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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

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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.

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

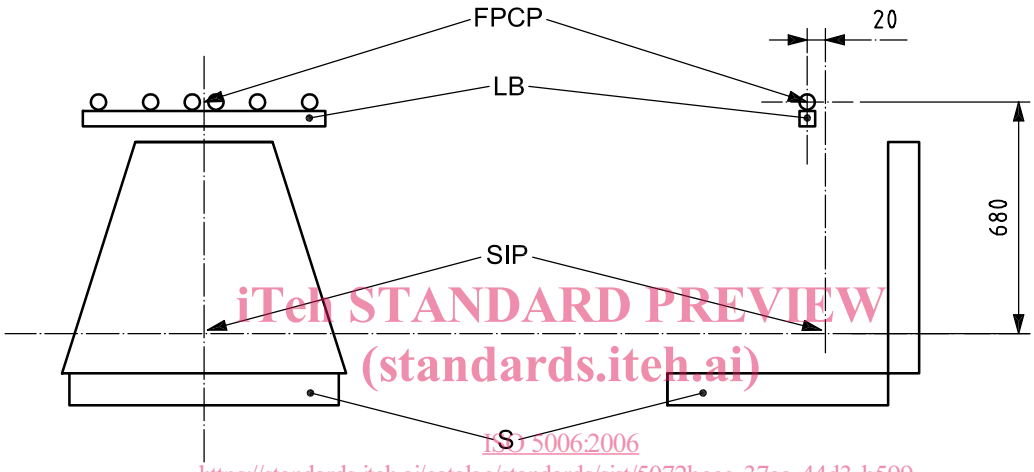
For the purposes of this document, the following terms and definitions apply.

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.

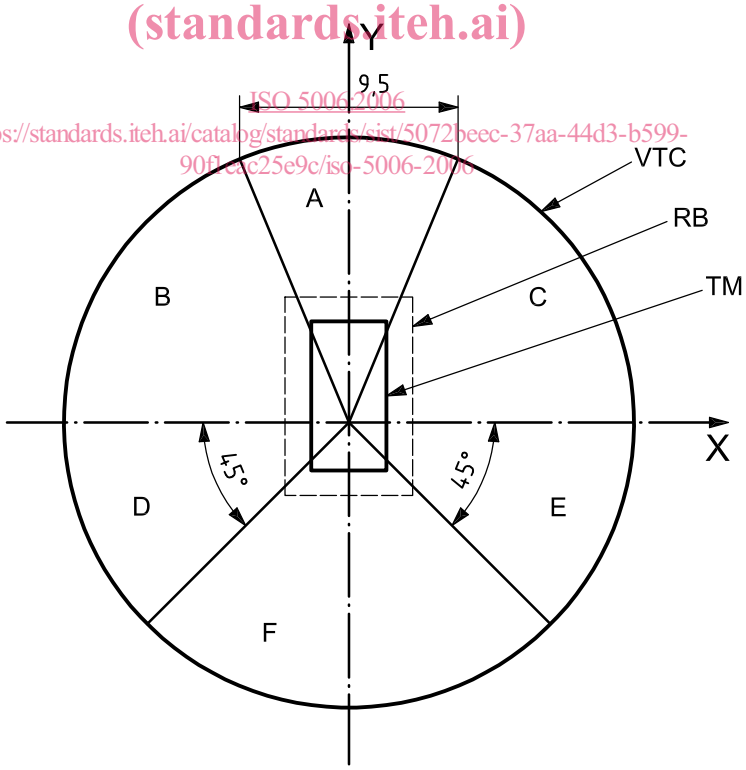
3.3.5
sectors of vision D and E
segments of the visibility test surface to the rear defined by an angle of 45° to both the right and left sides of the longitudinal plane passing through the filament position centre point

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.