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# Electrical installations for lighting and beaconing of aerodromes — Advanced Visual Docking Guidance Systems (A-VDGS)

## National foreword

This British Standard is the UK implementation of EN 50512:2009.

The UK participation in its preparation was entrusted to Technical Committee EPL/97, Aeronautical ground lighting.

A list of organizations represented on this committee can be obtained on request to its secretary.

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EUROPEAN STANDARD

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# EN 50512

February 2009

ICS 93.120

English version

# Electrical installations for lighting and beaconing of aerodromes - Advanced Visual Docking Guidance Systems (A-VDGS)

Installations électriques pour l'éclairage et le balisage des aérodromes - Systèmes Avancés de Guidage Visuel pour l'Accostage (SAGVA)

Elektrische Anlagen für Beleuchtung und Befeuerung von Flugplätzen - Erweitertes optisches Andockführungssystem (A-VDGS)

This European Standard was approved by CENELEC on 2008-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

**Central Secretariat: avenue Marnix 17, B - 1000 Brussels**



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## Foreword

This European Standard was prepared by Working Group 3 of the Technical Committee CENELEC TC 97, Electrical installations for lighting and beaconing of aerodromes.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50512 on 2008-12-01.

The following dates were fixed:

| | | |
|---|---|---|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2009-12-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2011-12-01 |

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 2004/108/EC. See Annex ZZ.

# Contents

## Introduction

This European Standard contains the requirements for an Advanced Visual Docking Guidance System (A-VDGS) as it is described in the ICAO Annex 14. This standard covers the characteristics of the electrical and mechanical components. This standard includes the software design where this affects the required system performance and safety.

An A-VDGS is to be designed to achieve safe and precise guidance during the docking procedure of an aircraft. The system provides at least a display which shows information of azimuth guidance and stop information.

The use of an A-VDGS is in principle limited to a defined area with an opening angle and a border distance to the stop point related to the centre line. The reference point for all distances and guidance information at the aircraft is the central axis of the nose wheel.

It has to be considered that in some cases the topographical situation of an airport requires a reduced working area for an A-VDGS which will result in the area being different from the requirements stated herein.

For practical use on the airport it has to be considered that the detection range can be limited due to the actual weather and visibility condition prevailing (fog, rain, snow, etc.).

## 1 Scope

This European Standard specifies requirements of electrical and mechanical design, installation, maintenance and testing procedures for advanced visual docking guidance systems.

## 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.

EN 60068-2-1, Environmental testing - Part 2-1: Tests - Test A: Cold (IEC 60068-2-1)

EN 60068-2-2, Environmental testing - Part 2-2: Tests - Test B: Dry heat (IEC 60068-2-2)

EN 60068-2-5, Environmental testing - Part 2-5: Tests - Test Sa: Simulated solar radiation at ground level (IEC 60068-2-5)

EN 60068-2-30, Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle) (IEC 60068-2-30)

EN 60068-2-64, Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64)

EN 60439-1:1999, Low-voltage switchgear and control gear assemblies - Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1:1999)

EN 60529, Degrees of protection provided by enclosures (IP Code) (IEC 60529)

EN 60825-1, Safety of laser products - Part 1: Equipment classification and requirements (IEC 60825-1)

EN 61000-3-2, Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase) (IEC 61000-3-2)

EN 61000-3-3, Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection (IEC 61000-3-3)

EN 61000-3-11, Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection (IEC 61000-3-11)

EN 61000-3-12, Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase (IEC 61000-3-12)

EN 61000-6-2, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments (IEC 61000-6-2)

EN 61000-6-3, Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3)

HD 472, Nominal voltages for low-voltage public electricity supply systems
(IEC 60038 'IEC standard voltages', mod.)

HD 60364 series, Low voltage electrical installations (IEC 60364 series, mod.)

## 3 Definitions

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

The following definitions were developed to be included in international standards relating to A-VDGS on aerodromes.

**3.1**
**Advanced Visual Docking Guidance System (A-VDGS)**
those systems that provide additional guidance information to pilots, e.g. aircraft type indication, distance-to-go information and closing speed. Docking guidance information is provided on an A-VDGS display. Advanced-VDGS also permit interfacing to external management, guidance or allocation systems

**3.2**
**A-VDGS display**
display which presents the guidance and other information to the pilots in the left and/or right hand seats and to the drivers and to any other persons assisting the aircraft docking procedure

**3.3**
**aircraft type**
the aircraft manufacturer's designation for an aircraft grouping with similar design or style of structure

**3.4**
**ambient brightness**
the overall brightness level in the viewing environment surroundings

**3.5**
**azimuth guidance**
information which will enable the pilot of an aircraft to follow the required track

**3.6**
**control of the A-VDGS**
any manual or automatic means to operate the A-VDGS. This includes the required settings for an individual guidance procedure

**3.6.1**
**local control**
the control of the A-VDGS from a position where the A-VDGS display and the docking area can be observed by the A-VDGS operator

**3.6.2**
**remote control**
the control of the A-VDGS from any remote position where the operator may not be able to observe the docking procedure

**3.7**
**detection range**
the distance within which the A-VDGS is able to detect an aircraft

**3.8**
**earthed**
connected to the general mass of earth in such a manner as to ensure at all times an immediate discharge of electrical energy to reduce the danger of equipment damage or personnel injury

**3.9**
**electrical equipment**
anything used, intended to be used or installed for use, to generate, provide, transmit, transform, rectify, convert, conduct, distributes, control, store, measure or use electrical energy

**3.10**
**emergency stop**
the event caused by manual or automatic means that initiates the emergency stop indication

**3.11**
**emergency stop indication**
a stop indication to pilots, drivers and any other persons assisting the docking procedure to immediately interrupt the docking procedure

**3.12**
**guidance**
presentation of any information assisting the pilot and/or driver to reach safely and with the required accuracy the designated stop area

**3.13**
**Luminance Ratio (*LR*)**
the ratio of luminance emitted from the display in the ON state compared to the luminance in the OFF state

Luminance ratio (*LR*) shall be calculated as follows:

$$LR = (L_a - L_b) / L_b$$

where

$L_a$ is defined as the measured luminance of the display in the ON-state when under external illumination;

$L_b$ is defined as the measured luminance of the display in the OFF-state when under external illumination

**3.14**
**Meteorological Optical Range (MOR)**
the length of the path in the atmosphere required to reduce the luminous flux in a collimated beam from an incandescent lamp, at a colour temperature of 2 700 K, to 0,05 of its original value, the luminous flux being evaluated by means of photometric luminosity function of the International Commission on Illumination (CIE) (metre (m) or kilometre (km))

**3.15**
**nose wheel**
the single or multiple wheels of the undercarriage at the front of the aircraft used to steer the aircraft on the ground. The reference point for the docking is the centre of the nose wheel footprint

**3.16**
**on-block**
end of a docking procedure where the aircraft is parked in the dedicated stop area

**3.17**
**off-block**
end of the aircraft parking period usually initiated by the push-back procedure

**3.18**
**working area of an A-VDGS**
the area the A-VDGS is intended to perform the aircraft docking. The working area can be temporarily limited by environmental or operational influences

**3.19**
**functional safety**
part of the overall safety which depends on the correct functioning of the A-VDGS

**3.20**
**power loss**
the abnormal power supply condition or a total loss of the external energy supply that does not allow operating the A-VDGS or parts of the system

**3.21**
**stop point**
the predefined location where the particular aircraft shall be parked related to the predefined aircraft reference point

**3.22**
**stop area**
the area defined by the maximum lateral and longitudinal tolerance around the stop point

**3.23**
**towed aircraft**
an aircraft that is moved by an external device like a towing truck or any other towing or pushing equipment operated outside the aircraft

## 4 Requirements

### 4.1 System performance

#### 4.1.1 General conditions

The manufacturer shall state the electrical, mechanical, environmental conditions and functional performances for which the A-VDGS is designed.

The A-VDGS shall cover an area having a horizontal opening angle of at least 10° to either side of the centre line with a border distance to the stop point of 1 m to either side of the centre line according to Figure 1.

The origin of the defined distances is the stop point of the actual aircraft type. The reference point at the aircraft is the nose wheel.

Due to the topographical situation of an airport the A-VDGS shall provide the capability to limit the working area.

The detection range can be limited caused by the actual weather and visibility situation (fog, rain, snow, etc.).

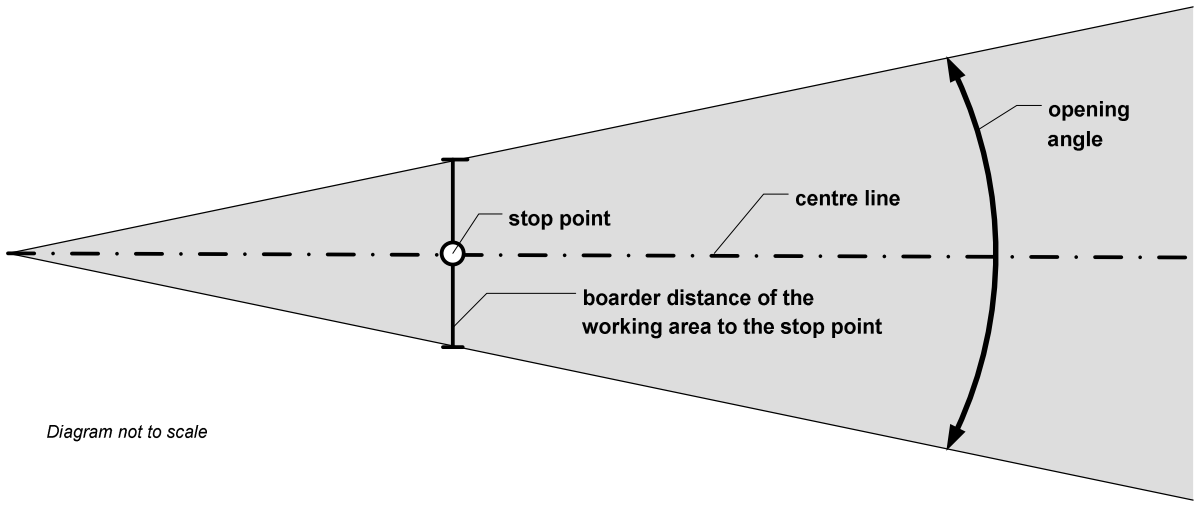



**Figure 1 – Area covered by the A-VDGS**

#### 4.1.2 System accuracy

The A-VDGS shall provide at least the accuracy defined in Table 1.

The accuracy defines the maximum acceptable deviation between the presented information on the A-VDGS display and the actual aircraft position.

The deviation is divided in a lateral and longitudinal portion.

The accuracy shall be provided in the range of aircraft speed defined in Table 2.

Indication to the user shall be provided when the A-VDGS is used outside the defined specification or an internal failure does not allow guidance with the required accuracy.

A positive indication has to be provided when the aircraft stops inside the defined stop area.

The docking procedure shall not be affected by persons, vehicles or other objects as long as they do not mask the aircraft significantly.

The A-VDGS shall be capable to guide towed aircraft. The guidance information shall be related always to the aircraft position.

**Table 1 – A-VDGS accuracy**

| Guidance presentation | Max. deviation at stop position (stop area) | Max. deviation at 9 m | Max. deviation at 15 m | Max. deviation at 25 m |
|---|---|---|---|---|
| Azimuth | A = ± 250 mm | B = ± 340 mm | C = ± 400 mm | D = ± 500 mm |
| Distance | a = ± 500 mm | b = ± 1 000 mm | c = ± 1 333 mm | --- |

**Table 2 – Maximum aircraft taxi speed during the docking procedure**

| Remaining distance to the stop point in m | Maximum aircraft speed in m/s (values in km/h and knots are informative) | | |
|---|---|---|---|
| m | m/s | *(km/h)* | *(kt)* |
| 25 | 8,9 | *(32,2)* | *(17,4)* |
| 18 | 7,6 | *(27,3)* | *(14,8)* |
| 13 | 6,4 | *(23,2)* | *(12,5)* |
| 9 | 5,4 | *(19,3)* | *(10,4)* |
| 7 | 4,7 | *(17,0)* | *(9,2)* |
| 5 | 4,0 | *(14,4)* | *(7,8)* |
| 3 | 3,1 | *(11,2)* | *(6,0)* |
| 2 | 2,5 | *(9,1)* | *(4,9)* |
| 1,5 | 2,2 | *(7,9)* | *(4,3)* |
| 1 | 1,8 | *(6,4)* | *(3,5)* |
| 0,5 | 1,0 | *(3,6)* | *(1,9)* |

#### 4.1.3 Control

##### 4.1.3.1 General

The local control function shall be able to override or disconnect the remote control.

##### 4.1.3.2 Local control

The A-VDGS shall be provided with means for local control with at least the following functionalities:

- password or key for access control;
- selection of aircraft type to be docked;
- start of docking procedure;
- emergency stop (no interlock by password or key).

##### 4.1.3.3 Remote control

Where an A-VDGS remote control interface is provided it shall support the exchange of at least the following information:

Receive by the individual docking system at the gate:

- selection of aircraft type to be docked;
- activating and cancelling of docking procedure;
- bridge interlock signal by which the docking procedure can be blocked in case the boarding bridge is not properly parked;
- emergency stop.

Send by the individual docking system at the gate:

- selected aircraft type;
- actual A-VDGS status:
  - On / Off;
  - technical failure;
  - docking activated / deactivated;
  - emergency stop activated locally,
- actual stand status:
  - docking in progress;
  - aircraft stopped too far;
  - aircraft stopped in range,
- on-block and off-block time.

### 4.2 Design

#### 4.2.1 Display for the presentation

##### 4.2.1.1 Reading angle

The minimum reading area shall be ± 25° horizontal and +20° to -30° vertical to the display reference axis.

#### 4.2.1.2 Luminance ratios and colours

The luminance ratio values must be maintained for all ambient brightness conditions between 20 lx and 40 000 lx. To avoid dazzling the users, the display luminance shall be adjustable to be suitable for the actual ambient brightness and background luminance.

The display shall provide the minimum luminance ratios of the presentation in accordance with Table 3.

**Table 3 – Minimum luminance ratios (*LR*) for various colours, at test angles on the reference axis and off the reference axis**

| Colour | On display reference axis | Off display reference axis |
|---|---|---|
| White | 5 | 3 |
| Yellow | 3 | 1,8 |
| Green | 1,5 | 0,9 |
| Red | 1,25 | 0,75 |

The definition of the display reference axis is given in 5.1.1.3.2.

#### 4.2.1.3 Alpha numeric characters

If information is presented in alpha numeric characters the minimum size of the characters should be calculated by the formula:

$$h = D / 600$$

where

***h*** is defined as the height of a capital letter;

***D*** is defined as the distance at which the information is intended to be read.

For optimum performance the minimum:

- character width should be 5/7 *h*;
- character spacing should be 2/7 *h*;
- word spacing should be 5/7 *h*;
- line spacing should be 4/7 *h*;
- backing board border distance should be *h* (this distance is measured from the border of text to the border of backing board); and
- number of elements for an alphanumeric character should be 7 (7 elements in vertical direction) by 5 (5 elements in horizontal direction).

If the display is not based on a dot matrix technology, the resolution and readability of characters should be equal to or better than a 7*5 matrix. If symbols are used to provide information, the selected size, resolution and distance between the symbols should provide the same readability as defined for the text.

#### 4.2.2 Environmental condition

##### 4.2.2.1 Outdoor equipment

Equipment which is intended for outdoor operation shall be designed to operate under the following conditions:

- temperature range from –25 °C to +50 °C;
- relative humidity from 10 % to 100 %;
- wind load up to 44 m/s (no active operation);
- snow load up to 1 000 N/m²;
- environmental brightness range from direct sunshine down to an average illuminance of at least 10 lx with a uniformity ratio (average to minimum) of not more than 4 to 1 measured at 2 m height;
- protection against dust and water according to IP54 as specified in EN 60529.

NOTE The selection of the cables and components shall consider that chemicals are used in the apron area (e.g. for the aircraft de-icing process).

##### 4.2.2.2 Indoor equipment

Equipment which is intended for permanent indoor installation shall be designed to operation under the following conditions:

- temperature range from +5 °C to +40 °C;
- relative humidity from 10 % to 95 % without dewing;
- altitude from sea-level to 1 000 m.

##### 4.2.2.3 Vibrations

Equipment which is intended to operate outdoor close to the aircraft stand shall be capable of withstanding vibration and shall be tested in accordance with 5.1.1.7.

#### 4.2.3 Electromagnetic compatibility (EMC)

##### 4.2.3.1 General

For the EMC requirements A-VDGS with all the components installed at the stand intended for the use as an aircraft docking device on airports only will be seen as a fixed installation.

##### 4.2.3.2 Emission

To ensure an acceptable level of emission, the A-VDGS shall fulfil the requirements according to EN 61000-6-3 excluding the requirements for EN 61000-3-2/3-12 and EN 61000-3-3/3-11.

##### 4.2.3.3 Immunity

To ensure a sufficient level of immunity, the A-VDGS shall fulfil the requirements according to EN 61000-6-2.

#### 4.2.4 Input power supply

##### 4.2.4.1 Input power specification

The input power supply specification shall meet the applicable requirements of HD 472. The input power supply shall be provided with a local means of isolation in accordance with HD 60364. Where necessary, overload protection devices shall be installed.

##### 4.2.4.2 Input power availability

Any power loss shall not cause any misleading information on the A-VDGS.

After input power restoration the system shall start-up automatically in a safe mode.

##### 4.2.4.3 Protection against overvoltage surges

All electrical appliances intended for outdoor installation shall provide an adequate protection against damaging caused by overvoltage surges on the power supply or control cable.

### 4.3 Safety

#### 4.3.1 General

The requirements stated in this section are intended to ensure the safety of persons, livestock and property against the risk of danger and damage which may arise in the reasonable use of A-VDGS installations. The requirements are, where necessary, explained in greater detail in other sections of this European Standard.

NOTE In electrical installations, two major types of risk exist:

- shock currents due to normal or fault conditions;
- excessive temperatures likely to cause burns, fires and other injurious effects.

#### 4.3.2 Functional safety

The general design of the A-VDGS has to consider that in the case of any internal failures the system shall ensure that no misleading information is presented to the user.

The system shall provide adequate self-test routines which detect immediately faults which affect the function of the A-VDGS.

All operational events and detected failures of at least the last docking procedure shall be stored on a non-volatile log to allow analysis of the monitored mal function.

NOTE It should be considered that for a detailed investigation and system analysis to take place a log including a number of completed docking procedures in the history may be required.

In case of a major failure the display shall immediately present stop information to the pilot. If, due to the nature of an internal failure, a stop information can not be generated the display shall as a fail-safe mode be switched to show a blank display.

Each major failure shall be indicated on the local control panel and on the remote control (if applicable).

#### 4.3.3 Protection against electrical shock and burns

The design of the A-VDGS shall ensure that persons are protected against risks of injuries which may arise from:

- contact with live parts of the installation (direct contact);
- contact with exposed-conductive-parts in case of a fault (indirect contact);
- the ignition of flammable materials due to high temperature or electric arc (thermal effects);
- damage due to excessive temperatures or electromechanical stresses caused by any overcurrents likely to arise in live conductors (overcurrent);
- any harmful effects as a consequence of a fault between live parts of circuits supplied at different voltages (overvoltage), or damage as a consequence of any excessive voltages likely to arise due to other causes (e.g. atmospheric phenomena or switching overvoltages);
- excessive temperature in conductors, other than live conductors, and any other parts intended to carry a fault current.

Conductive internal and external parts of the A-VDGS shall be earthed in accordance with HD 60364.

#### 4.3.4 Protection against harmful radiation

Systems incorporating radiation producing components shall be designed so that humans are never exposed to excessive radiation even when a system component fails or malfunctions.

If laser equipment is used, it shall be according to Class 1 defined in EN 60825-1. If other methods using electromagnetic or other radiations are deployed, they shall fulfil a corresponding health and safety level.

### 4.4 Installation and maintenance

#### 4.4.1 General

Proper installation and periodical maintenance ensures that the components are in a condition so that they allow operation of the A-VDGS so that the system meets the functional, design, installation, technical interfacing and safety requirements.

#### 4.4.2 Documentation

The procedures for installation and periodical maintenance (including levels and time intervals), repairs, upgrades, modifications and re-calibrations shall be specified in the documentation provided by the manufacturer.

#### 4.4.3 Level of competency of the maintenance and installation personal

The installation and maintenance of the A-VDGS requires an adequate level of skilled personnel. The required competence has to be defined in the manufacturer’s installation and maintenance documentation.

### 4.5 Verification of equipment quality

All equipment manufactured under specifications shall pass the appropriate tests according to Clause 5.

A document with all test results shall be provided.

Where applicable, evidence of certification or type approval shall be provided.

# 5 Test

Provisions shall be made for the safe use and maintenance of the overall system during the lifetime of the system.

The tests shall verify the requirements of this standard.

The tests shall be repeatable. A third party shall be able to perform the tests.

## 5.1 Type test

A type test shall be executed to verify the requirements of this standard for the A-VDGS.

The type test shall be repeated after a change that may affect the system properties, function or safety.

Where this standard refers to another standard, the applicable tests required by that standard shall be performed.

### 5.1.1 Environmental test

The environmental type test shall verify that the A-VDGS operates under the environmental extremes.

#### 5.1.1.1 Temperature test

The described tests are based on EN 60068-2.

**Table 4 – Temperature tests**

| | | |
|---|---|---|
| **Test** | General note:<br>During normal operation the majority of VDGS generate heat, this results in increased temperatures within the equipment. Operation in high ambient air temperatures can further increase the internal temperature. When equipment is used in a situation where it can be in direct sunlight, the effects of solar Radiation can result in the surface temperature of the equipment being significantly higher than the air temperature. | |
| **Cold**<br>**EN 60068-2-1**<br>**Test Ab** | Pre-conditioning: | None |
| | Initial measurements: | Visual inspection and principle function test |
| | Conditioning temperature: | -25 °C |
| | Measurement and/or loading during conditioning: | Function test shall be continuously repeated during the warm up period. |
| | Recovery condition: | Recovery at laboratory ambient |
| | Final measurements: | Visual inspection and principle function test |
| | Any deviation in procedure: | None |
| **Dry heat**<br>**EN 60068-2-2**<br>**Test Bb** | Pre-conditioning: | None |
| | Initial measurements: | Visual inspection and principle function test |
| | Conditioning temperature: | 50 °C |
| | Condition time: | 16 h |
| | Measurement and/or loading during conditioning: | The equipment shall be switched on and function test shall be continuously repeated. |
| | Recovery condition: | Recovery at laboratory ambient |
| | Final measurements: | Visual inspection and principle function test |
| | Any deviation in procedure: | None |

**Table 4 – Temperature tests** *(continued)*

| **Test** | | |
|---|---|---|
| **Damp heat cycling**<br><br>**EN 60068-2-30**<br><br>**Method Db** | Air temperature: | 40 °C |
| | Number of cycles: | 2 |
| | Initial measurements: | Visual inspection and principle function test |
| | State of test module during conditioning: | Unpacked, switched on and ready to use |
| | Details of mounting and supports: | None |
| | Variant: | 1 |
| | Intermediate measurements: | Function test continuously repeated during first 3 h of each cycle; during the last hour of each cycle at 40 °C; and during the final cool down period of the last cycle |
| | Recovery condition: | Recovery at laboratory ambient |
| | Special precautions to be taken regarding removal of surface moisture: | Not applicable |
| | Final measurements: | Visual inspection and principle function test |
| **Solar radiation**<br><br>**EN 60068-2-5**<br><br>**Test Sa** | Test procedure: | B |
| | Air temperature within the test chamber during irradiation: | 40 °C |
| | Maximum permissible air velocity within the test chamber: | Normal air circulation required to achieve temperature stability |
| | Humidity conditions: | No requirement |
| | Test duration: | 1 cycle |
| | Measurement and/or loading during conditioning: | The VMS/test module shall be switched on and the function test will be continuously repeated during the first three hours of test, the last hour of radiation and during the cool down period. |
| | Recovery condition: | Recovery at laboratory ambient |
| | Final measurements: | Visual inspection and principle function test |

#### 5.1.1.2 Wind and snow load test

Resistance against wind load and snow load shall be verified by calculation.

#### 5.1.1.3 Optical performance

##### 5.1.1.3.1 General

The tests shall be performed at an ambient temperature of 20 °C ± 3 °C.

The luminous sources shall have been in operation for a sufficient time to be stabilized before making measurements. Supplied sources must be suitably aged so that their electrical and optical characteristics are as stable as possible. A light source is considered to be stable when its light output does not change more than ± 2 % over a time period of 15 min.

Modules may be inverted and be operated on their side in accordance with any recommendation of the manufacturer, in order to simplify the physical arrangement of the test equipment. Care shall be taken to ensure the correct optical orientation of components and surfaces of the test and measurement equipment to assure a representative assessment. Any deviation from normal mounting position shall be recorded.

All optical tests shall be repeated for each individual colour of the colour class the A-VDGS is required to display.

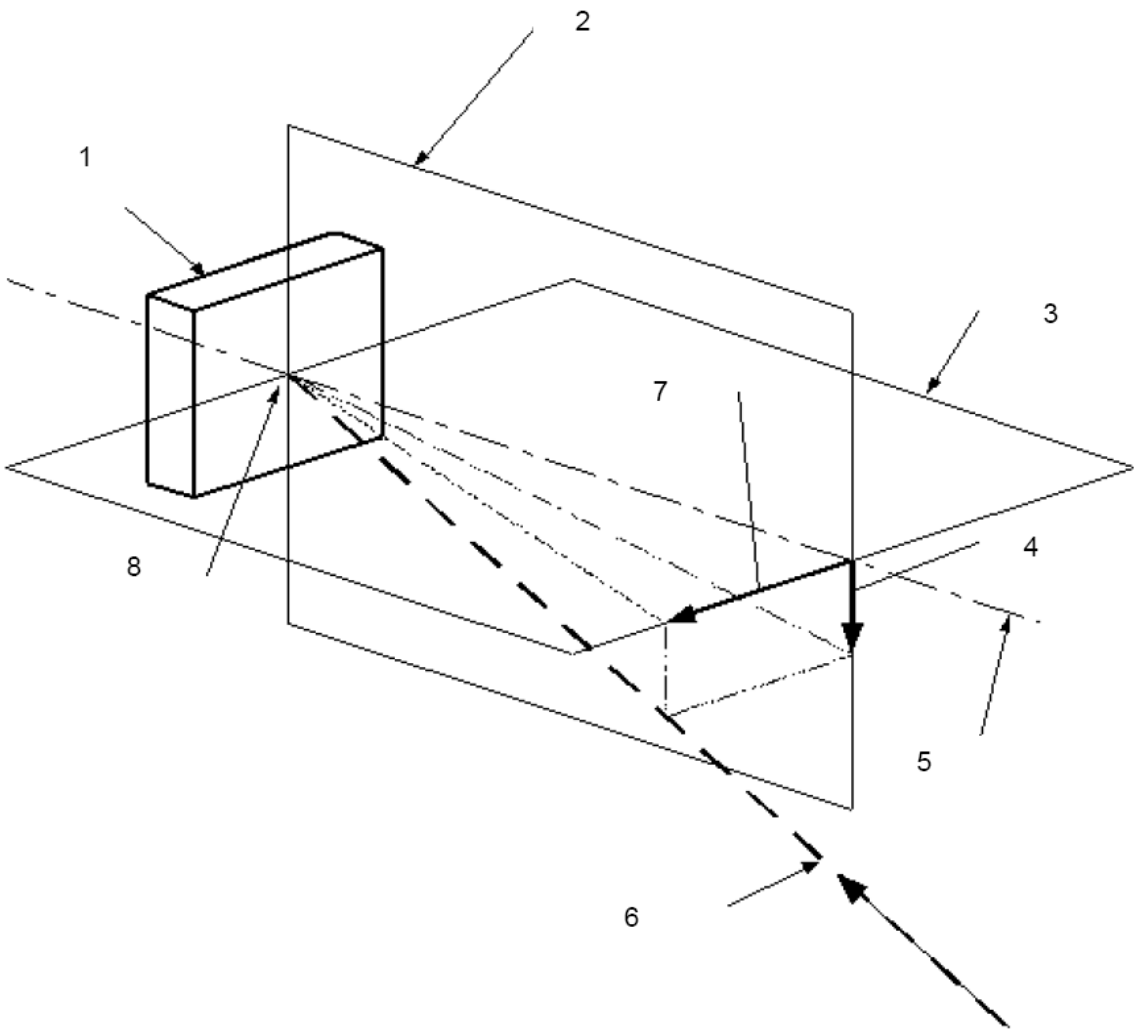
Measurement shall be made with a photo-detector and measuring unit that is stable in operation and not subject to fatigue when exposed to maximum level of luminance. The combination of detector and measuring unit in all ranges shall have linear response to light up to the maximum level of luminance. The spectral sensitivity of the detector shall closely follow the IEC spectral luminous efficiency curve $V_e$.

For all photometric measurements it is important to eliminate stray light.

NOTE The optical performance can be dependent on the ambient temperature.

##### 5.1.1.3.2 Principle test configuration

For measurements on an A-VDGS display the reference axis is the basis; this axis originates in the reference centre of the A-VDGS. The vertical reference plane and the horizontal reference plane are vertical respectively horizontal planes containing the reference centre. Horizontal and vertical test angles describe the angle between the test axis and the vertical and horizontal reference planes respectively.




**Key**

1 A-VDGS display,
the display to provide information to the guided aircraft

2 Vertical reference plane,
the vertical plane containing the reference axis

3 Horizontal reference plane,
the horizontal plane containing the reference axis, when the A-VDGS display is positioned in such a way that the reference axis is horizontal

4 Vertical test angle,
the angle between the test axis and the horizontal reference plane

5 Display reference axis,
the axis originating on the reference centre of the A-VDGS display being perpendicular to the front of it, unless otherwise defined by the manufacturer

6 Test axis,
the line from the reference centre of the A-VDGS display to the luminance meter head

7 Horizontal test angle,
the angle between the test axis and the vertical reference plane

8 Display reference centre,
a point on or near the A-VDGS display which is designated to be the centre of the device for specifying its performance and which shall be defined by the manufacturer

**Figure 2 – Principle test configuration**

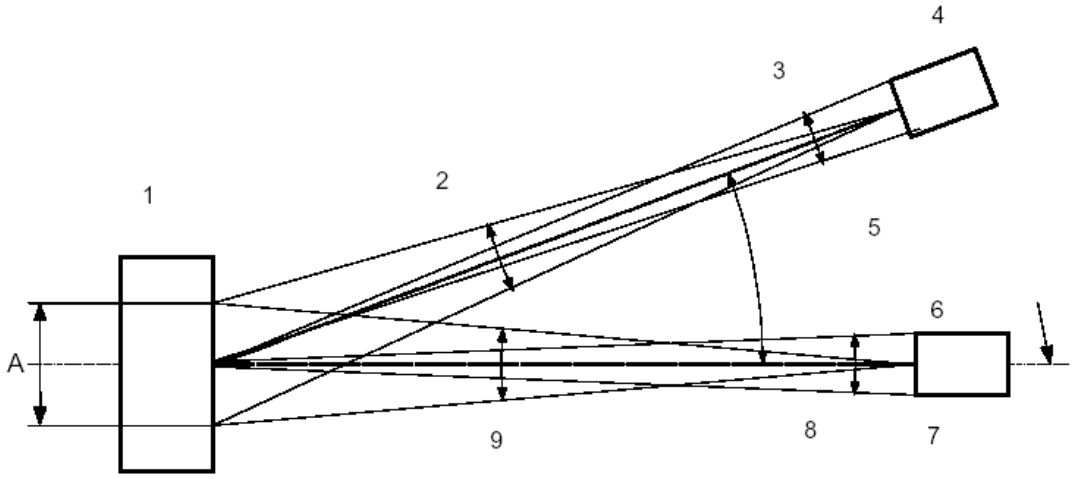
NOTE 1 When the test axis is lower than the horizontal reference plane the vertical component of the test angle is designated as negative.

NOTE 2 When the test axis is to the left of the vertical reference plane as seen from the reference centre the horizontal component is designated as negative.

#### 5.1.1.4 Luminance and luminance ratio

##### 5.1.1.4.1 General

The measurement configuration of the display, solar simulator and the luminance meter shall be arranged according to Figure 3. In order to limit measuring errors some angles are limited. The measuring aperture of the luminance meter shall not be larger than 3°. The beam divergence of the solar simulator at the area of interest shall not be larger than 3°. The diameters of the object lenses of the solar simulator and the luminance meter, as seen from the A-VDGS/test module, shall not be larger than 2° and 0,5°, respectively.




Side elevation of the set-up for the measurement of luminance and luminance ratio.
A is the measurement area, see Figure 4.

**Key**

1 A-VDGS/test module
2 ≤ 3°
3 ≤ 2°
4 Solar simulator
5 10° ± 0,1
6 Reference axis
7 Luminance meter
8 ≤ 0,5°
9 ≤ 3°

**Figure 3 – Measurement configuration**

The solar simulator shall have a spectral content close to that of natural daylight and a correlated colour temperature within the range of 5 000 K to 6 500 K.

The solar simulator, in conjunction with an optical attenuation device, shall be capable of achieving the required luminance range, which shall be uniform (± 10 %) over the area of measurement.

The illumination shall be measured in the reference centre, perpendicular to the reference axis.

#### 5.1.1.4.2 Test area for luminance ratio measurement

The test area shall meet the following criteria:

- the whole of the optical test area must be fully populated with elements;
- the minimum size is (100 x 100) mm, including the outer dimensions of the equivalent areas of the elements;
- it must contain at least 5 x 5 = 25 elements;
- the spacing of the elements must be constant in horizontal and vertical direction, but can be different for these two orthogonal directions (Figure 4c and Figure 4d);
- separations of the elements have to be representative for the separations on the real sign.

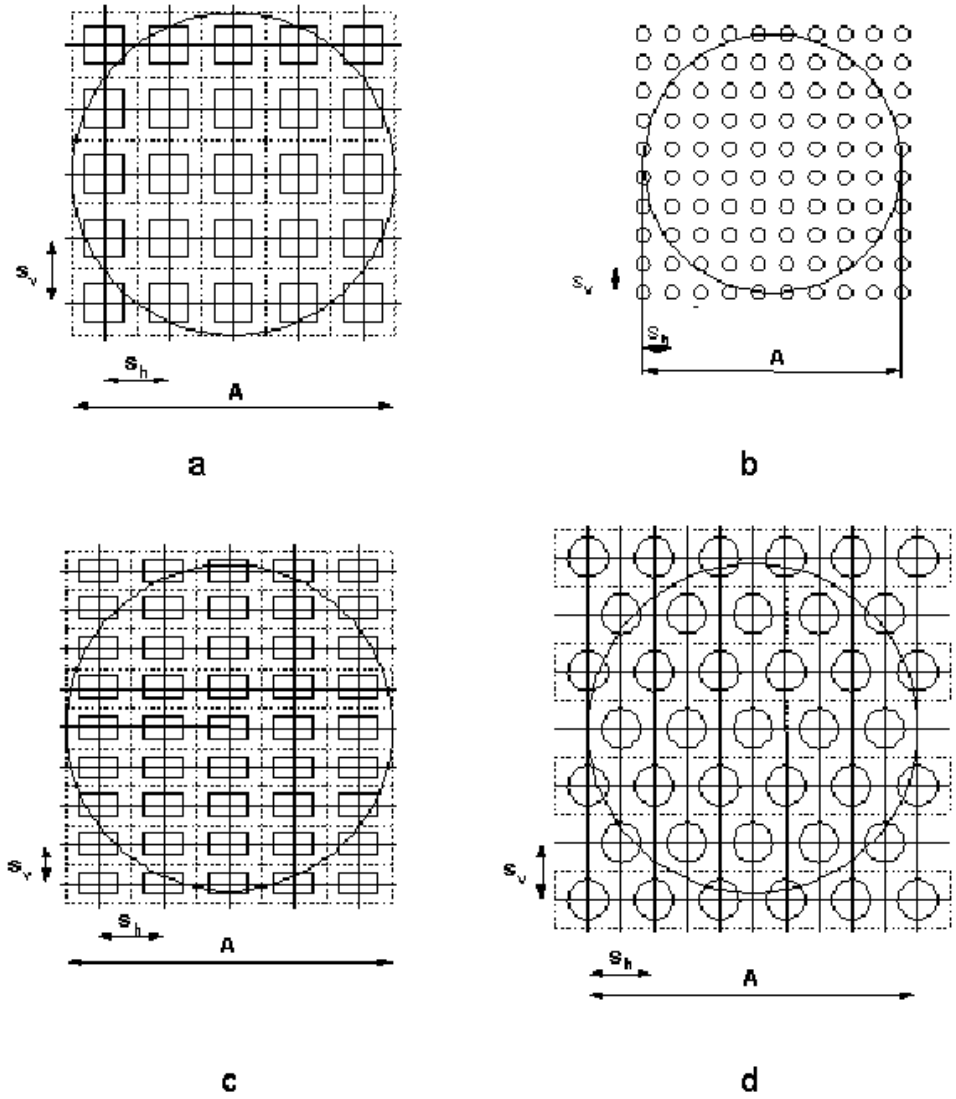



**Figure 4 – Measurement area**

Layout examples for a test module and the positioning of the measuring area (circle) of the luminance meter. The equivalent areas of the elements are indicated by dotted lines. $s_h$ and $s_v$ are the distances between the elements in horizontal and vertical direction.

*A* = 100 mm; *a* = 5 x 5 matrix ($s_v = s_h$); *b* = 10 x 10 matrix ($s_v = s_h$); *c* = 5 x 9 matrix ($s_v$ = 0,6 $s_h$); *d* = hexagonal grid ($s_v$ = 0,5 Ö3·$s_h$)

When the test module has (5 x 5) elements the measuring area shall just encompass the extremities of the equivalent areas of the five elements in both the horizontal and vertical direction (Figure 4a).

When the test module has more than (5 x 5) elements the measuring area shall comprise a circle with a diameter of at least 100 mm (Figure 4b).

When the element spacing of the horizontal and vertical direction is not equal, the measuring area shall just encompass the extremities of the equivalent areas of the five elements in direction with the largest element spacing (Figure 4c).

It is also allowed to use a non-rectangular grid when it is possible to modify it to a rectangular grid by moving rows of element along horizontal and vertical lines (Figure 4d).

#### 5.1.1.4.3 Measurement of luminance and luminance ratio

The luminance of the area under test shall be measured under external illumination of 40 000 lx, 10 000 lx (when required by the purchaser) and 4 000 lx.

The luminance shall also be measured with a randomly selected external illumination between 4 000 lx and 40 000 lx.

Luminance measurements shall be made with the test display in the following states:

- all elements of the display test area ON;
- all elements of the display test area OFF.

Luminance ratio shall be calculated as follows:

$$LR = (L_a - L_b)/L_b$$

where

$L_a$ is the measured luminance of the display in the ON-state when under external illumination;

$L_b$ is the measured luminance of the display in the OFF-state when under external illumination.

In addition to the requirements for luminance ratio, for various luminance classes, an additional requirement shall be met. With the test module set up to achieve the stated luminance ratio requirements for the 4 000 lx and 40 000 lx illumination level, a luminance measurement shall be taken with the module element “ON” and the solar simulator “OFF”.

NOTE This is to establish that the A-VDGS test module is emitting light to an appropriate level without external illumination.

### 5.1.1.5 Resistance to ingress of dust and moisture

The test shall be carried out according to IP54 as specified in EN 60529.

#### 5.1.1.6 Chemical resistance test

The test shall be carried out according to the applicable parts of EN 60068-2 with all chemicals stated in this standard in 4.2.2.1.

#### 5.1.1.7 Vibration test

All equipment that will be installed at a location exposed to vibrations shall be tested for mechanical conditions according to Table 5.

**Table 5 – Vibration test**

| | | |
|---|---|---|
| **Vibration test**<br><br>**EN 60068-2-64**<br><br>**Test Fh, Class AJ2** | Mounting: | The test module shall be securely fixed to the vibrating table. |
| | Reference and check-points: | The reference point shall be chosen on the vibrating table; in the case of large test module it shall be a virtual point, where the reference signal spectrum will be defined as the arithmetic mean of ASD (Acceleration Spectrum Density) values of signals measured at the check points. |
| | Frequency range: | 10 Hz to 200 Hz |
| | ASD levels: | 0,02 $g^2$/Hz (10 Hz to 50 Hz)<br><br>0,02 $g^2$/Hz (50 Hz to 200 Hz with slope 3 dB/octave)<br><br>Overall RMS acceleration 1,2 g |
| | Duration of conditioning: | 90 min in each of 3 axes |
| | Reproducibility: | Low |
| | Initial measurements: | Visual inspection and function test |
| | Functioning during conditioning: | No |
| | Final measurements: | Visual inspection and function test |

After the exposure to the vibration the system shall be checked regarding functionality.

The equipment shall not have any deformation or damage in any part of the test unit's assembly.

The height of the object gives that the normal fixture requirements cannot be fulfilled. Instead the standards permit that actual levels in relevant points are registered and reported.

### 5.1.2 EMC test

#### 5.1.2.1 Emission test

The emission test shall verify that the A-VDGS build up in a typical installation conforms to the requirements defined in 4.2.3.

#### 5.1.2.2 Immunity test

The immunity test shall verify that the A-VDGS build up in a typical installation conforms to the requirements defined in 4.2.3.

The test has passed successfully if

- the display doesn't show any unintended significant changes of information during the test,
- the A-VGDS continues to operate as intended after the test.

NOTE Flicker or minor changes in the display which doesn't produce misleading information to the pilots are acceptable.

### 5.1.3 Input power supply test

The test unit shall be tested to be resistant to a minimum of 3 000 V DC (input circuit lines to ground) at 50 Hz for one minute without failure. The minimum insulation resistance shall be 50 MΩ. Components of the test unit not designed to meet the requirements of this test shall be disconnected for this test.

After the test the equipment shall be assembled to the complete system and then be checked for the basic functions which are

- function of the display,
- function of the sensor,
- general function of the electrical system.

### 5.1.4 Test against electric shock

#### 5.1.4.1 Verification of protection by enclosures

The specified degree of protection provided by enclosures shall be verified in accordance with the procedures specified in EN 60529.

#### 5.1.4.2 Verification of clearances and creepage distances

It shall be verified that the clearances and creepage distances comply with values which are consistent with the rated insulation voltages. Tables 14 and 16 included in EN 60439-1 contain minimum values for clearances and creepage distances for low voltage circuits. If necessary, the clearances and creepage distances have to be verified by measurements, taking account of possible deformation of parts of the enclosure or of the internal screens, including possible changes in the event of a short-circuit.

#### 5.1.5 Functional test

The functional test shall verify that the system complies with the functional requirements which are defined in this standard.

To consider all the different technical solutions and methods to realize an A-VDGS and to take into consideration the safety related operation, the test shall be carried out according to a test manual.

The test manual has to be provided by the manufacturer and shall describe in detail how and why the tests are applicable to the system to prove the requirements. This test manual has to be proved and certified by an independent accredited third party. The third party shall have knowledge about the used technology and functions.

The manufacturer shall provide a type test report that shows all tested items, the test principles, the test results and the name of the third party that has certified the test manual and has monitored the tests that has been declared as safety critical.

The test can be based on simulated conditions or on an evaluation of statistical data from real operations.

The type test shall be based on at least 200 real or simulated docking procedures.

During the type test it shall be at least recorded the deviation of the displayed position from the actual position regarding azimuth and distance.

To pass the type test successfully the following criteria shall be fulfilled:

- the standard deviation of all recorded data has to be within the defined accuracy requirements;
- not more than 1 % of all test docking procedures in the required environmental conditions are disrupted by external influences;
- the test shall cover at least 10 % of all test docking procedures under extremes of the required environmental situations that provides in combination the worst case for the particular technique.

#### 5.1.6 Safety test

Safety tests shall verify the functional safety of system components and of the overall system.

Safety tests, specified by the manufacturer, shall be carried out for the individual systems which verify the operational safety requirements previously defined in this standard.

The results of the safety tests shall be documented.

##### 5.1.6.1 Test for harmful radiation to humans and livestock

If the A-VDGS produces potentially harmful radiation to humans and livestock according to the requirements in 4.3.4, a test according to the relevant standard shall be performed by an accredited third party.

The results of the radiation tests shall be documented.

### 5.2 Factory test

All equipment manufactured under specifications shall pass appropriate factory tests prior to shipment.

A factory test shall be conducted to verify that the assembly line is producing units of same properties and performance as the type tested units.

The following test has to be carried out with all systems:

- visual inspection;
- representative functional test.

The result of the factory test shall be documented. Where applicable, evidence of certification or type approval shall be provided.

### 5.3 Site test

The site test shall verify that the installation has been done according to the documentation provided by the manufacturer to provide the requirements during the on site operation.

The test documentation has to be provided by the manufacturer and has to cover all special conditions of the location.

The site test shall be carried out with each individual system and if applicable with the total system including the interfacing to other systems.

The site test shall include but not be limited to:

- correct and safe mechanical installation;
- correct and safe electrical installation;
- correct labelling;
- correct calibration and adjustment of the system;
- correct parameterisation of the software according to the place of installation;
- test of each safety function;
- representative functional test;
- representative performance test.

The result of the site test shall be documented.

# Annex A
(informative)

## Best practices for an A-VDGS and proved methods – Functions to support the operation particular on busy airports

This annex includes information and definitions not considered as minimum requirement. The following information is considered as best practices for an A-VDGS and proved methods and functions to support the operation particular on busy airports.

### A.1 Informative documents

The listed documents could be useful for the design and the operation of an A-SMGCS. The documents can be changed without notice and influence to this European Standard:

- ICAO Annex 14, Aerodromes, Volume I: Aerodrome Design and Operations
- ICAO Aerodrome Design Manual, Part 4
- ICAO Document 8643, Aircraft Type Designators
- EN 55011, Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement (CISPR 11, mod.)
- EN 55022, Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement (CISPR 22, mod.)
- EN 61140, Protection against electric shock – Common aspects for installation and equipment (IEC 61140)
- EN 61508 series, Functional safety of electrical/electronic/programmable electronic safety-related systems (IEC 61508 series)

### A.2 Indications to the guided aircraft pilot

The A-VDGS is part of the airport facilities intended to support aircraft operation. Under this aspect the minimum operational requirements are given by the ICAO in Annex 14. This includes the operational distances and the basics of the presentation.

For airports with a complex parking area and high traffic it has been proved that the following extensions to the distances defined by ICAO Annex 14 operational are useful to provide safe and efficient docking procedures.

The A-VDGS display should be able to provide continuously at least the following information or indications to the pilots at least in the defined range related to the actual stop point.

**Table A.1 – Information provided by the A-VDGS display**

| Information | Minimum range m |
|---|---|
| Emergency stop indication in case of a failure or dangerous situation | 100 |
| Stand is open and prepared for docking | 100 - 25 |
| Aircraft type which the system is actually selected to guide | 80 - 25 |
| Guidance in progress (positive active indication) | 25 |
| Speeding (speed to high for an accurate guidance) | 25 |
| Azimuth guidance | 25 |
| Remaining distance of the nose wheel to the stop point<br>*The presentation shall be analogue in a resolution of 1 m* | 15 |
| Remaining distance of the nose wheel to the stop point<br>*The presentation shall be digital in a resolution of 1 m for a distance range down to 3 m and a 1/10 of a meter in the distance range less than 3 m* | 9 |
| When provided:<br>Aircraft ground speed in knots<br>*The presentation shall be digital in a resolution of 1 kt* | 9 |
| Aircraft reached the stop point | Inside of the stop area only |
| Aircraft overruns the stop area | Behind the stop area only |

### A.3 Weather independency

It should be considered that the mostly weather independent operation is a strong operational factor for airports operating under CAT II and CAT III low visibility conditions.

To provide an acceptable low visibility operation with the A-VDGS the system should ensure that docking can be carried out even during weather conditions down to 100 m Meteorological Optical Range (MOR) on the stand.

### A.4 Operational log

For airports with high traffic it is helpful to provide an automatic log to allow an analysis of the docking history. Such a log should fulfil at least the following requirements.

A log should be stored for at least the last 10 docking procedures.

The log should include all data, events and inputs that enable back tracing a docking with a time stamp in a resolution of at least one second. The time information should include the complete information about year, month, day, hour, minute and second of the event.

The data should include all system inputs, information displayed or exchanged with external systems and all failure codes generated by internal self checks.

The storage device should consist of a non-volatile type.

## Annex ZZ
(informative)

## Coverage of Essential Requirements of EC Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Article 1 of Annex I of the EC Directive 2004/108/EC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

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