## ПІДТВЕРДЖУВАЛЬНЕ ПОВІДОМЛЕННЯ

**Державне підприємство**
**«Український науково-дослідний і навчальний центр**
**проблем стандартизації, сертифікації та якості»**
**(ДП «УкрНДНЦ»)**

Наказ від 21.10.2016 № 336

**EN 50545-1:2011**
**Electrical apparatus for the detection and measurement of toxic and combustible gases in car parks and tunnels — Part 1: General performance requirements and test methods for the detection and measurement of carbon monoxide and nitrogen oxides**

прийнято як національний стандарт
методом «підтвердження» за позначенням

**ДСТУ EN 50545-1:2016**
**(EN 50545-1:2011, IDT)**

**Електричні прилади для виявлення та вимірювання вмісту токсичних та горючих газів в автомобільних паркінгах та тунелях. Частина 1. Загальні технічні вимоги та методи випробування для виявлення та вимірювання вмісту монооксиду вуглецю та оксидів азоту**

З наданням чинності від 2016–11–01

***Відповідає офіційному тексту***

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 50545-1:2011+A1

March 2016

ICS 13.040.50

English version

# Electrical apparatus for the detection and measurement of toxic and combustible gases in car parks and tunnels Part 1: General performance requirements and test methods for the detection and measurement of carbon monoxide and nitrogen oxides

Appareil électrique de détection de mesure de gaz combustible et toxique dans les parcs de stationnement et les tunnels – Partie 1: Exigences de performance générales et méthodes pour la détection et la mesure du monoxyde de carbone et d'oxyde d'azote

Elektrische Geräte für die Detektion und Messung von toxischen (und brennbaren) Gasen in Tiefgaragen und Tunneln - Teil 1: Allgemeine Anforderungen an das Betriebsverhalten sowie Prüfverfahren für die Detektion und Messung von Kohlenmonoxid und Stickoxiden



**Management Centre: Avenue Marnix 17, B - 1000 Brussels**



Ref. No. EN 50545-1:2011 E

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## Foreword

This document (EN 50545-1:2011) has been prepared by CLC Technical Body 216 "Gas detectors".

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2012-08-15
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2014-08-15

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

## Foreword to amendment A1

This document (EN 50545-1:2011/A1:2016) has been prepared by CLC/TC 216 "Gas detectors".

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2017-01-25
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2019-01-25

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## Introduction

This European Standard does not give guidance on installation of a gas detection system.

This European Standard specifies unique ranges and alarm levels for type testing, specifying minimum requirements. All alarm levels are variable and may be adapted to national and/or local regulations.

Separate type testing of remote gas sensors and control units is permitted. It is common practice to use an integrated tunnel control system that includes processing of toxic gas measurement along with other monitoring functions. When remote gas detectors and control units are type tested separately, it is the responsibility of the manufacturer to ensure that the assembled system complies with the requirements of this European Standard. The maximum capacity of the assembled system should not exceed the capacity of the system that has been type tested.

Engineering companies or installers who buy equipment from different manufacturers are responsible for the proper integration of the system.

# 1 Scope

This European Standard applies to apparatus for the detection and/or the measurement of carbon monoxide (CO), nitrogen monoxide (NO) and nitrogen dioxide ($NO_2$) intended to control a ventilation system and/or to give an indication, alarm or any other signal to warn of a toxic hazard. These three gases are generically called “target gases” for the purpose of this European Standard.

National and local regulations might not require detection of NO or $NO_2$ and might require detection of other gases or vapours.

This European Standard includes requirements for remote gas sensors (RGS) to be used in car parks and tunnels and requirements for the control unit (CU) to be used in car parks.

This European Standard specifies general requirements for construction and testing and describes the test methods that apply to fixed apparatus for the detection and/or the measurement of the concentration of the target gases in car parks and tunnels. This European Standard may also be applied to similar applications where the concentration of the target gases could lead to a risk to health, for example loading areas for trucks and underground bus stations.

This European Standard also applies when an apparatus manufacturer makes any claims regarding superior performance that exceeds these minimum requirements.

This European Standard applies to apparatus, including the sampling system if applicable.

This European Standard does not specify requirements for apparatus to be installed in hazardous areas.

This European Standard does not apply for applications already covered by the following standards:

- domestic premises, covered by EN 50291-1;
- boats, craft, caravans or mobile homes, covered by EN 50291-2;
- workplace atmospheres, covered by EN 45544 series;
- emissions of heaters, covered by EN 50379 series;
- motor vehicles emissions, covered by ISO/PAS 3930;
- monitoring of the LEL level of combustible gases, covered by EN 60079-29-1.

This European Standard does not apply for the following applications and technologies:

- confined spaces not accessible to people;
- laboratory or analytical equipment;
- apparatus used to control industrial processes;
- portable and transportable apparatus;
- open path gas detection;
- tunnel construction;
- monitoring of particulates and dust;
- monitoring of combustible gases;
- CO monitoring for fire detection.

## 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 50270, *Electromagnetic compatibility – Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen*

EN 50271, *Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen – Requirements and tests for apparatus using software and/or digital technologies*

EN 60073, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators* (IEC 60073)

EN 60335-1:2002 + corr. Jul.2009 + corr. May.2010 + A1:2004 + corr. Jan.2007 + A2:2006 + A11:2004 + A12:2006 + corr. Feb.2007 + A13:2008 + A14:2010, *Household and similar electrical appliances – Safety – Part 1: General requirements* (IEC 60335-1:2001 + A1:2004 + A2:2006 + corrigendum Aug. 2006*)*

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

## 3 Terms and definitions

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

### 3.1 Gas properties

**3.1.1**
**clean air**
air that is free of target gas, interfering gases or contaminating substances

**3.1.2**
**hazardous area (potentially explosive atmosphere)**
an atmosphere which could become explosive due to local and operational conditions

NOTE Operation in hazardous areas may require legislative measures for the approval, installation and construction requirements of the apparatus.

**3.1.3**
**ppm.min**
gas concentration multiplied by the time, in minutes, of gas application

NOTE Used for testing Time-weighted Average (TWA).

**3.1.4**
**volume ratio**
V/V
ratio of one component in a mixture divided by the sum of the volumes of all the components before they are mixed at specified temperature and pressure conditions

[ISO 7504]

NOTE 1 This is also known as concentration.

NOTE 2 Assuming ideal behaviour or gases, the volume ratio coincides with the molar ratio (mol/mol). The ppm units are equivalent to the International System units $10^{-6}$ vol/vol.

## 3.2 Types of apparatus and components

**3.2.1**
**calibration mask**
device that when applied to the sensor provides the continuous and renovated gas supply to the sensor such that the gas concentration reaching the sensing element remains unchanged

**3.2.2**
**control unit**
CU
part of the apparatus that receives and processes the analogue or digital signal generated by the sensors and also generates alarms and output functions

**3.2.3**
**fixed apparatus**
apparatus that is intended to have all parts permanently installed

**3.2.4**
**power supply**
device that, by means of mains electricity or one or more rechargeable batteries, provides the suitable power to the system or part of it

**3.2.5**
**remote gas sensor**
RGS
sensor that is not integral to the control unit of the apparatus

**3.2.6**
**sample line**
tubing and connection components by means of which the gas being sampled is conveyed to the sensor

**3.2.7**
**special tool**
tool required to gain access to, or to adjust controls

NOTE The design of the tool is intended to discourage unauthorized interference with the apparatus.

## 3.3 Sensors

**3.3.1**
**aspirated sensor**
sensor that accesses the gas by drawing it to the sensing element with a pump or by other means. If the device samples more than one point, it cycles through all related points

**3.3.2**
**diffusion sensor**
sensor that accesses the gas by convection and diffusion from the atmosphere to the sensing element, i.e. under conditions in which there is no aspirated flow

**3.3.3**
**sensing element**
device with an electric output signal that changes when it interacts with the target gas

**3.3.4**
**sensor**
assembly in which the sensing element is housed and that may also contain associated circuit components

NOTE The sensor may be integral with either the CU or remote (RGS).

## 3.4 Signals and alarms

**3.4.1**
**activation levels**
sensor signal levels that trigger outputs and/or an alarm indications

**3.4.2**
**alarm indication**
audible or visible indication activated when a pre-set concentration level is reached

**3.4.3**
**alarm set point**
adjustable setting of the apparatus that sets the level of concentration over a period of time at which the apparatus will automatically initiate an alarm indication and/or output

**3.4.4**
**fault**
dysfunction of a part of the system that does not disable the rest of the measure and control functions

**3.4.5**
**fault signal**
audible, visible or other type of output different from the alarm signal, signalling, directly or indirectly, a warning or indication that the apparatus is not working satisfactorily

**3.4.6**
**indicators**
means to provide visible and/or audible information

**3.4.7**
**latching alarm**
alarm that, once activated, requires deliberate action for deactivation

**3.4.8**
**system fault**
dysfunction of the system that disables the control function

**3.4.9**
**output**
physical interface that drives external actuators

EXAMPLES Air extractors, remote warning and alarm devices.

**3.4.10**
**quiescent condition**
normal operative condition where no alarm or fault or other abnormal condition occurs

## 3.5 Time

**3.5.1**
**final indication**
sensor signal indication given by the apparatus after stabilization

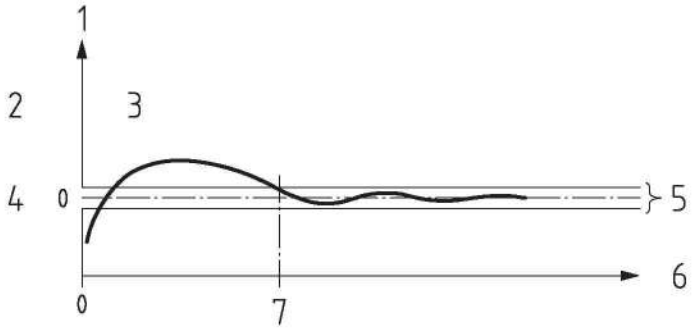
**3.5.2**
**stabilized apparatus**
state when three successive readings of an apparatus, taken at five-minute intervals, indicate no changes greater than ± 1 % of the measuring range

**3.5.3**
**time of response**
$t_x$
time interval, with the apparatus in a warmed-up condition, between the time when an instantaneous variation in volume ratio is produced at the apparatus inlet and the time when the response reaches a stated percentage ($x$) of the final indication

NOTE This European Standard refers to $t_{90}$ as the time of response.

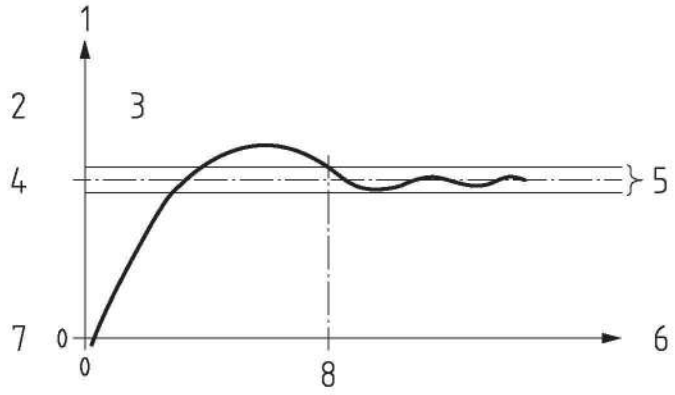
**3.5.4**
**warm up time**
time interval, with the apparatus in a stated atmosphere, between the time when the apparatus is switched on and the time when the indication reaches and remains within the stated tolerances

NOTE See Figures 1 and 2.




**Key**
1 indication
2 power off in clean air
3 power on in clean air
4 apparatus zero
5 specified tolerance band on zero indication
6 time
7 warm-up time

**Figure 1 – Warm-up time in clean air (typical)**




**Key**
1 indication
2 power off in standard test gas
3 power on in standard test gas
4 volume ratio of standard test gas
5 specified tolerances of the indication
6 time
7 zero in clean air
8 warm-up time

**Figure 2 – Warm-up time in standard test gas (typical)**

## 3.6 Other

**3.6.1**
**systematic error of deviation**
difference between the arithmetic average value of n consecutive measurements of a reference gas, carried out at reference conditions, and the accepted reference value

**3.6.2**
**zone**
geographical subdivision of the surveyed premises in which one or more sample points or RGS are installed and for which a common output and/or indication is provided

# 4 General requirements

## 4.1 Introduction

### 4.1.1 Purpose

The apparatus shall detect the presence of target gases in fixed installations under the stated application conditions. The sensor shall produce an analogue or digital signal (related to the concentration of the target gases) that is processed in the CU and produces an output signal and/or an alarm indication as defined in 4.3. Its function is to prevent and warn about the potential toxic gas risks.

### 4.1.2 Functionality

Apparatus for the detection and measurement of target gases in car parks and tunnels shall include the following functionalities:

- sensors (RGS or internal in the apparatus);
- control unit / control indicating equipment (CU);
- power supply;
- indicators (visible and audible);
- output functions.

NOTE Functionalities may be in a single housing or distributed in multiple housings, and may be combined with other functional modules. Type testing may be carried out for a complete apparatus or separately for RGS and/or CU.

### 4.1.3 Software-controlled apparatus

Software-controlled apparatus shall conform to EN 50271.

## 4.2 Construction requirements

### 4.2.1 General

The apparatus or parts thereof (e.g. RGS) specifically intended for use in the presence of corrosive vapours or gases, or which might produce corrosive products as a result of the detection process shall be constructed of materials known to be resistant to corrosion by such substances.

The apparatus shall be constructed to facilitate regular operation and performance checks. All adjustment devices shall be designed so as to discourage unauthorized or inadvertent interference with the apparatus.

The RGS shall be constructed to provide the degree of protection, as defined in EN 60529, in all orientations of installation specified by the manufacturer as defined in 4.5.2. The degree of protection shall be at least IP54.

Aspirated apparatus and control units, when separated from the RGS, shall be constructed to provide a degree of protection of at least IP20.

### 4.2.2 Interface requirements

#### 4.2.2.1 Interface requirements for separately tested RGS

A specification shall be supplied with the RGS that describes the relationship between the gas concentration and the corresponding output signal (transfer function). The specification shall be detailed to the extent that the accuracy of the transfer function can be verified. As a minimum, data shall be provided showing the relationship between the output signal and the gas concentrations corresponding to 0 %, 10 %, 25 %, 50 %, 75 % and 100 % of full-scale indication. Over-range and status signals (e.g. fault or inhibit) shall also be specified.

Where necessary, equipment shall be provided to interpret the output signal or indication, which will enable the accuracy of the transfer function to be verified.

#### 4.2.2.2 Interface requirements for separately tested CU

A specification shall be supplied with the apparatus that describes the relationship between the input signal and the calculated gas concentration (transfer function). The specification shall be detailed to the extent that the accuracy of the transfer function can be verified. As a minimum, data shall be provided showing the relationship between the input signal and the gas concentrations corresponding to 0 %, 10 %, 25 %, 50 %, 75 % and 100 % of full-scale output indication. Required inputs for over-range indications and status signals (e.g. fault or inhibit) shall also be specified.

Where necessary, equipment shall be provided to generate any required input signal, which will enable the accuracy of the transfer function to be verified.

### 4.2.3 Measuring range and alarm levels

The apparatus shall measure the target gas volumetric concentrations with alarm levels and measuring range as specified in 4.3.2.2.

For car parks, the apparatus shall identify at least three threshold conditions.

### 4.2.4 Indicating devices on the CU

#### 4.2.4.1 General

The apparatus shall be equipped with the devices listed below, in order to give operating and maintenance personnel the necessary information about the functioning conditions and the installation it controls. These indications shall be visible and/or audible without manipulation at any access level (as defined in 4.4).

NOTE Remote indicating devices are not covered by this European Standard; they are specified by local regulations.

#### 4.2.4.2 Audible indications

The audible indications of the CU shall be the following:

– alarm indication (at least for alarm 3);

– fault indication.

The audible indication for the gas alarm condition may be the same as that for the fault warning condition. If they are different, the gas alarm indication shall have priority.

The audible indications may be substituted by a system where the CU forwards faults and alarms.

#### 4.2.4.3 Visual indications

The visual indications shall be the following:

– power indication;

– mains fault indication (when an emergency battery is part of the apparatus);

– fault indication;

- warm-up indication (when the function is provided);
- low battery indication (when an emergency battery is part of the apparatus);
- alarm indication;
- low flow rate indication (for aspirated apparatus);
- test condition (maintenance mode);
- disabled condition (part of the system).

A display shall be provided to indicate the measured gas concentration for each detection point. It shall show either the instant or the average measurement.

When displaying different target gases, the concentrations shall be displayed unambiguously.

Indications relating to different status and alarm conditions may be displayed at the same time.

Indicator lights shall be adequately labelled to show their functions and shall be coloured as follows (in accordance with EN 60073):

- alarms indicating the presence of a gas concentration above an alarm set point shall be coloured **RED**;
- equipment fault indicators shall be coloured **YELLOW**;
- power supply indicators shall be coloured **GREEN**.

#### 4.2.4.4 Priority of indications

If several fault or alarm indications are generated simultaneously by the apparatus, it shall be possible to identify separately each indication.

A warning shall be shown if not all indications can be displayed simultaneously. In this case, the indication with the highest alarm priority at the given time shall be displayed or activated. It shall be possible to interrogate the indications that are not currently shown or activated.

Priority of alarm indications shall be defined and documented in the instruction manual.

It is sufficient to indicate the higher priority alarm only.

EXAMPLE Exceeding the second threshold value includes exceeding of the first threshold value.

After cancelling the higher order indication, any lower priority indication shall be shown if the reason for its activation still exists.

### 4.2.5 Output of CU

For each zone, the apparatus shall provide at least one output for each gas alarm condition (as specified in 4.3.2.3) to initiate indicating devices or control actions.

One output shall be provided for fault signalling.

### 4.2.6 Digital components

The apparatus (RGS, if any, and CU) including the digital interface shall conform to EN 50271 for digital components.

### 4.2.7 User interface

The apparatus shall be supplied with all the items such as special tools, keyboards, displays, terminals and software for configuration to make all necessary field adjustments or maintenance operations.

#### 4.2.8 Calibration mask

For diffusion apparatus, the manufacturer shall provide a calibration mask adapted to the apparatus that shall be verified as being appropriate for the calibration and type testing (see 6.18).

The verified calibration mask shall be used for type testing of the sensor.

When applying it, removal of any protection cover that could be mounted on the RGS is allowed.

### 4.3 Operational requirements

#### 4.3.1 Introduction

The apparatus shall have two operational modes:

– measuring mode, which includes quiescent mode and gas alarm condition;

– special state mode, which includes fault condition, disabled RGS, warm-up and maintenance.

#### 4.3.2 Measuring mode

##### 4.3.2.1 Measuring range

The measuring range for each target gas shall be as specified in Table 1.

**Table 1 – Measuring range**

| Target gas | Range<br>ppm |
|---|---|
| CO | 0 … 300 |
| $NO_2$ | 0 … 30 |
| NO | 0 … 100 |

##### 4.3.2.2 Alarm levels

The apparatus shall be type tested with the target gas volumetric concentrations and alarm levels as defined in Table 2.

To fulfil different local regulations, alarm set points shall be adjustable throughout the measuring ranges and averaging time periods shall be adjustable from 5 min to 60 min.

The resolution for alarm setting shall be 1 % of the measuring range or better.

**Table 2 – Alarm levels**

All values in ppm

| Target gas | Alarm 1 | Alarm 2 | Alarm 3 |
|---|---|---|---|
| CO | 30 | 60 | 150 |
| $NO_2$ | 3 | 6 | 15 |
| NO | 10 | 20 | 50 |

Alarms 1 and 2 are 15 min Time-weighted Averages (TWA).

Alarm 3 shall be triggered when any RGS or sample point is above the specified level continuously for a period of one minute. The period shall be adjustable from 1 min to 5 min.

#### 4.3.2.3 Alarm conditions and outputs

The following gas concentration measurements shall apply for sampling points or RGS:

The apparatus shall enter an alarm condition when one or more measurements exceed the alarm set points.

Each measurement shall be processed independently, without interference from any other measurement in the same or any other zone.

For each zone, the alarm condition (alarm 1, alarm 2, alarm 3) shall be determined by the highest of its measurements.

The alarm 2 and alarm 3 conditions comprise and maintain (or initiate when not yet active) its related lower alarm conditions (alarm 1, alarm 2).

For each zone, the outputs related to the alarm conditions shall be activated.

The audible indication of alarm conditions within the CU may be silenced.

### 4.3.3 Special state

#### 4.3.3.1 Fault condition

If the apparatus or some of its parts are not working properly then the fault condition shall be switched on. This shall be overridden by

- any gas alarm, which has priority, and/or
- disablement of the corresponding sensor or function, and/or
- testing of a corresponding sensor or function.

The fault indication shall be switched on if the apparatus or some of its parts are not working properly, including, for example, a short circuit or interruption of a connection to the RGS or any other component contained in a different cabinet than the CU.

The following faults shall be indicated separately by means of light emitting indicators and optionally by an alphanumeric display. The indications may be suppressed during the gas alarm condition.

a) An indication for each RGS or zone in which the transmission of signals to the CU is affected by
   - short circuit or interruption in a detection circuit,
   - removal of a RGS or a sensor.

b) At least one common indication of any power supply fault resulting from
   - short circuit or an interruption in a transmission path to a power supply, when the power supply is contained in a different cabinet from that of the CU,
   - failure of either AC or DC power supply when also provided with a back-up battery.

c) Low battery condition for a back-up battery if supplied.

d) An indication of any short circuit or interruption, at least common to all transmission paths between parts of the CU contained in more than one mechanical cabinet, which is capable of affecting a mandatory function, and which is not otherwise indicated as a fault of a supervised function.

e) Flow fault indication, for aspirated apparatus only.

The audible indication of fault conditions may be silenced.

In the case of software-controlled apparatus, a system fault shall be visibly and audibly indicated, as specified in EN 50271. This fault state shall not be suppressed by any other functional condition of the apparatus and shall remain until manually reset and/or another manual operation.

#### 4.3.3.2 Disabled RGS (when this function is implemented)

The following functions shall be independently disabled and re-enabled:

- each RGS (or zone);
- output signals and/or transmission paths to automatic controls or alarm devices.

The disablement shall be indicated by means of separate light emitting indicators and/or an alphanumeric display. The indications shall not be suppressed during the gas alarm condition.

#### 4.3.3.3 Warm-up (when this function is implemented)

When the RGS is waiting for stabilization of the sensor, an initial warm-up time during which the RGS monitoring activity is disabled is acceptable, provided that during such time the output function of fault or warm-up disablement is active.

If an indicator is provided, signalling that the RGS is not in measuring mode during warm-up, it shall be different to the indicators of 4.3.3.2.

#### 4.3.3.4 Maintenance

Maintenance mode includes

- commissioning,
- calibration,
- test (when this function is implemented),
- repair.

Maintenance mode for a single RGS, a group of RGSs or the entire system may be entered. When maintenance mode is entered, the related outputs may be re-set to the non-alarm condition. During maintenance, new related alarms shall not trigger the outputs.

### 4.3.4 Multiple point selector (aspirated only)

If the apparatus samples sequentially at multiple points, the maximum cycle time shall be 3 min for measuring all related measuring points to ensure that at least five measurements are used in the TWA calculation as specified in 4.3.2.2.

### 4.3.5 Display of CU

This read-out device is intended for the presentation of the measured gas concentrations. When the apparatus has more than one sampling point or RGS and only one indication device, this shall show on demand the value of each measuring point(s), distinguishing between the instant and the average value(s). Different indication modes may be selected on user request.

## 4.4 Access level

The apparatus shall be designed in order to avoid manipulation by persons without specific skills or authorization of the protected functions.

NOTE This could be done, for example, by mechanically restricting access to the apparatus with keys or special tools or by software that may have different access levels.

The manufacturer's established access levels shall be explained clearly.

The protected functions are

- modification of configuration,
- re-setting of latched alarms if fitted,
- maintenance including test and calibration,
- replacement of components.

## 4.5 Information for the user

### 4.5.1 Labelling and marking

The RGS shall carry a label placed onto the case of the device that is easily accessible to the installer. The label is not required to be visible in normal operation.

The CU shall carry a label placed onto the case of the device that is easily accessible during operation.

The labels shall be marked legibly and indelibly with the following minimum requirements:

- name of the manufacturer;
- CE certification marking;
- designation of series or type;
- serial number;
- reference to this European Standard.

### 4.5.2 Instruction manual

Each apparatus shall be provided with an instruction manual that includes the following information:

a) complete instructions, drawings and diagrams for safe and proper operation, installation and servicing of the apparatus;

b) operating instructions and adjustment procedures;

c) recommendations for initial checking and calibration of the apparatus;

d) complete instructions for checking, calibrating and function tests of the apparatus on a routine basis, including any necessary information, especially
   - concentrations of calibration gases,
   - flow rate,
   - application method,
   - calibration mask, including instructions for the use of the field calibration kit, if provided;

e) checking and calibration intervals shall be specified. Calibration interval shall be a maximum of 12 months;

f) details of operational limitations including, where applicable, the following:
   - gases for which the apparatus is suitable;
   - information that describes the cross interference of other gases to which the apparatus is responsive;
   - response times ($t_{90}$) for the target gas(es);
   - temperature range;
   - humidity range;
   - pressure range;
   - supply voltage range;
   - maximum power consumption;
   - relevant characteristics and construction details of required interconnecting cables and interface specification;
   - back-up battery information (if fitted);
   - sample flow rate;
   - warm-up time;
   - stabilization time;

g) details of storage life and limitations for the apparatus, replacement parts and accessories, including, where applicable, the following:
   - temperature;
   - humidity;
   - pressure;
   - time;

h) for aspirated apparatus, indication of the minimum and maximum flow rates and pressure; also: tubing type, maximum length and size for proper operation;

i) for aspirated apparatus, instructions for ensuring that the sample lines are intact and that proper flow is established;

j) for the CU, statements of the nature and significance of all alarms and fault signals, the duration of such alarms and signals (if time-limited or non-latching), and any provisions that can be made for silencing or resetting such alarms and signals, as applicable;

k) details of any method for the determination of the possible sources of a malfunction and any corrective procedures (i.e. trouble-shooting procedures);

l) for the CU, statement that alarm devices, outputs or contacts are of the non-latching types, where applicable;

m) recommended replacement parts list.

# 5 Test requirements

## 5.1 General

For the purpose of type testing, the tests shall be carried out on one apparatus. Additional apparatus may be used for each of the long-term stability, impact and vibration tests.

In addition to the performance testing in Clause 6, other testing is required.

- Verifications shall be carried out to ensure that the apparatus conforms to the construction requirements of 4.2. The requirements of these tests are in general obvious, except the requirement for short circuits of 4.3.3.1, in which resistances shall replace each wire that connects the instrument to a RGS. The values of these resistances shall be the maximum resistance of the connecting wires as specified in the instruction manual, which allows compliance with this European Standard. The device used for the short circuit shall be of negligible resistance and shall be applied at the ends of the resistances, close to the CU.
- The instruction manual shall be inspected for conformity to the requirements of 4.5.2.
- When the manufacturer makes any claims regarding any special features of construction or superior performance that exceed these minimum requirements, additional tests shall be performed to verify the claimed features or superior performance.

## 5.2 Sequence of tests

### 5.2.1 General

All tests of Clause 6 shall be carried out, where applicable, in an order agreed between the manufacturer and the test laboratory. The test specified in 6.2 shall be carried out first and the one specified in [A1] 6.17 [A1] shall be carried out second, if applicable.

### 5.2.2 Separate testing of RGS

For RGS having serial or parallel communications options used during normal gas detection operation, the tests specified in 6.3, 6.5 to [A1] 6.10, 6.12 to 6.17 and 6.20 [A1] shall be performed with all communication ports connected. The maximum transaction rate, cabling characteristics and activity level specified by the instrument's manufacturer shall be employed.

### 5.2.3 Separate testing of CU

For CU, the tests specified in 6.3 to 6.6, [A1] 6.12 to 6.15, 6.18 and 6.20 [A1] shall be performed with the maximum system communications transaction rate and activity level. This shall correspond to the largest and most complex system configuration permitted by the manufacturer.

## 5.3 Preparation of apparatus before testing

### 5.3.1 Apparatus

The apparatus shall be prepared and mounted in accordance with the instruction manual.

Adjustments may be done, where appropriate, at the beginning of each test, but once the test is running, no subsequent adjustment shall be carried out except when it is specifically permitted by that particular test.

For apparatus where the resolution and/or update time of the readout device is inadequate to demonstrate conformity to this European Standard, suitable points for connecting indicating or recording devices for the purpose of testing shall be provided.

During type testing (except for the test specified in 6.4), the audible alarm may be disabled.

In particular, the following points shall be noted.

For apparatus having RGS, for the purpose of the tests in Clause 6, where reference is made to exposure of the sensor to the test conditions, the entire RGS shall be exposed to the test conditions.

For CU having analogue (e.g. 4 mA to 20 mA) connection facilities for more than one RGS, only one RGS for each target gas needs to be subjected to the tests. The replacement of all but one sensor by "dummy" impedances yielding the worst-case load conditions for the test in question shall be permitted. The worst-case load conditions shall be as specified in the instruction manual.

For CU having digital connection facilities for more than one RGS, only one RGS for each target gas shall be subjected to the tests.

NOTE Testing of the digital data transmission is covered by EN 50271.

For apparatus having self-contained sensors, the entire apparatus shall be exposed to the test conditions without removal of any normally attached parts, including any sampling system for tests as in [A1] 6.8, 6.13 and 6.18 [A1].

In all cases, optional parts shall be either attached or removed according to which condition will give the most unfavourable result for the test being conducted.

### 5.3.2 Test chamber

The construction of the test chamber and gas delivery system shall be such as to ensure that the apparatus is exposed to a specific volume ratio of test gas in a reproducible manner.

## 5.4 Test gas application

### 5.4.1 Calibration mask

For diffusion apparatus, the manufacturer shall provide a calibration mask.

This mask shall be used for type testing, or the gas shall be applied using test chambers.

### 5.4.2 Aspirated apparatus or aspirated RGS

During type testing, the flow-rate shall be 10 % greater than the lowest specified flow-rate for the activation of the fault indication.

NOTE Functional testing of "multiple point selector" is described in A1 6.18 A1.

For all tests except the one specified in A1 6.18 A1, all the inlets of the apparatus shall be connected to one aspiration pipe used for applying test gas.

## 5.5 Normal conditions for test

### 5.5.1 General

The test conditions defined at 5.5.2 to 5.5.8 shall be used for all tests, unless otherwise stated.

### 5.5.2 Test gases

For each target gas, the test gas concentration (standard test gas and other gases) shall be known with a maximum uncertainty as specified in Table 3.

Mixtures may be prepared by any standard method (for example, according to the methods described in EN ISO 6142, EN ISO 6143, EN ISO 6144 and EN ISO 6145 series).

**Table 3 – Maximum uncertainty and concentration of standard test gases**

| Target gas | Maximum uncertainty | Concentration ppm |
|---|---|---|
| CO | ± 2 % | 180 ± 10 |
| $NO_2$ | ± 4 % | 18 ± 2 |
| NO | ± 2 % | 60 ± 4 |

To avoid problems due to the maximum uncertainty of calibration gas cylinders for testing the linearity according to 6.3 for each gas, only one cylinder shall be used. To achieve different gas concentrations, it shall be diluted as appropriate.

For $NO_2$ testing, the adhesive property of this gas shall be minimized by using suitable materials for pipe-work and for the test chamber, if used, see Annex A.

For NO testing, the chemical reaction with oxygen shall be minimized by avoiding static conditions and by starting with an NO in nitrogen gas mixture before final dilution to the target values.

### 5.5.3 Voltage

Mains powered apparatus shall be operated within ± 2 % of the manufacturer's recommended supply voltage and frequency.

### 5.5.4 Temperature

The ambient air and test gas shall be held at a constant temperature ± 2 °C within the range 15 °C to 25 °C, throughout the duration of each test.

The temperature shall be recorded during each test.

### 5.5.5 Pressure

Tests shall be performed at constant pressure ± 1 kPa within the interval 86 kPa and 108 kPa during the test, unless otherwise specified in Clause 6.

#### 5.5.6 Humidity

Tests shall be performed in ambient air having a relative humidity (RH) controlled to within ± 10 % RH over the range 20 % to 80 % throughout each test, unless otherwise specified in Clause 6.

The test gases may be humidified, if specified in the instruction manual, at a constant RH (± 10 % RH) throughout each test.

NOTE To avoid problems with absorption of target gas by humidification, the method specified in Annex A should be used.

When humidified test gases are used, the test gas concentration shall be corrected for dilution by the water vapour.

#### 5.5.7 Stabilization time

Every time the apparatus is subjected to a different test condition, it shall be allowed to stabilize for the period specified in the instruction manual.

#### 5.5.8 Orientation

The RGS shall be tested in the orientation recommended by the manufacturer.

## 6 Test methods

### 6.1 General

– All tests shall be performed with the standard test gas, unless otherwise stated;

– the apparatus shall be stabilized in clean air for 5 min;

– test gas shall be applied for 5 min; the final measurement shall be recorded;

– clean air shall be applied for a minimum of 5 min.

### 6.2 Unpowered storage

All parts of the apparatus shall be exposed sequentially to the following conditions in clean air only:

a) a temperature of (-20 ± 2) °C for 24 h;

b) ambient temperature for at least 24 h;

c) a temperature of (50 ± 2) °C for 24 h;

d) ambient temperature for at least 24 h.

### 6.3 Linearity

The apparatus shall be exposed to clean air and to four volume ratios (10 %, 20 %, 50 % and 90 % of the measuring range), starting with the lowest and finishing with the highest of the selected volume ratios.

The deviation of each measurement with respect to nominal values of the volume ratios used shall not exceed the values specified in Table 4 and shall not exceed ± 3 % of the measuring range of the apparatus.

**Table 4 – Tolerance for linearity**

All values in ppm

| Target gas | Concentrations and maximum deviations | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Conc. | Max. dev. | Conc. | Max. dev. | Conc. | Max. dev. | Conc. | Max. dev. |
| CO | 30 | 2,0 | 60 | 2,0 | 150 | 5,0 | 270 | 9,0 |
| $NO_2$ | 3 | 0,5 | 6 | 0,5 | 15 | 0,5 | 27 | 1,0 |
| NO | 10 | 1,0 | 20 | 2,0 | 50 | 2,0 | 90 | 3,0 |

## 6.4 Alarm set points and outputs (car parks only)

The method for confirming that the outputs are activated at the same time as the alarms shall be agreed between the test laboratory and the manufacturer.

Activation of the alarm set points and outputs shall be verified by first testing the TWA alarms 1 and 2, then alarm 3.

Alarm set points shall be tested by applying a known gas concentration for a known time until alarms are activated. For alarms 1 and 2, the test gas shall be in the range specified in Table 5 and shall be known to within ± 2 %. Alarm 3 shall be tested using standard test gas.

**Table 5 – ppm.min calculated from Table 2 and alarms 1,2 test gas concentrations**

| Target gas | Alarm 1 | Alarm 2 | Alarms 1,2 test gas conc. | Alarm 3 |
|---|---|---|---|---|
| | ppm.min | ppm.min | ppm | ppm |
| CO | 450 | 900 | 75 ... 90 | 150 |
| $NO_2$ | 45 | 90 | 7,5 ... 9,0 | 15 |
| NO | 75 | 150 | 12,5 ... 15 | 25 |

Test gas for alarms 1 and 2 shall be applied to the apparatus and the times for both alarms 1 and 2 to activate shall be recorded, together with confirmation that the outputs related to alarms 1 and 2 are activated at the same time. The time to alarm is the period from reaching the $t_{90}$ value until alarm activation.

The apparatus shall then be exposed to clean air for 30 min.

The apparatus shall then be exposed to standard test gas and the time for alarm 3 to activate shall be recorded, together with confirmation that the output related to alarm 3 is actuated at the same time. The time to alarm is the period from reaching the indication of alarm 3 value until alarm activation, and shall be 60 s ± 10 s.

The apparatus shall then be exposed to clean air for 30 min.

The ppm.min values until alarms 1 and 2 are activated are calculated and shall be within the tolerances shown in Table 6. If the simple calculation specified above results in the tolerances not being met, a more accurate calculation shall be used considering the systematic error due to the response time of the sensor ($t_{90}$ shall be not greater than 60 s). An example for such a calculation is given in Annex B.

**Table 6 – Tolerances for alarm 1 and alarm 2 activation**

| Target gas | Alarm 1<br>ppm.min | Alarm 2<br>ppm.min |
|---|---|---|
| CO | ± 50 | ± 75 |
| $NO_2$ | ± 5 | ± 8 |
| NO | ± 8 | ± 12 |

## 6.5 Repeatability

The apparatus shall be exposed to the following test gases in turn:

– clean air for 5 min;

– standard test gas for 5 min;

– repeat 5 times for each target gas. Ignore alarm conditions.

Any zero suppression facility shall be deactivated during this test.

Deviation with standard gas between the first and last measurements shall be less than ± 5 % of the indication, allowing for correction of zero deviation. Deviation in clean air shall not be greater than that specified in Table 7 below.

**Table 7 – Tolerances for zero deviation**

| Gas | Maximum deviation<br>ppm |
|---|---|
| CO | 3,0 |
| $NO_2$ | 0,5 |
| NO | 1,0 |

Zero suppression shall not exceed 3 ppm for CO, 0,5 ppm for $NO_2$ and 1 ppm for NO.

## 6.6 Temperature

This test shall be performed in a temperature chamber having the capability of holding the complete apparatus at any temperature in the specified temperature range.

The complete equipment shall be tested (RGS, if any, and CU). The apparatus shall be maintained for at least 90 min at each test temperature: (20 ± 2) °C, (-10 ± 2) °C, (20 ± 2) °C, (40 ± 2) °C and (20 ± 2) °C. At each test temperature, the sensor shall be exposed to clean air and then to the standard test gas, which should be at the same temperature as the test chamber. The dew point of the clean air, test chamber air and the standard test gas shall be lower than the lowest temperature of the test chamber.

Deviations of the indications at -10 °C and 40 °C with respect to the average of the three indications obtained at 20 °C shall not exceed ± 10 % of the indication for the standard test gas and ± 2 % of the measuring range for clean air.

The deviation from the average of the three indications with standard test gas obtained at 20 °C shall not exceed ± 2 % of the measured value.

## 6.7 Humidity

Clean air and standard test gas shall be applied to the sensor with relative humidity of (15 ± 10) %, (50 ± 10) % and (85 ± 10) % at (40 ± 2) °C, using a climatic chamber or a mask, maintaining each condition for 30 min, recording the indications at the end of this period. The uncertainty of the applied humidity shall not exceed ± 5 % RH.

Deviation of the indications at 15 % RH and 85 % RH with respect to the indications obtained at 50 % RH for standard test gas shall not exceed ± 10 % of measuring range.

Deviation of the indications at 15 % RH and 85 % RH with respect to the indications obtained at 50 % RH for clean air shall not exceed ± 3 % of measuring range.

NOTE Humidity dependence can be tested easily with CO test gas, but is more difficult for NO and $NO_2$ test gases, due to their solubility in water; see Annex A for the recommended method.

〈A1〉 *Text deleted* 〈A1〉

## 6.8 Flow rate (for aspirated apparatus only)

For automatically aspirated apparatus the flow rate shall be set to + 30 % and - 30 % of nominal value. If the manufacturer specifies a greater flow tolerance for flow fault, the flow rate shall be set at this fault flow rate.

This low flow rate shall cause the flow fault signal to be activated. The higher flow rate shall not activate the fault signal.

Deviation of the indications at + 30 % with respect to the nominal flow rate shall not exceed ± 3 % of the measured value.

## 6.9 Interfering gases

The apparatus shall be exposed to each of the gases listed in Table 8, in turn, for at least 10 min.

**Table 8 – Interfering gases table: test results to be inserted into the blank cells**

| Target gas | Interfering gas | | | | |
|---|---|---|---|---|---|
| | CO (180 ppm) | NO (60 ppm) | $CO_2$ (5 000 ppm) | $NO_2$ (18 ppm) | Hexane (100 ppm) |
| CO | 100 % | | < 0,2 % | | < 10 % |
| NO | | 100 % | < 0,1 % | | < 2 % |
| $NO_2$ | | | < 0,1 % | 100 % | < 2 % |

Negative interferences shall be less than 10 % relative.

Gas mixtures may be prepared by any suitable method. The tolerances of the volume ratio of each interfering gas shall be no more than ± 20 % relative with an uncertainty of no more than ± 10 % relative.

The sensitivity of each target gas to the interfering gases in Table 8 shall be recorded, and shall conform to the values specified in the instruction manual and shall not exceed the limits specified in Table 8 for hexane or carbon dioxide.

## 6.10 Recovery from high gas concentrations

One RGS for each target gas shall be subjected to a step change from clean air to the concentration listed in Table 9 below.

**Table 9 – Gas concentration for recovery test**

| Target gas | Gas concentration ppm |
|---|---|
| CO | 3 000 ± 300 |
| $NO_2$ | 300 ± 30 |
| NO | 1 000 ± 100 |

The gas concentration shall be maintained for at least 15 min. The CU shall indicate either full scale or over-range during the exposure.

The RGS shall then be exposed to clean air for 60 min, followed by the standard test gas.

The indications for standard test gas after high gas application shall differ by no more than ± 10 % from the indications before the test and the clean air indications shall not exceed ± 3 % of the measuring range.

## 6.11 Mechanical strength

The RGS shall be tested in accordance with EN 60335-1:2002, Clause 21, with the following modification to the third paragraph.

The apparatus shall be rigidly mounted and three blows shall be applied with an impact energy of (4 ± 0,2) J to every point of the enclosure that is likely to be weak.

The RGS shall meet the requirements specified in EN 60335-1:2002, Clause 21.

## 6.12 Warm-up time

The apparatus shall be switched off and exposed to clean air for at least 8 h. It shall then be switched on in clean air and allowed to warm up.

During warm-up, the apparatus shall indicate a fault signal until it enters measuring mode.

When the apparatus exits the warm-up period, it shall not be in any alarm condition.

The warm-up period shall not exceed 30 min.

## 6.13 Response time

The apparatus shall enable measurement with resolution and update time sufficient to determine the response time accurately.

For aspirated apparatus, gas tubing shall be used with the maximum dimensions specified in the instruction manual, and at the nominal flow rate specified in the instruction manual.

The apparatus shall be tested with the standard test gases.

The response time ($t_{90}$) shall be determined. The response time shall not exceed 1 min.

### 6.14 Power supply variations

The apparatus shall be prepared in normal conditions, at the nominal supply voltage and frequency. For apparatus with RGS, the test shall be performed first with the maximum, and then with the minimum cable impedance. The apparatus shall then be subjected to the test as follows:

The apparatus shall be operated at + 15 %, and then at - 20 % of nominal supply voltage, at the nominal supply frequency.

Deviation of the indications for the standard test gases at + 15 % and - 20 % of nominal voltage with respect to the indications obtained at the nominal voltage shall not exceed ± 3 % of the measured values.

### 6.15 Long-term stability

The apparatus shall be powered continuously for a period of two months while exposed to clean air.

Once every seven days, the apparatus shall be exposed to standard test gas for four hours and the final indication shall be recorded. The indications for clean air shall be recorded immediately before the test gas exposure and after a 30 min recovery period in clean air.

The deviation of the initial indications for the standard test gases with respect to the final indications at the end of the two-month period shall not exceed ± 10 % of the initial measured values.

The deviation of the initial indications for clean air with respect to the final indications at the end of the two-month period shall not exceed ± 3 % of the measurement range.

### 6.16 Field calibration, or field verification kit

If a field calibration or verification kit is provided with the apparatus, the following test shall be performed:

a) calibrate the apparatus in accordance with 5.3.1 using the test conditions given in 5.5 and using the test equipment for the tests described in 5.4,

b) use the field calibration kit in a manner corresponding to the manufacturer's instructions for checking the apparatus response.

The deviation of the indications obtained shall not exceed ± 5 % of the measured values.

### 6.17 Calibration mask

Measurements of standard test gas(es) using the supplied test mask shall be compared with measurement of standard test gas(es) in the test chamber and any deviation shall be less than ± 3 % of the measured values.

Flow rate variations of ± 25 % of the flow rate specified in the instruction manual for the calibration mask shall result in less than ± 2 % deviation of the reading at standard test gas concentration.

### 6.18 Testing of multiple point selector

The maximum number of channels/sample points and the maximum length of pipe-work specified in the instruction manual shall be connected to carry out this test.

Standard test gas shall be applied to one channel/sample point. Clean air shall be applied to all other channels/sample points. During the test, it shall be verified that the correlation between the indication and the number of the channel/sample point is correct.

After two cycles of measurement, the test gas shall be applied to another channel/sample point and two further cycles shall be recorded.

During normal cycling of the different channels/sample points, all channels/sample points exposed to clean air shall meet the requirements for zero deviation specified in Table 7 (see 6.5), while the standard test gas deviations shall be less than ± 5 % of the measured values.

## 6.19 Vibration

This test is applicable to RGS only.

The vibration test machine shall consist of a vibrating table capable of producing a vibration of variable frequency and variable constant excursion (or variable constant acceleration peak), with the test apparatus mounted in place, as required by the following test procedures.

The apparatus shall be mounted on the vibration table in the same manner as intended for service use including any resilient mounts, carrier or holding devices that are provided as standard parts of the apparatus.

Before and at the conclusion of the test, the apparatus shall be exposed to clean air followed by the standard test gas.

The apparatus shall be energized and vibrated over the frequency range specified below at the excursion or constant acceleration peak specified while exposed to clean air, for a period of 1 h in each of the three mutually perpendicular axes:

– lower frequency range: 10 Hz to 30 Hz, 1,0 mm total excursion;
– higher frequency range: 31 Hz to 150 Hz, 2 g acceleration peak.

The rate of change of frequency shall not exceed 10 Hz/min.

The apparatus shall show no loss of function, false alarm or fault signal during or after vibration in clean air.

The indications for standard test gas before and after the test shall not exceed ± 5 % of the measuring range.

## 6.20 Electromagnetic compatibility

The apparatus shall be tested, including the RGS interconnecting wiring, for electromagnetic compatibility with the performance requirements for “type 2” in accordance with EN 50270.

# Annex A
(informative)

# Using NO and $NO_2$ standard test gases for standard and humidity testing

## A.1 General

Although CO has low solubility in water vapour and so can be mixed easily with wet air without significantly diluting the CO gas concentration, both NO and $NO_2$ have significant solubility in water vapour. In addition, $NO_2$ is a "sticky" gas and will deposit on the gas sample train, reducing the actual gas concentration as seen by the sensor.

## A.2 $NO_2$ gas testing

Since $NO_2$ will deposit on the tubing or piping of the delivery system to the RGS or sensor:

- a suitable tubing/ piping material should be used. Best materials are micro-polished SS316 stainless steel and FEP fluoropolymer tubing. Other materials can be used, but the supplier should be consulted for compatibility;
- the gas sampling line should be purged for at least 20 min at a flow rate of at least 500 sccm (0,5 l/min) before testing. Long sampling lines will require longer purges.

## A.3 Humidity testing

Both gases are soluble in water; any gas that preferentially dissolves in the wet air will reduce the gas concentration at the RGS or sensor.

The NO/$NO_2$ gas line should not be bubbled through water in order to control the RH. Rather, two gas lines should be supplied: a dry gas with the required NO/$NO_2$ concentration (after dilution with the wet air stream) and a water saturated line, that, when blended with the dry target gas line will produce the correct RH.

These two gas streams should be mixed as close to the RGS/ sensor as possible to minimize the mixing time when the target gas can dissolve in the wet air.

# Annex B
(informative)

## Clarification regarding "6.4 Alarm set points and outputs (car parks only)"

**B.1** No sensor will show ideal behaviour, therefore it is essential that the response time of the sensor is taken into account (see the example in Figure B.1).

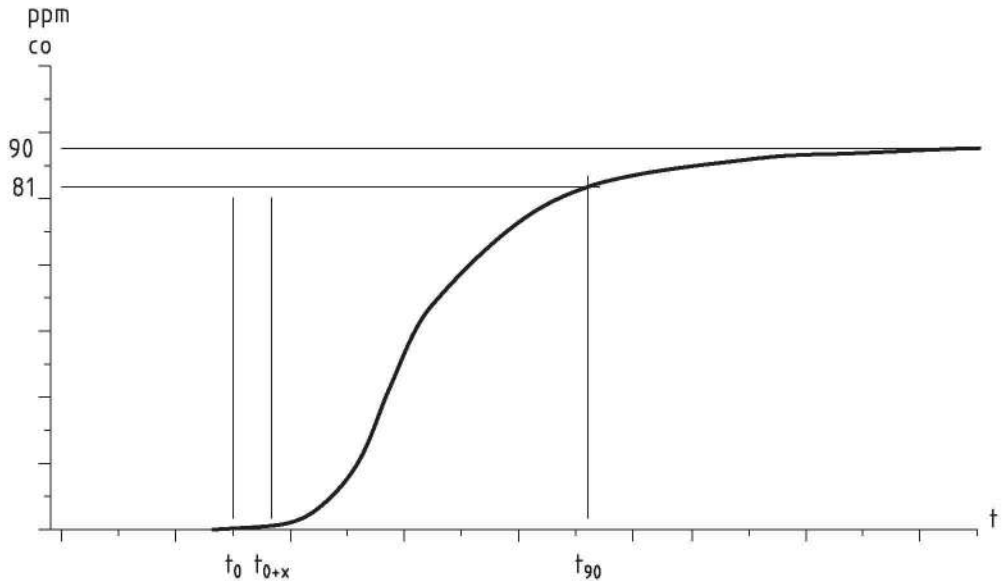



**Figure B.1 – Output of the sensor**

Figure B.1 shows the output of a sensor when a gas of 90 ppm CO is applied at $t_0$. After a short delay $x$, the sensor gives an output that reaches 90 % of the final reading at $t_{90}$. A typical response curve is shown in Figure B.1.

**B.2** To calculate the time-weighted concentration, see the example in Figure B.2.

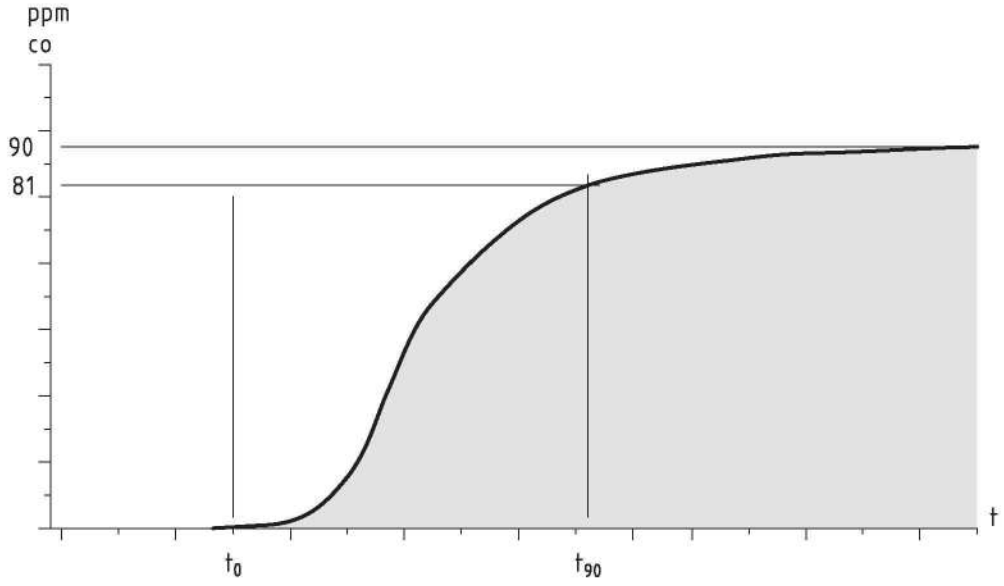



**Figure B.2 – Time-weighted measured gas concentration**

Figure B.2 shows the time-weighted measured gas concentration as the shaded area. This is important, since alarms 1 and 2 are defined as time-weighted averages, where the measured concentration is integrated over time (ppm.min).

**B.3** Error in calculation of the time-weighted concentration is shown in Figure B.3.

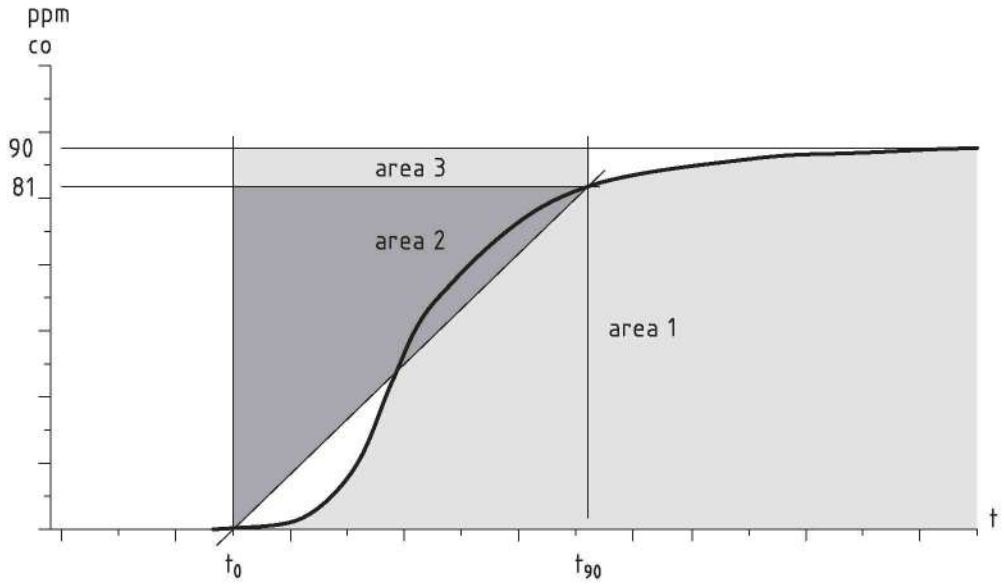



**Figure B.3 – Missing areas for TWA calculation**

Area 1 under the curve is used for calculating the time-weighted average, and areas 2 and 3 should not be included.

The calculation has to take into account that the response time $t_{90}$ may be the maximum allowed (i.e. 1 min, see 6.4). In this calculation example, the applied gas concentration is 90 ppm CO, and for the worst-case calculation, $t_{90}$ is 1 min.

In this case, area 2 is ½ × 90 % of 90 ppm × 1 min = 40,5 ppm.min.

Area 3 is 10 % of 90 ppm × 1 min = 9 ppm.min.

The sum of both is 49,5 ppm.min, which means that it is nearly equal to the tolerances allowed in Table 6.

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