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

Engins de terrassement — Visibilité de l'opérateur — Méthode d'essai et critères de performance

Reference number
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Foreword

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 1, *Test methods relating to safety and machine performance*.

This second edition cancels and replaces the first edition (ISO 5006:2006), which has been technically revised. It also incorporates the Technical Corrigendum ISO 5006:2006/Cor 1:2008. The changes from the previous edition include the following:

— improved guidance on the use of mirrors;

— new guidance on maskings caused by moving excavator linkages;

— enhancement of visibility at the rectangular boundary;

— general improvements and clarifications in the language.

This corrected version of ISO 5006:2017 incorporates the following corrections:

— the second paragraph of 8.3.3.3 has been modified by the deletion of the phrases "in the forward direction" and "at the same height".

Introduction

The purpose of this document is to address the 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. The test method 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 a visibility test circle (VTC) of 12 m radius. The test method used does not include all aspects of the operator's visibility, but provides information to assist in determining the acceptability of visibility from the machine. Criteria are included in this document to provide guidance for designers as to the extent of visibility maskings that are acceptable.

Allowing for operator capability and the operation mode of the machine, 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's physical characteristics are considered. Besides eye spacing of 65 mm — the nominal binocular eye spacing of a medium operator — additional adjustments can be made considering that the operator is able to turn the head and move the body torso from 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 of the 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 300 mm masking dimension on the rectangular boundary represents approximately the chest depth of personnel working in the near field of earth-moving machinery (see, for example, 2D in ISO 3411).

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 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.

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 document specifies a static test method for determining and evaluating the operator's field of view on a rectangular boundary around the machine and on a 12 m visibility test circle (VTC).

It is applicable to the earth-moving machines as defined in ISO 6165 that have a seated operator, and which are intended to operate on work sites and travel on public roads. It provides visibility performance criteria for machines up to the maximum operating mass according to ISO 6016, depending on the type of machine family listed in Table 1. For those machines not listed — including larger machines, derivative and other types of earth-moving machinery — the visibility test procedures can be used along with the risk assessment process defined in 10.4.

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 3411, *Earth-moving machinery — 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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6165 and the following apply.

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

— ISO Online browsing platform: available at http://www.iso.org/obp

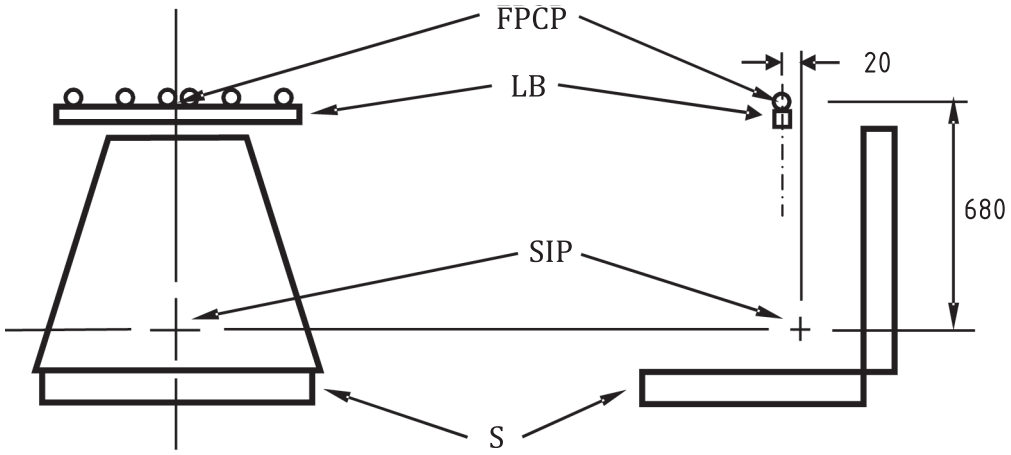
— IEC Electropedia: available at http://www.electropedia.org/

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

3.2
filament position centrepoint
FPCP
midpoint of the line between the light-bulb filaments

Note 1 to entry: 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 *FPCP* (3.2)

Note 1 to entry: See Figure 2.

3.3.2
rectangular boundary
RB
line on the ground reference plane located at 1 m distance from the outside rectangular boundary of the machine, except for articulated-frame 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

Note 1 to entry: 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 *FPCP* (3.2) (X axis) with the chord length bisected by the longitudinal plane (Y axis)

Note 1 to entry: 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 *FPCP* (3.2)

Note 1 to entry: See Figure 2.

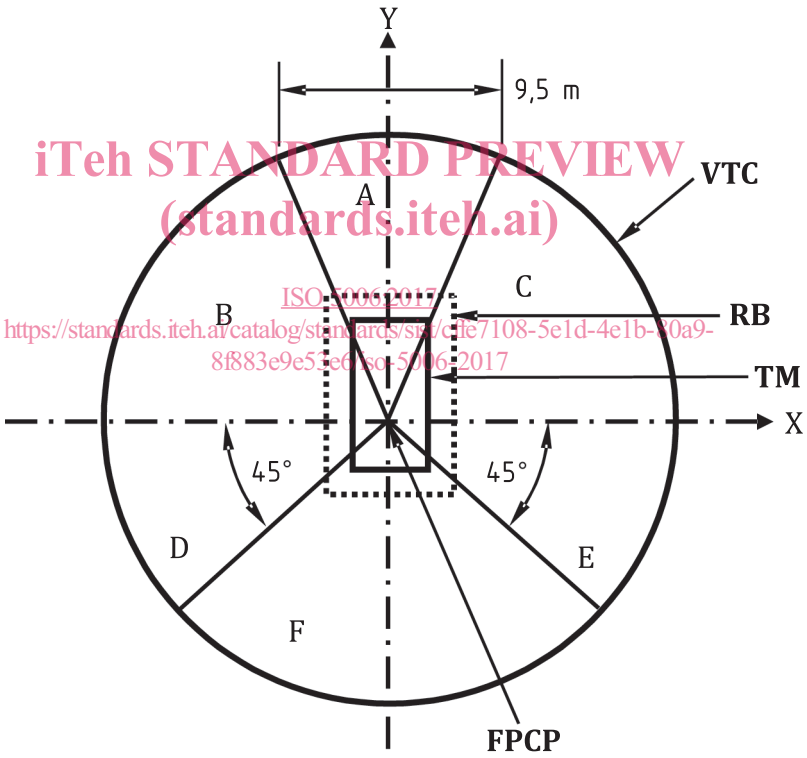
3.3.5
sectors of vision D and E
segments of the visibility test surface to the rear defined by an angle of 45° to both the right and left sides of the transverse plane passing through the *FPCP* (3.2)

Note 1 to entry: See Figure 2.

3.3.6
sector of vision F
segment of the *visibility test circle* (3.3.1) to the rear between sectors D and E

Note 1 to entry: See Figure 2.

Dimensions in metres



Key

VTC	visibility test circle
RB	rectangular boundary
TM	test machine
Y	forward direction of machine
A, B, C, D, E, F	sectors of vision
FPCP	filament position centre point

Figure 2 — Visibility test locations

3.4
masking
shadow on the 12 m *visibility test circle* (3.3.1) or the vertical test object at the *RB* (3.3.2) created because parts of the base machine or its equipment block the light rays from both of the light bulb filaments

Note 1 to entry: Examples of parts that can cause maskings include 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 that have adjustable light spacing, 360° rotatable, with its rotation point at the *FPCP* (3.2), to simulate the range of eye positions for an operator

Note 1 to entry: See Figure 1.

3.6
visibility performance criteria
criteria intended to minimize risk to persons in the vicinity of the machine during machine operation and travelling

Note 1 to entry: These visibility performance criteria are specified as maximum allowed maskings at the 12 m visibility test circle or at the *RB* (3.3.2).

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 (special warning lights, warning signs, etc.), restrictions on travelling in reverse, communication systems.

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 or attachments that influence visibility as compared with the standard configuration of the machine

Note 1 to entry: This definition is different from the one given in ISO 6165.

4 Basic dimensions

4.1 Light spacing dimensions

The following three maximum light spacings for intended machine operations shall be used as specified in Table 1:

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

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

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

4.2 Masking dimensions

The allowable masking dimensions are specified in Table 1.

4.3 Reference dimensions for measurement purposes

The following reference dimensions for measurement shall be used:

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

b) 1,5 m, 1,2 m and 1,0 m, the maximum height above the ground reference plane on which a visibility observation in the near field is made according to Table 2.

NOTE 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 a small earth-moving machinery operator (1,55 m as specified in ISO 3411).

c) 12 m, the radius of the VTC on a horizontal surface measured from the FPCP.

NOTE The 1 m rectangular boundary in a) above has been modified in 8.3.3.1.

5 Test apparatus

5.1 Light source apparatus, capable of positioning a light bar horizontally with at least 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 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 FCCP. 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, 1,0 m,1,2 m, or 1,5 m high, with a suitable width (e.g. 100 mm to 150 mm), used to evaluate the maskings on the RB. See Table 2 for the test object height to be used by machine type, mass, and region of the RB. The 1,5 m test object can also be used for possible mirror evaluation (see 7.3).

5.3 Test surface, an area of firm surface, e.g. compacted earth, concrete, paved surface, with a gradient of not more than 3 % in any direction.

5.4 To determine the maskings on the VTC or the RB, 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 attachments and equipment according to the manufacturer's specification for operation on a work site, travelling on public roads, or both.

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 FPCP shall be vertically above the VTC centre point. The front of the machine shall be directed to sector A. See 8.3.3.3 for additional requirements for excavators.

6.4 The 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. For ease of testing the seat or seat backrest extension may be removed.

7 Performance criteria for indirect visibility

7.1 Visibility aids

In designing machinery, direct visibility shall first be maximized. However, machine design and application can require visibility aids for the operator on many machine types. Visibility aids shall be added where there is insufficient direct visibility to meet the performance requirements in this document.

7.2 Position of display devices

The devices (e.g. CCTV display, mirror) used by the operator to view the area being monitored shall be placed such that they are in the 180° arc centred in front of the operator.

Excavators may have indirect visibility aids (e.g. mirrors) located in the 270° arc centred in front of the operator. Mirrors located behind the operator shall only be so placed to enable the operator to see the area along the sides of the machine or the area to the side of the machine which extends beyond the rear of the machine.

The centre of the mirror shall be used as the reference for mirror location. The mirror locations shall be noted in the test report.

7.3 Performance criteria for mirrors

For indirect visibility with mirrors fitted for the purpose of meeting the performance requirements of this document, the height of the reflection of a 1,5 m test object in the mirror shall be at least 7 mm for every 1,2 m that the mirror is positioned away from the FPCP. As an example, the reflection of a 1,5 m test object shall be at least 28 mm for a mirror located 4,8 m from the operator's FPCP. The mirror performance shall be evaluated at the longest distance from the mirror to the vertical test object that the mirror is intended to be used at. This evaluation may be done by physical testing, simulation or calculation. This evaluation is a linear relationship of distance from the operator eye to the mirror, distance from the mirror to the test object, and the size of the image on the mirror.

NOTE A 1,2 m test object would need to have a 5,6 mm tall reflection for every 1,2 m of viewing distance. Likewise, a 1,0 m test object would need to have a 4,7 mm tall reflection for every 1,2 m of viewing distance.

