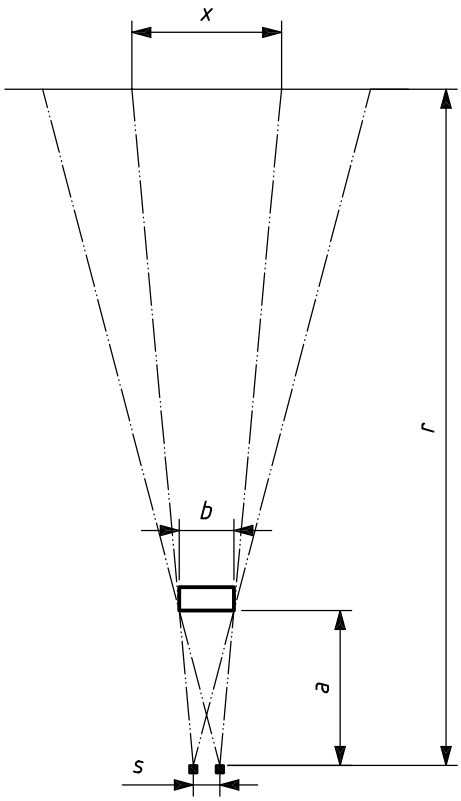
b is the width of the component causing the maskings, measured horizontally, and perpendicular to the radius from the light-bulb filament position centre-point and the centre of the component, in millimetres;

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 1 m boundary, in millimetres;

s is the distance between the light-bulb filaments, used to represent binocular vision with this eye spacing, in millimetres;

x is the width of the masking tangent to the visibility test circle or masking effective length (ME in Figure 3) on the rectangular 1 m boundary, in millimetres.

NOTE This equation 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.



NOTE For a definition of the symbols, see the preceding equation.

Figure 5 — Calculation method for determining maskings

9.2 Computer-simulation

Computer-simulation based on the principles specified in this International Standard may be used to determine the visibility maskings and provide results for the test report.

10 Evaluation method and performance criteria

10.1 Visibility performance criteria on the visibility test circle

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

Adjacent narrow maskings may be combined with the space between them and treated as one larger masking to reduce the number of maskings to be reported.

The machine meets the requirements of this International Standard if the measurement results show no maskings or maskings smaller than or equal to the performance criteria with direct view as specified in Table 1.

NOTE The visibility performance criteria are summarized in Table 1 for the different machine types/masses. The first column of Table 1 defines the type of machine and the class of machine based upon machine mass. The maximum allowed masking widths on the visibility test circle are specified in Table 1 for each machine type/mass. Visibility criteria are specified for sectors A, B, C, D, E and F on the visibility test circle. The first line for each visibility sector specifies the maximum allowed light-bulb filament spacing. The other lines specify the number and maximum width of maskings for each visibility sector.

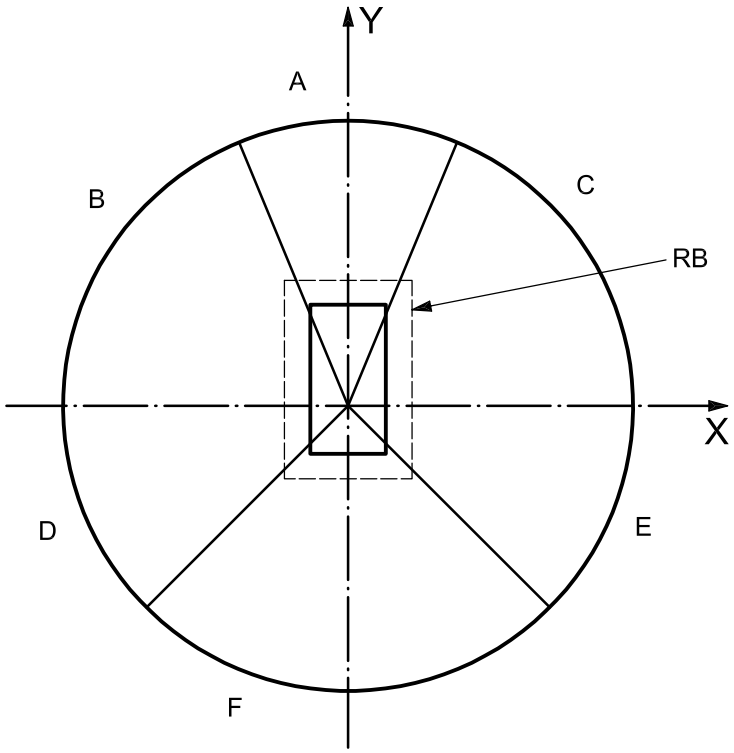
The visibility testing that is done with a 65 mm eye spacing for sectors A, B, and C is for test purposes and does not consider the normal head and eye movement capability of the operator of up to 405 mm. The actual size of the visibility masking as seen by the operator is less than the masking size measured with 65 mm eye spacing. As an example, the measured masking for a cab post that is 160 mm wide and located 570 mm from the filament position centre point would be 2 000 mm for an eye spacing of 65 mm, but the masking would completely disappear with an eye spacing of 205 mm — see Figure 6.

10.2 Visibility performance criteria for the rectangular 1 m boundary

The machine meets the requirements of the standard if the measurement results show no maskings or maskings smaller or equal to the acceptable maskings (300 mm).

Table 1 — Visibility performance criteria

Dimensions in millimetres



The first row for each machine type is the allowed eye spacing. The second row is the allowed number and width of maskings.

Operating (empty) mass according to ISO 6016, m, t	**A**	**B**	**C**	**D**	**E**	**F**	**RB**
Wheel loader							
$m < 10$	65 --- 2 - 700	205 --- 0	205 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	65 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 --- 300
$10 \leqslant m < 25$	65 --- 2 - 700 or 1 - 1 300	205 --- 0	205 --- 0	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 --- 3 - 1300	405 --- 300
$25 \leqslant m \leqslant 30$	405 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 --- 3 - 1 300	405 --- 300
Skid steer loader							
All – Wheeled and crawler	65 --- 0	65 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- (2 - 2 100 and 2 - 1 300) or (2 - 4 000)	---	---	405 --- 300

Table 1 (*continued*)

Operating (empty) mass according to ISO 6016, m, t	A	B	C	D	E	F	RB
Crawler loader							
$m < 20$	65 2 - 700	205 0	205 0	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 300
$20 \leqslant m \leqslant 30$	405 0	205 1 - 700 and 1 - 1 300	205 1 - 700 and 1 - 1 300	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 300
Backhoe loader							
$m \leqslant 15$	65 2 - 700	205 1 - 700 and 1 - 1 300	205 1 - 700 and 1 - 1 300	205 1 - 700 and 1 - 1 300	205 1 - 700 and 1 - 1 300	65 1 - 1 300 and 1 - 3 000	405 300
Wheel excavator							
$m < 10$ front boom	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)			205 0	205 0	65 (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 300
$m < 10$ side boom	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 0	405 1 - 2 500	205 0	205 0	65 (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 300
$10 \leqslant m \leqslant 25$	405 1 - 700 and 1 - 1 300	205 0	405 1 - 700 and 1 - 5 500	205 1 - 700 and 1 - 1 300	 No specific criteria *	65 1xmachine width and 2 - 1 300	405 300
Crawler excavator							
$m < 10$ front boom	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)			205 0	205 0	65 (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 300
$m < 10$ side boom	205 (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 0	405 1 - 2 500	205 0	205 0	65 (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 300
$10 \leqslant m < 25$	405 1 - 700 and 1 - 1 300	205 0	405 1 - 700 and 1 - 5 500	205 1 - 700 and 1 - 1 300	 No specific criteria *	65 1 × machine width and 2 - 1 300	405 300
$25 \leqslant m \leqslant 40$	405m 1 - 700 and 1 - 1 300	205 0	405 1 - 1 600 and 1 - 5 500	205 1 - 700 and 1 - 1 300	 No specific criteria *	65 1 × machine width and 2 - 1 300	405 300

Table 1 (*continued*)

Operating (empty) mass according to ISO 6016, m, t	A	B	C	D	E	F	RB
Rigid-frame dumper							
$m < 10$	65 --- 0	205 --- 0	205 --- 0	205 --- 0	205 --- 0	65 --- 0	405 --- 300
$10 \leqslant m < 20$	65 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	205 --- 0	205 --- 1 - 700 and 1 - 1 300	65 --- 0	405 --- 300
$20 \leqslant m \leqslant 50$	65 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	205 --- 0	--- No specific criteria *	65 --- 3 - 1 300	405 --- 300
Articulated frame dumper							
$m < 25$	65 --- 0	205 --- 0	205 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	65 --- 3 - 1 300	405 --- 300 X = 1 500 see Figure A.5
$25 \leqslant m \leqslant 50$	65 --- 0	205 --- 0	205 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	65 --- 3 - 1 300	405 --- 300 X = 2 500 see Figure A.5
Dumper (front body)							
$m \leqslant 10$	65 --- 0	205 --- 0	205 --- 0	205 --- 0	205 --- 0	65 --- 0	405 --- 300
Crawler dozer							
$m < 10$	205 --- 1 - 700 and 2 - 1 300	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700	205 --- 1 - 700	65 --- 2 - 700 and 1 - 1 300	405 --- 300
$10 \leqslant m \leqslant 18$	405 --- 0	405 --- 0	405 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	65 --- 2 - 700 and 1 - 1 300	405 --- 300
Grader							
$m < 15$	65 --- 2 - 700 and 1 - 1 300	205 --- 0	205 --- 0	205 --- 0	205 --- 0	65 --- 2 - 700 and 1 - 1 300	405 --- 300 y = 2 000 see Figure A.6

Table 1 (*continued*)

Operating (empty) mass according to ISO 6016, m, t	A	B	C	D	E	F	RB
Soil and landfill compactor							
$10 \leqslant m < 25$	65 --- 2 - 700	205 --- 0	205 --- 0	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 --- 3 - 1 300	405 --- 300
$25 \leqslant m \leqslant 35$	405 --- 0	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- (1 - 700 and 1 - 1300) or (1 - 2 000)	65 --- 3 - 1 300	405 --- 300
Roller							
$5 \leqslant m < 10$	65 --- 0	65 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- 1 - 700 and 1 - 1 300	205 --- 1 - 700 and 1 - 1 300	65 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	405 --- 300
$10 \leqslant m \leqslant 25$	65 --- 2 - 700	205 --- 0	205 --- 0	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	205 --- (1 - 700 and 1 - 1 300) or (1 - 2 000)	65 --- 3 - 1 300	405 --- 300
NOTE No specific criteria are specified in this Table when no significant hazards exist for the machine sector, e.g. due to machine speed, distance to the test circle, machine manoeuvrability.							

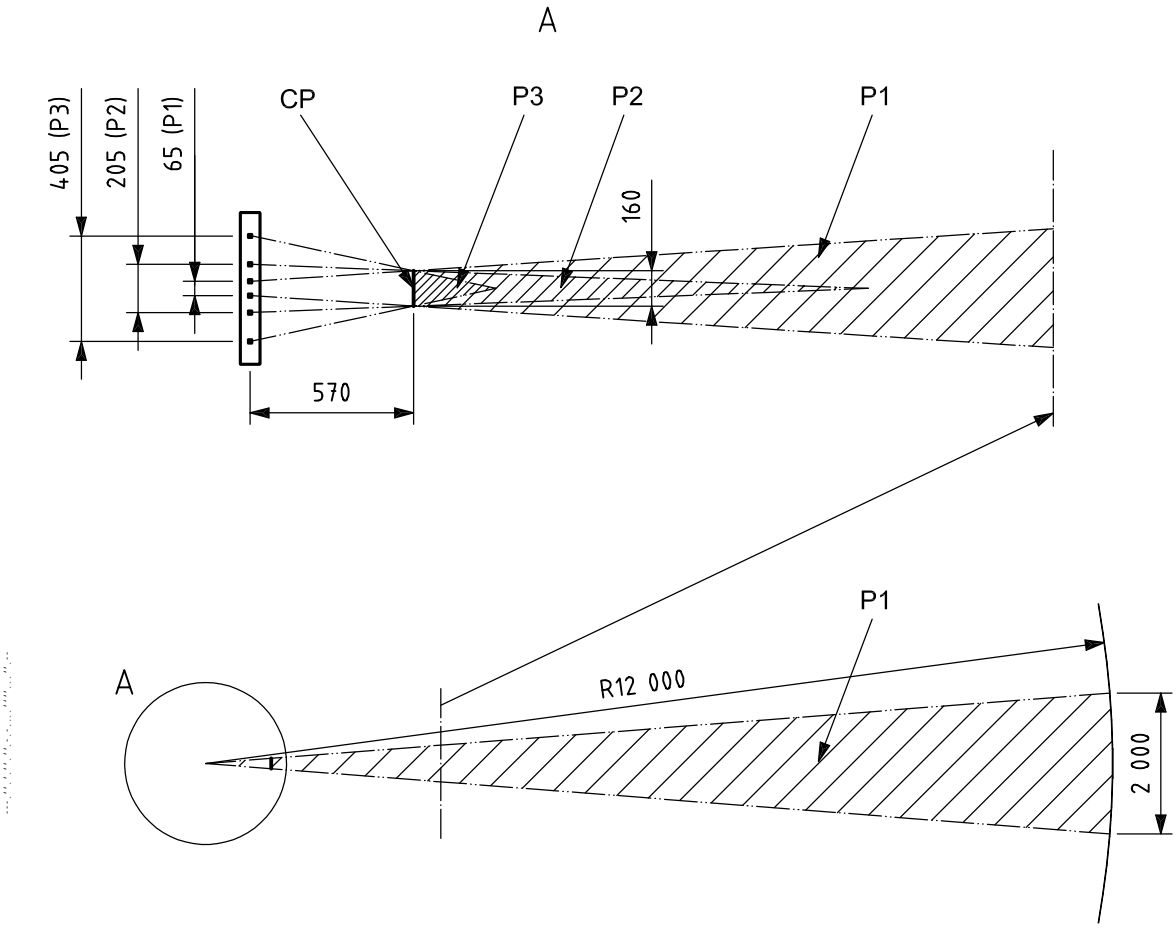
10.3 Visibility maskings that exceed the visibility performance criteria with direct view

If the direct view does not comply with the performance criteria specified in 10.1 for the visibility test circle and in 10.2 for the rectangular 1 m boundary, the visibility provided by the following additional devices shall be considered:

a) incorporate the indirect view provided by mirrors;

b) incorporate the view provided by additional visual aids, e.g. CCTV.

The machine meets the requirements of this International Standard if the visibility with the additional devices complies with the performance criteria in Table 1 and 10.1 and 10.2.



Key

CP cab posts

P1 masking width with 65 mm bulb spacing

P2 masking width with 205 mm bulb spacing

P3 masking width with 405 mm bulb spacing

Figure 6 — Example of masking width versus bulb spacing

10.4 Requirements for larger, derivative and other types of earth-moving machines not covered in Table 1

10.4.1 Larger machines

For machines that are not included in Table 1 due to their machine mass (large size), the manufacturer should apply the tests and criteria as specified in this International Standard. For those machines that do not meet the criteria for the highest specified category of machine mass in the respective machine family, the manufacturer shall consider appropriate technical measures and shall put an imperative indication (i.e. instructions) in the operator's manual that the customer is required to ensure suitable jobsite organization with respect of acceptable visibility and operation of the machine.

For the assessment of derivative and other types of earth-moving machines, the visibility test circle radius may be larger (preferably 24 m) and with maskings, increased in proportion to the ratio of the radius.

10.4.2 Derivative and other types of earth-moving machines

For other types of earth-moving machines (including a combination of machine families from ISO 6165) or derivative earth-moving machines that are not included in Table 1, the manufacturer should apply the tests and criteria as specified in this International Standard. For those machines, the criteria for the most similar machine type(s) (considering design and use) from Table 1 should be used. If it is not possible for those machines to meet the criteria, the manufacturer shall consider appropriate technical measures and shall put an imperative indication (i.e. instructions) in the operator's manual that the customer is required to ensure suitable jobsite organization in respect of acceptable visibility and operation of the machine.

If the machine has a seat position that is not parallel to the longitudinal centre line of the machine, the eye spacing from Table 1 shall be rotated with the operator. The visibility performance criteria of the different sectors with respect to the longitudinal centre line of the machine shall stay the same.

11 Test report

11.1 Machine details

The test report shall include the following information:

a) manufacture;

b) model;

c) operating (empty) mass according to ISO 6016;

d) product identification number;

e) operator enclosure and/or operator protective structure description or identification;

f) equipment installed on the machine;

g) any other information that affects the visibility measurements;

h) pictures (or illustration) of the machine configuration for the visibility test;

i) record the position dimension(s) (HH and RR) used for the test as illustrated in Annex A.

11.2 Drawing

The drawing shall illustrate the test results of the static test the direct view and the indirect view including the maskings (dimensions in millimetres) on the visibility test circle by the designated visibility sector with the specific light bulb filament spacing. The distance between maskings and their positions shall be provided. Also, the maskings at the rectangular 1 m boundary line shall be provided.

12 Visibility information for the operator’s instructions

The machine operator’s instructions shall contain the following so that the operator can minimize visibility hazards when operating the machine:

a) recommendation that the operator is required to survey his/her field of vision when operating the machine;

b) information regarding the position and the use of mirrors or visual aids (CCTV), when provided;

c) information that for machines specified in 10.4 an appropriate jobsite organization is required to minimize hazards due to restricted visibility;

d) information that modifications of the machine configuration by the user of the machine that result in a restriction of the machine visibility shall be verified according to this International Standard.

Annex A
(informative)

Dimensions and position of HH and RR

A.1 Loader

Bucket in carry position — HH = 300 ± 50 mm.

Dimensions in metres

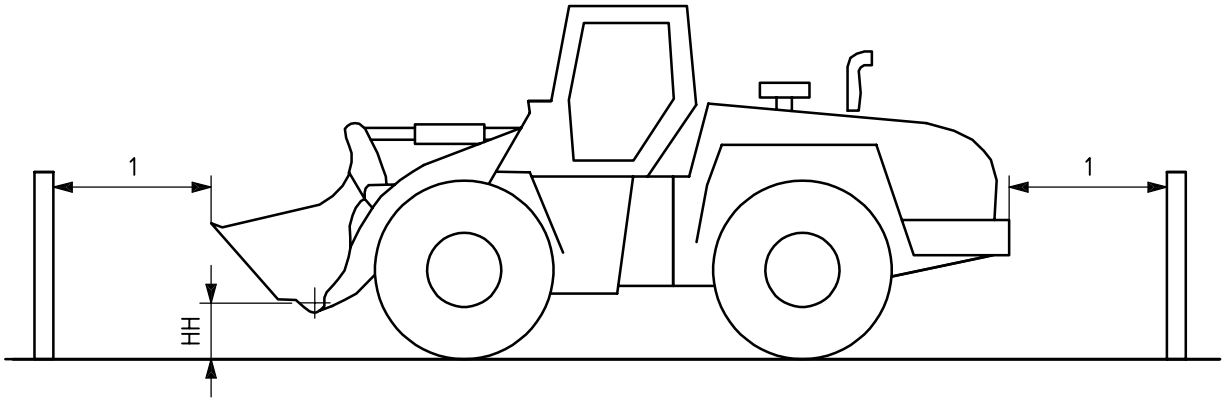


Figure A.1 — Loader

A.2 Backhoe loader

Loader bucket in carry position — HH = 300 ± 50 mm. The smallest rectangle around the machine with the backhoe bucket in carry position (for both centre pivot and side-shift) is used for determining the position of the rectangular 1 m boundary.

Dimensions in metres

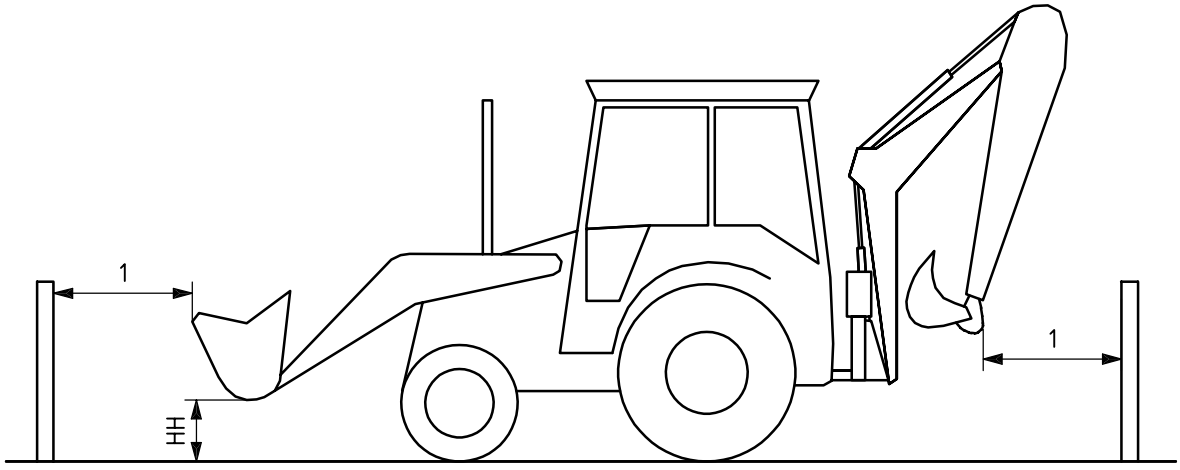


Figure A.2 — Backhoe loader

A.3 Excavators

Position as shown. Front of track or the dozer blade (whichever is the furthest forward) is used for determining the position of the rectangular 1 m boundary around the base machine, including the blade if it is standard (see ISO 7135).

Dimensions in metres

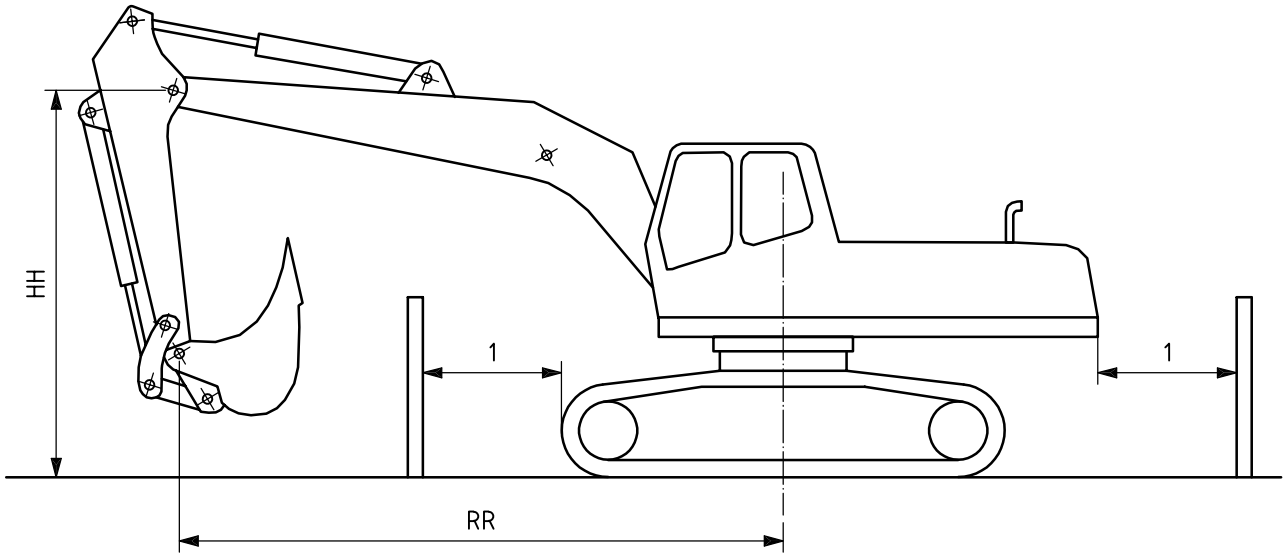


Figure A.3 — Excavator

A.4 Rigid-frame dumper

Dimensions in metres

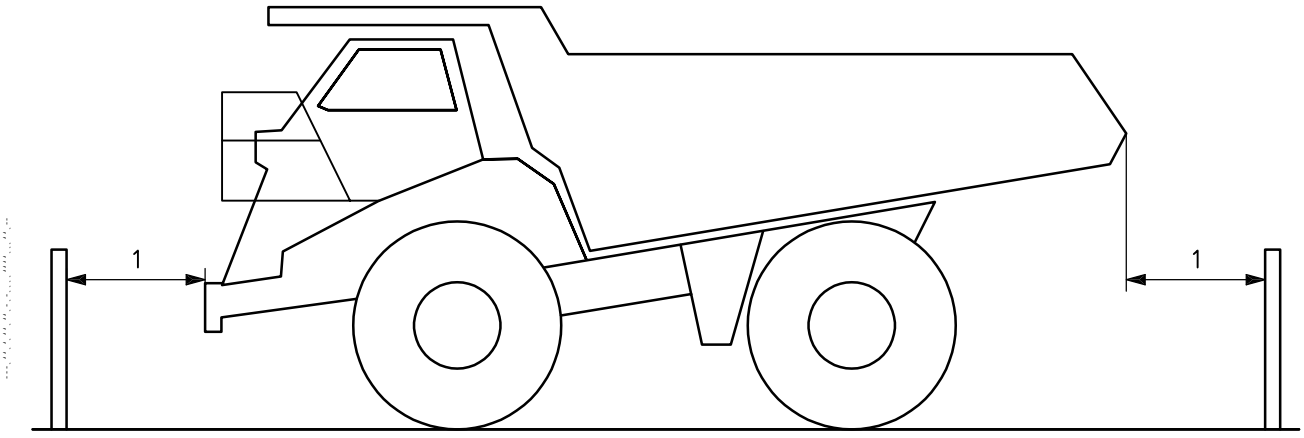


Figure A.4 — Rigid-frame dumper

A.5 Articulated-frame dumper

See Table 1 for X dimension. The 1 m dimension on the rear also applies to the sides of the machine.

Dimensions in metres

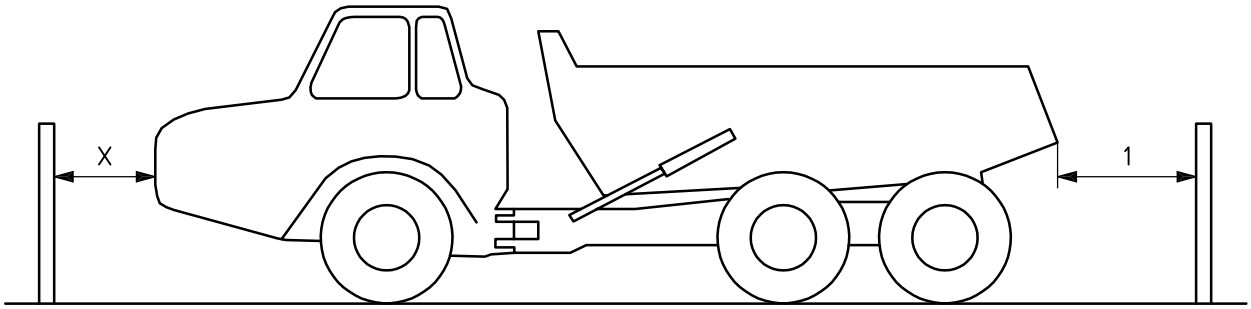


Figure A.5 — Articulated-frame dumper

A.6 Grader

All blades 50 mm ± 50 mm above the ground reference plane.

See Table 1 for Y dimension. The 1 m dimension on the front also applies to the sides of the machine.

Dimensions in metres

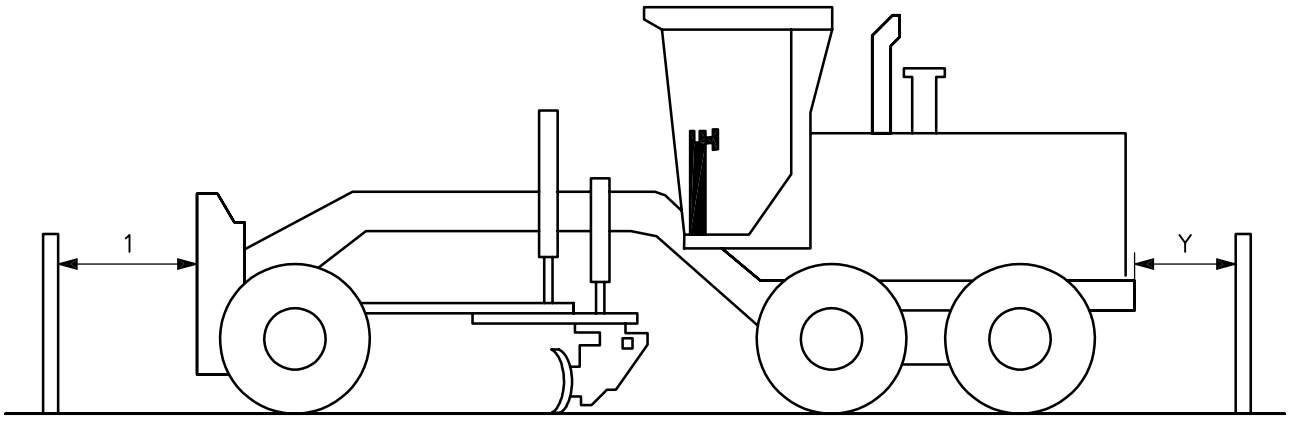


Figure A.6 — Grader

A.7 Compactor

HH = 150 ± 50 mm.

Dimensions in metres

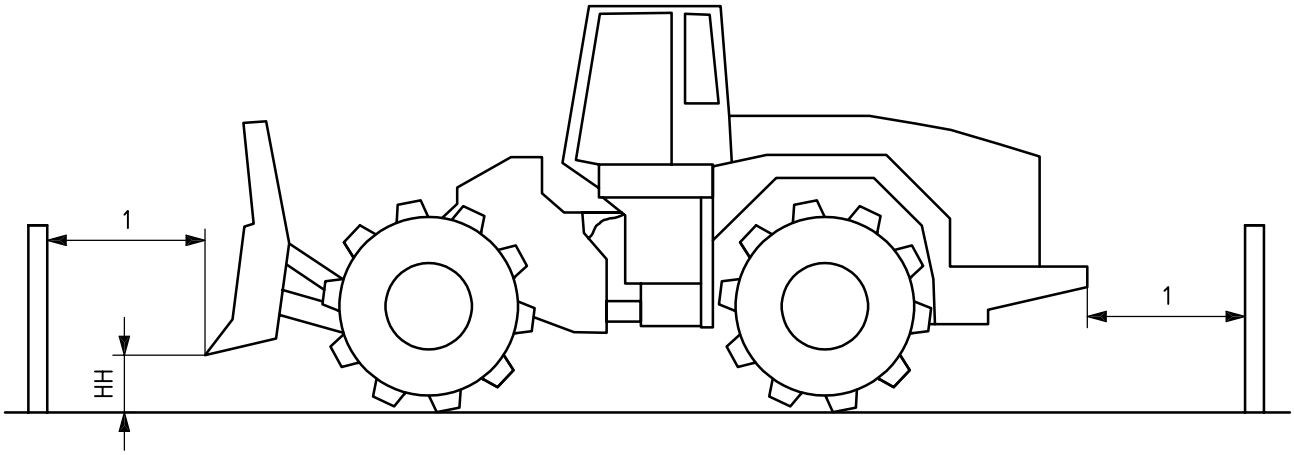


Figure A.7 — Compactor

A.8 Roller

Dimensions in metres

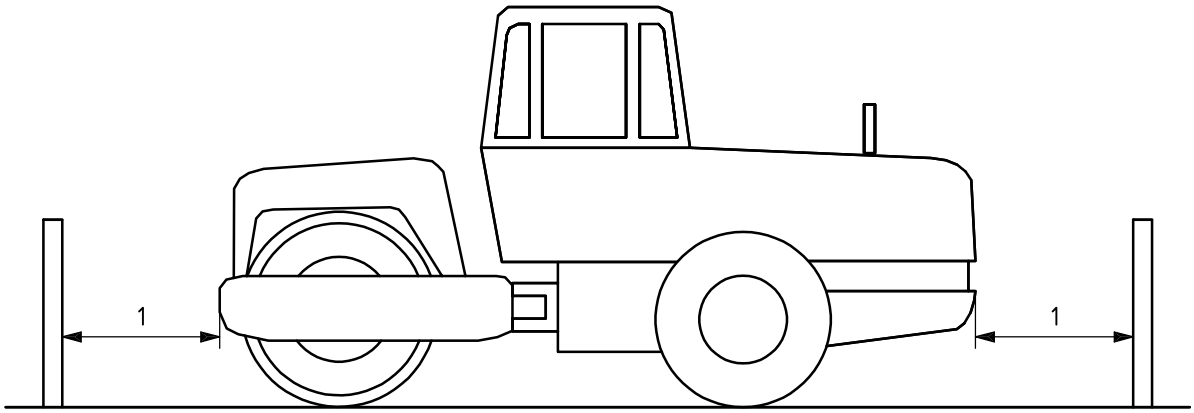


Figure A.8 — Roller

ICS 53.100

Price based on 21 pages