SLOVENSKI STANDARD
oSIST prEN ISO 16001:2016

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Stroji za zemeljska dela - Sistemi zaznavanja nevarnosti in vizualni pripomočki - Zahtevane lastnosti in preskusi (ISO/DIS 16001:2016)

Earth-moving machinery - Hazard detection systems and visual aids - Performance requirements and tests (ISO/DIS 16001:2016)

Engins de terrassement - Dispositifs de détection d'objets et d'aide visuelle - Exigences de performances et essais (ISO/DIS 16001:2016)

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53.100	Stroji za zemeljska dela	Earth-moving machinery

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Earth-moving machinery — Object detection systems and visibility aids — Performance requirements and tests

Engins de terrassement — Dispositifs de détection des risques et d'aide visuelle — Exigences de performances et essais

ICS: 53.100

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel three month enquiry.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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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 16001 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

This second edition cancels and replaces the first edition (ISO 16001:2008) of which has been technically revised.

Introduction

This International Standard outlines test procedures and sets criteria for the development of object detection systems (ODS) and visibility aids (VA) which indicate to the operator the presence of objects which are within the detection zone of these systems.

Proper job-site organization, operator training and the application of relevant vision standards (ISO 5006 and ISO 14401) address the safety of people on job sites. In some cases, vision of the working area cannot be achieved either by the operator's direct view or indirect view using mirrors. In such cases, operator awareness can be improved by the use of ODS and VA.

ODS and VA provide information to the operator as to whether a person or object is in the path of the machine, primarily during rearward movement.

It is essential to note that ODS and VA have both advantages and disadvantages. There is no device that works perfectly in all situations. It is especially important that the shortcomings of ODS and VA be recognised and known to system users. The advantages and disadvantages of selected devices are summarized in Annex A.

Earth-moving machinery — Object detection systems and visibility aids — Performance requirements and tests

1 Scope

This International Standard specifies general requirements and describes methods for evaluating and testing the performance of object detection systems (ODS) and visibility aids (VA) used on earth-moving machines. It covers the following aspects:

- detection and/or visibility of objects including people in the detection zone;
- visual, audible, or both warnings to the operator and if appropriate to the persons in the detection zone;
- operational reliability of the system;
- compatibility and environmental specifications of the system.

It is applicable to machines as defined in ISO 6165. ODS, VA or both can be used to augment the operator's direct vision (see ISO 5006) or indirect vision using mirrors (see ISO 14401) or to provide additional means of object detection, for example, where ergonomic considerations limit the effectiveness of direct vision and to avoid repeated turning of the head and upper body.

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

ISO 6394, *Earth-moving machinery — Determination of emission sound pressure level at operator's position — Stationary test conditions*

ISO 9533, *Earth-moving machinery — Machine-mounted forward and reverse audible warning alarm — Sound test method*

ISO 13766, *Earth-moving machinery — Electromagnetic compatibility*

ISO 15998, *Earth-moving machinery — Machine-control systems (MCS) using electronic components — Performance criteria and tests for functional safety*

3 Terms and definitions

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

3.1
object detection system
ODS
system that detects objects including people that are in the detection zone and warns the operator

The system can also warn the person on the ground.

NOTE 1 The system generally includes a sensing device, warning device and evaluation device.

NOTE 2 ODS, by detecting visual image, is called “OVD (object visual detection system)”.

3.1.1
sensing device
ODS component that detects a test body in the detection zone

3.1.2
warning device
ODS component that transmits information to the operator and/or to persons in the detection zone by visual and/or audible signals

3.1.3
evaluation device
ODS component or components that analyse the signals and information transmitted from the sensing device and transform the corresponding signal to the warning device

3.2
visibility aid
VA
system that provides indirect visibility without warning

NOTE The system generally includes one or more monitors and cameras.

3.2.1
monitor
VA component that provides a visual image of the detection zone on a screen

3.2.2
camera
VA component that transmits to the monitor an image of the detection zone

3.3
detection zone
zone within which a test body is detected by an ODS or is shown by a VA

3.4
test body
person or a standard measuring unit representative of a person, used to test the geometry and size of the detection zone

NOTE Depending on the system used, test bodies can be varied (see Annexes B to F).

3.5
self-testing
capability of the system to self-check continuously and immediately to inform the operator, audibly, visually, or both, of a failure

3.6
detection time
time required for an object detection system to detect the test body in the detection zone and activate the signal output

3.7
stand-by
operation mode whereby the object detection and visibility aid systems are active, but no information is transmitted by the warning device or monitor

3.8
job-site organization
rules and procedures for managing the working together of machines and people at a job site

EXAMPLE Safety instructions, traffic patterns, restricted areas, operator training, machine and vehicle markings, communications systems.

4 Performance requirements and tests

4.1 General requirements

4.1.1 Test of detection zone

The test method shall be performed on a system that is either fitted to the machine or to a representative configuration in accordance with Annex B through Annex I.

4.1.2 Test body requirements

The test body requirements are specified in Annex B through Annex I.

4.1.3 Evaluation of test results

4.1.3.1 Detection

Detection shall take place unambiguously with an uninterrupted sequence of the signal or information appropriate to the warning range. For further details, see Annex B through Annex I.

For a combined system, which several ODS and VA installed at the same time, its partial system detection zone can consist the total combined system detection zone by its other partial detection zones.

EXAMPLE For a combined system consisting of a bird's eye view system and another object detection system, the combined system "total" detection zone can contain its object detection system detection zone even though it contains the area where its bird's eye view system image size of an object is less than required.

4.1.3.2 Evaluation of wrong signals

Wrong signals, such as the following, should be minimized:

- from objects outside the detection zone;
- from weather conditions of fog, snow, rain, wind, dust, etc.

4.2 Location and fixing of ODS and VA devices

Devices shall be located and arranged on the machine in accordance with the specification of the device manufacturer so that

- the device does not restrict any function or operation of the machine,
- the device is protected against external damage,
- the device is affixed to the machine so as to deter unauthorized disablement or removal,
- the device is mounted so as to limit exposure to, or amplification of, dynamic loads, temperature, shock or vibration that could prematurely damage the device,
- the attachment and fixings of ODS and VA devices do not affect the integrity of the protective structures, e.g. rollover protective structures (ROPS),

4.3 Operator station devices

4.3.1 Location of monitor

The monitor shall be located such that it is in the 180° arc in front of the operator, except for use in excavators. For excavators, the monitor shall be placed such that it is located in the 270° arc in front of the operator.

The image on the monitor should be displayed in the most intuitively logical way for the application. For example:

- The image of a rear view camera is commonly displayed as a mirror image. (See Figure 1)
- The image of a front view camera is commonly displayed as a 'normal' image.
- The image from a side-mounted camera looking downwards is commonly displayed as 'normal' image.
- The image from a side-mounted camera looking rearwards could be displayed either as a 'normal' or 'mirror' image.
- A 360° 'birds eye view' image is commonly displayed as a 'normal' image. (See Figure 2)

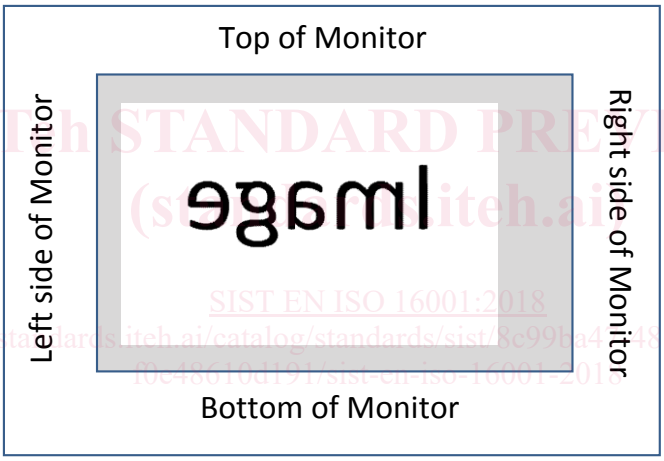

Figure 1 — Example of a mirror image on the monitor covering the area behind the machine

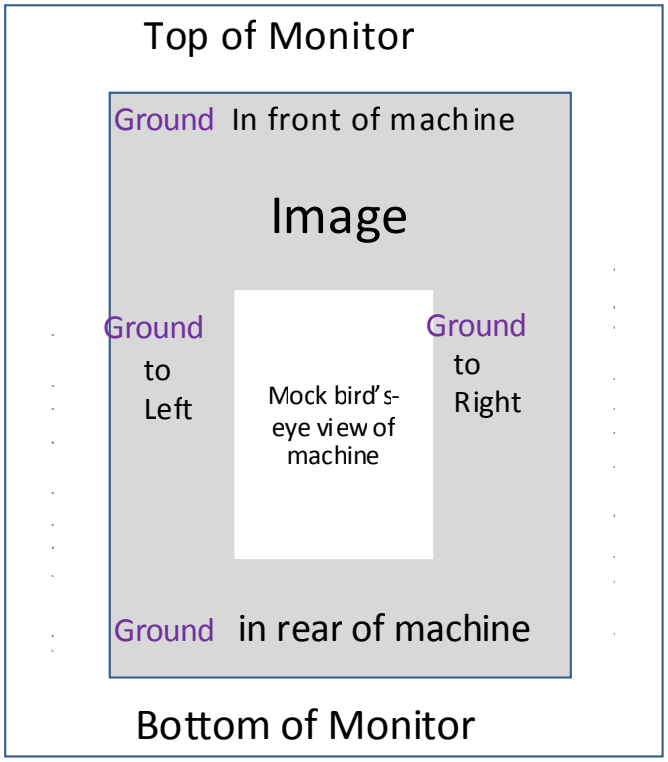

Figure 2 — Example of a normal image on the monitor showing the bird's eye view around the machine

The monitor should be within 1,2 m of the operator's eye point. The monitor shall be positioned so as to minimize the glare caused by direct sunlight.

NOTE Factors that influence an operator's ability to detect a person on the monitor are the position of the monitor within the cab, the distance of the operator from the monitor, the size of monitor, the ambient lighting, the lens on the camera and the distance of the object from the lens.

4.3.2 Warning devices

Both audible and visual warning devices are required for an ODS. These devices shall provide indications to the operator and may provide indications to workers and other persons present at the work site.

4.3.2.1 Audible devices

Operator station warning devices shall be set at, or shall automatically adjust to, a level at least 3 dB higher than the ambient noise level as measured at maximum governed speed under no load.

All in-cab warnings should be selected so that they are clearly audible at the operator station. The warning signal should be in the frequency range 500 Hz to 2 500 Hz.

In-cab alarms shall be distinguishable from other sounds (for example, warnings or machinery noise) in the operator's station.

NOTE Distinctiveness of the alarm can be achieved by varying the spectral characteristics and the temporal distribution of the signals (see ISO 9533).

4.3.2.2 Visual devices

A green system-status light shall inform the operator that the system is powered and functional. The status light may be continuous or may turn off after the function check is completed.

The warning signals in the cab shall be mounted in direct view of the operator and shall be visible in direct sunlight.

The warning signals shall be distinguishable from other instrument panel warnings; the most severe warning shall be a flashing red light.

4.3.2.3 External machine mounted warning devices

If an external machine mounted audible warning device is fitted as part of the ODS to alert workers and other persons at the worksite, then the external alarms shall comply with ISO 9533.

External machine mounted visual warning devices, when fitted, shall be visible to people in the detection zone.

4.4 System activation and initial check

4.4.1 System activation on engine start

The system shall activate automatically on engine start, shall perform an initial system check, and shall give a proper function indication.

In the case of an ODS malfunction, a warning shall be given to the operator.

4.4.2 System activation from stand-by mode

The system may remain in stand-by mode unless the relevant machine movement mode is selected.

The system shall wake up and provide information from the camera or sensor about the direction of the machine motion before the machine moves.

If multiple cameras or sensors are fitted, the system shall provide the camera view or sensor signal appropriate to the direction of travel or other machine movement, for example as according to following means.

- By using multiple monitors or multiple indicators, each of which provides information about its corresponding camera or sensor.

- By using a single monitor or indicator which sequentially provides information about multiple cameras or sensors.

- By using a single monitor or indicator which simultaneously provides information about multiple cameras or sensors.

4.5 ODS detection time

ODS detection time shall not exceed 300 ms.

4.6 Operational integrity

4.6.1 General

The operational integrity of the ODS and VA shall comply with ISO 15998 and ISO 13766.

4.6.2 Continuous self-checking

The availability of an image of the detection zone on the monitor is sufficient as a monitoring function for a VA.

An ODS shall have a permanent monitoring function including at least the following:

a) an operating indication light (green);

b) a stand-by indication light (flashing amber or green) (see 4.3.2.2);

c) a visual and/or audible failure signal if the operation of the system is impaired, including monitoring of each link on the ODS, which includes the monitoring of all machine signals used for system operation, for example:

- wire break,
- short-circuit,
- time management (if applicable),
- signal output and signal input, and
- checking of the system.

4.7 Warning device disablement

It shall be impossible to disable the warning device simply by switching it off.

EXAMPLE Stepped stop system may fulfil the requirement.

The activation of the warning device shall be so designed and installed that its operation cannot easily be altered by the operator.

Any exceptions shall be specified in accordance with Annex B through Annex I.

4.8 Physical environment and operating conditions

The ODS and VA shall comply with ISO 15998 in respect of the physical environment and operating conditions.

5 Marking and identification

Each device shall bear legibly and indelibly the following information:

- manufacturer;
- type and model;
- product serial number;
- regulatory markings, as required.

6 Operator's manual

ODS and VA shall be supplied with an operator's manual containing installation, technical and safety instructions for the intended use of such systems. Instructions shall cover the following:

- description of systems function;
- detailed description of performance and operating limits — in particular, the effect of different mounting heights and angles;
- detection area shape and size – and variances according to operational and external factors (e.g. interference, weather, presence of other systems);
- information for job-site organization;