

Principles for the testing of Person Detection Systems for Mobile Machinery

Stand: 02.2026

GS-BAU-71

DGUV Test
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We test for your safety.

GS-BAU-71

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1 Preliminary remark

These Principles of Testing contain principles for testing person detection systems for mobile machinery (e.g., for use in the construction industry or agriculture). They are for the assessment of safety requirements through the DGUV Test Testing and Certification Body, Expert Committee Construction (PZ BAU). Positive assessment is a prerequisite for admission for BG BAU work safety awards.

Additional requirements may apply for special work assignments.

The principles are regularly reviewed and revised or supplemented, as necessary, in keeping with the latest developments in the field of work safety and technical progress. The latest edition is always binding.

The Principles of Testing are intended for use in connection with a contractual agreement as part of a PZ BAU testing procedure. Any other use shall require the consent of PZ BAU.

The principles for testing apply in conjunction with:

- the DGUV Test Rules of Procedure for Testing and Certification, Part 1: Certification of Products, Processes, and Quality Management Systems (DGUV Principle 300-003), in the currently valid version,
- the respective certification program (if applicable) and
- any specifications of the Certification Body.

2 General

2.1 Area of application

These principles apply to the testing of person detection systems for mobile machinery.

2.2 Test basis

The safety test is based in particular on the following directives, harmonised standards, and other regulations in their currently valid versions:

EC directives and Regulations

- 2006/42/EC – (EC Machinery Directive)
- (EU) 2023/1230 (EU Machinery Regulation)

National laws

- German Product Safety Act (ProdSG)
- German Regulations on the Product Safety Act (ProdSV)

Harmonised standards

- EN ISO 12100: Safety of machinery – General principles for design – Risk assessment and risk reduction
- EN ISO 20471: High-visibility clothing – Test methods and requirements

Standards

- ISO 5006: Earth-moving machinery – Operator's field of view – Test methods and performance criteria
- EN ISO 16001: Earth-moving machinery – Object detection systems and visibility aids – Performance requirements and tests
- ISO 19206-2: Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 2: Requirements for pedestrian targets

Test Principles

- GS-BAU-70: Principles for the testing and certification of safety-related assistance systems on machines and commercial vehicles

In addition, other standards may be used as a basis for testing; a separate agreement is required in this case.

2.3 Validity

This test principle applies from **01.02.2026**

3 Definition of terms

Terms are used in accordance with EN ISO 16001 and ISO 5006. The following terms are additionally defined:

3.1 Person detection system

Visual object recognition system that can distinguish between objects and persons based on morphology.

3.2 Detection range

Zone within which a person detection system can detect a person.

3.3 Test object

3.3.1 Test object for simulating an obstacle

The test object must be a cylindrical object with a diameter of between 40 cm and 50 cm and a height of 80 cm to 100 cm. There are no specifications for the surface.

3.3.2 Test person

Test person for determining the performance of the person detection system.

The test person must be between 1.50 m and 1.90 m tall.

The test person must be wearing everyday clothing.

3.4 Warning area

Area within the detection range in which a clear warning is given when a person is present.

4 Test requirements

4.1 General

All applicable specifications from GS-BAU-70 are to be complied with.

The test requirements are modelled on EN ISO 16001 Annex I, however, they are adapted to the intended working environment.

4.2 Test setup

For the test a functional earth-moving machine with mounted person detection system is to be available as well as a flat surface covering at least the detection range.

The machine must be stationary for the test.

The level of lighting must be between 50 lx and 80 000 lx.

During the test, the ambient conditions must be without heavy rain, dust, fog, or smoke.

The length and width of the machine, the height of the sensor above ground level, and the distance between the sensor and the seat index point (SIP) are to be recorded and documented.

Details of the test setup are to be specified by PZ BAU.

4.3 Working environment and surrounding conditions

The operating conditions and technical specifications of the person detection system as specified by the manufacturer in the documents are to be tested for suitability for a construction site situation.

The test requirements are defined based on the test bases specified under point 2.2 as well as the test criteria listed in points 4.4.1 to 4.4.5 and documented in the following civil engineering List:

- 23.02 Person detection system

Test lists are internal documents of PZ BAU and are maintained in an application-specific database.

If required for the product, additional test requirements can be specified. Moreover, it is possible to stipulate certain test criteria in the contract. For example, the interpretation of a technical specification from a standard can be specified in greater detail.

4.3.1 Detection range

The range at which the test person wearing everyday clothing can be detected when moving slowly toward the person detection system is to be recorded and documented.

A machine width of 2.5 m is assumed. This results in a rectangular boundary (RB) width of 4.5 m at a distance of 1 m from the machine. For simplicity purposes, a distance of 10 m from the sensor is selected for the visibility test circle (VTC). The starting and ending points of the minimum detection range are the intersection between the VTC and a straight line from the respective corner point of the RB at an angle of 45° to the RB (see sketch drawing).

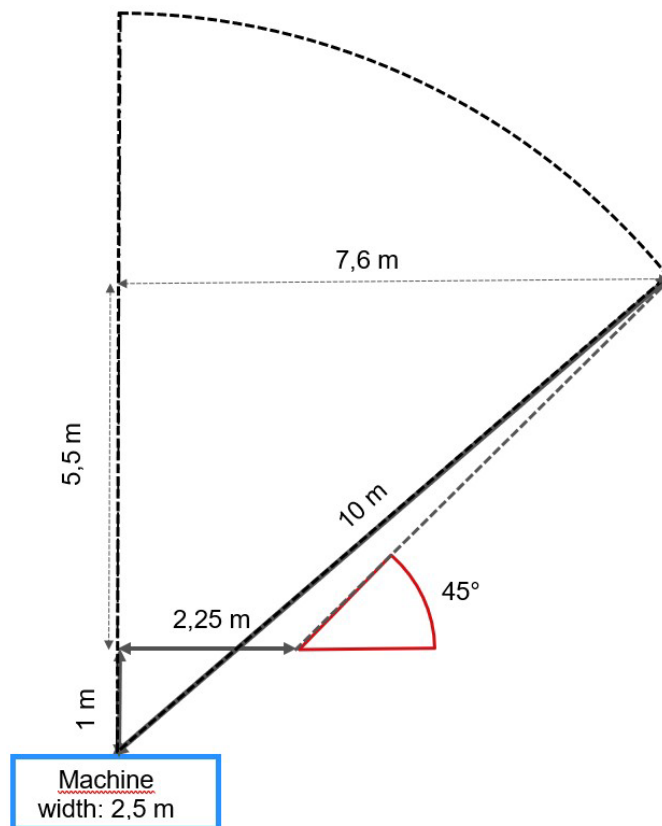


Figure1: Sketch drawing of minimum detection range

4.3.2 Warning area

The warning area must be adjustable in size and must be able to cover at least the minimum detection range.

The entire warning area must be displayable on the monitor.

4.3.3 Detection time

The detection time can be taken from the technical documentation. It must not exceed 300 ms. In the practical test, there must be no subjective delay between sensor activation and warning.

4.3.4 Object detection

The test object simulating an obstacle must be placed in at least 10 different positions within the warning area. Two positions must be selected at minimum distance (at a maximum on the RB)

and two at maximum distance (at a minimum on the VTC) from the sensor. The test object simulating an obstacle must be placed once in each position when covered with a high-visibility vest colour in accordance with EN ISO 20471 and once without a high-visibility vest.

For testing, the sensor must first be covered over and then uncovered.

Acceptance criteria are: No detection of the object as a person and no corresponding warning in all of the tests. Both acceptance criteria must be met.

4.3.5 Person detection

4.3.5.1 Person detection - unconcealed

The test person must stand in at least 20 different positions in the warning area. Three positions must be selected at minimum distance (at a maximum on the RB) and three at maximum distance (at a minimum on the VTC) from the sensor. In each case, the test person must one time be wearing a high-visibility vest colour in accordance with EN ISO 20471 and a helmet, and one time no high-visibility vest and no helmet.

The suitability of the system for all colours of high-visibility vests in accordance with EN ISO 20471 (orange, neon yellow, and red) is to be checked by sampling.

At the positions at the minimum distance, the test person must stand upright. Three positions must be assumed respectively in relation to the sensor (frontal, side position, with their back to the sensor).

At the other positions, the test person must assume two of the following six possible positions, selected at random:

- standing (frontal, side position, or with their back to the sensor)
- kneeling (front, side position, or with their back to sensor)

For the test, the sensor must first be covered over and then uncovered.

The acceptance criterion is the detection of the person and a warning in each and every test.

4.3.5.2 Person detection - partially concealed

The test person must stand in at least 10 different positions in the warning area and behind a covering (e.g. pillar, movable cover, or formwork board) so that approximately 1/3 of the vertical projection plane of the body is covered. Two positions must be selected at minimum distance (at a maximum on the RB) and two at maximum distance (at a minimum on the VTC) from the sensor. In each case, the test person must one time be wearing a high-visibility vest colour in accordance with EN ISO 20471 and a helmet, and one time no high-visibility vest and no helmet.

Vertical concealment: The test person must stand upright. Three positions must be taken up in relation to the sensor (frontal, in side position striding away from the concealment, with their back to the sensor).

Horizontal concealment: The test person must be standing upright. Three positions must be taken up respectively in relation to the sensor (frontal, sideways in a striding position, with their back to the sensor). The concealments must be of varying heights, from a concealment at floor level to concealment of the head.

For the test, the sensor must first be covered over and then uncovered.

The acceptance criterion is a person detection and a warning in each and every test.

4.3.5.3 Person detection in artificial light

The suitability of the system for applications in artificial light (night use or use in a hall) must be checked by sampling.

4.3.5.4 Person detection with low or high sensor mounting

The suitability of the system for applications with low or high sensor mounting is to be checked by sampling at a minimum distance (at a maximum on the RB) and at a horizontal distance of 10 m from the sensor.

The minimum and maximum mounting heights are to be documented. The aim is to ensure functionality at a mounting height of 1 m to 4 m.

4.4 System requirements

The following additional requirements shall apply to the system:

- The active software version must be identifiable.
- The acoustic warning must not be able to be deactivated when person detection is active.
- It must be clearly evident to the operator if the person detection is no longer functional or has been switched off (e.g., due to environmental conditions).
- Recognition patterns implemented in addition to person detection (e.g., animals or vehicles) must be able to be deactivated.
- The system's operating limits must be clearly specified in the documentation supplied.

5 Type, scope, and procedure of the test

5.1 General

The test is carried out on a representative product or a sample. The selection is made in accordance with the specifications of the Certification Body.

The test is usually carried out at the manufacturer's premises. Alternative sites for the test can also be agreed upon.

As a rule, non-destructive testing is carried out. If destructive testing is necessary, this is to be agreed in advance.

The working language for testing is German. Other languages are possible by prior agreement and, if needed, necessitate the services of a translator.

The test is carried out using the corresponding Test List (see section 4.3).

5.2 Types of tests

Initial inspection

Initial testing of a product.

Difference test

If individual assemblies are modified in a product that has already been tested, only the differences compared to the initial test are subjected to testing.

The scope of the test is determined based on the changes made to the product.

Renewal test

If the product has already been tested once, a renewal test can be carried out in the event of renewal of the certification. The scope of the test is determined as a function of the modifications to the product or production and changes to the test basis.

Repeat test

If a test has to be interrupted without sufficient test results, a date for repeating the test is to be set.

Follow-up test

The checking of corrective measures is required in the form of a follow-up test in the event of previously identified critical deviations or if the initial testing was carried out on a product that is not part of the series production (e.g. prototype).

5.3 Scope of testing

The scope of testing depends on the specifications of the test basis, the test mandate, and the specifications of the Certification Body. As a rule, the tests comprise the following methods and content:

Visual inspection

A visual inspection is the examination of the product for completeness and condition without the use of tools.

Measurement

Measurements are carried out in accordance with the Test List (see section 4.3). In individual cases, detailed drawings or mathematical calculations may also be accepted, which are then cross-checked using samples. An example of a measurement is, for instance, the recording of the actual dimensions of the detection and warning area.

Functional test

A functional test is the verification of an intended function, such as the detection of a person.

Assessment of documentation of manufacturer

Manufacturer's evidence requested for testing (e.g., drawing, calculation) is assessed for relevance and accuracy (e.g., verification and/or plausibility check).

Third-party verification

Third party documentation required for testing (e.g., calibration certificates) is subject to verification.

5.4 Test procedure

The test procedure is carried out in accordance with the specifications of the Certification Body and generally follows the processing steps:

- Internal acceptance of the process documentation by the responsible testing personnel
- Organisational preparation and coordination of the test date

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- Assessment of the technical documentation already existing
- Assessment of the person detection system on site
- Assessment of any further supporting documents required from the manufacturer or third parties
- Test report with test results as well as noted deviations and findings
- Internal handover of the process documentation to the Certification Body (completion of the test)

Process-related deviations may occur or can be defined between the contracting parties. Further measures may be required depending on the certification procedure, e.g., assessment of supporting documents requested for subsequent submission.

6 Documentation

6.1 Documentation during the test

Relevant findings during the on-site assessment of the product are documented by the testing personnel in the corresponding Test List (see Section 4.3).

6.2 Test report

After the test has been carried out, the testing personnel will prepare a test report in accordance with the requirements of EN ISO/IEC 17025. The test report is sent to the mandating party.

The test report gives the results obtained during the test, including a statement regarding conformity with the test criteria or standard conformity.

The statements have the following relevance:

Statement	Explanation
No deviation: complete fulfilment of a test requirement	Target/actual assessment in relation to a relevant test requirement (e.g., condition, dimension, function): A criterion given in the test report without comment is generally considered to be fulfilled.
Non-critical deviation: Safety level is considered equivalent	Deviations from the test requirement with an equivalent safety level and in the context of the intended use: a separate consideration in the risk assessment is required.
Critical deviation: Safety level is not met	Deviation from test requirements: A technical modification is required and must be proven to have been rectified in the ongoing certification process.
Note: Informative value	Supplementary information: A note may be added with reference to a specific test requirement, e.g., regarding the safety level.

6.3 Subsequent submissions

Any required supplementary submissions (e.g., verification that a detected deviation has been rectified) are specified in the test report and must be submitted by the mandating party.