

Guide for selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases or oxygen

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ICS 13.320; 29.260.20

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 24, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments
13167 Corrigendum No.1	June 2001	Changes to national foreword

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 September 1999

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ISBN 0 580 32803 1

English version

Guide for selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases or oxygen

Guide de sélection, d'installation, d'utilisation et de maintenance des appareils de détection et de mesure de gaz combustible ou d'oxygène

Leitfaden für Auswahl, Installation, Einsatz und Wartung von Geräten für das Aufspüren und die Messung brennbarer Gase oder von Sauerstoff

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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

This European Standard was prepared by SC 31-9, Electrical apparatus for the detection and measurement of combustible gases to be used in industrial and commercial potentially explosive atmospheres, of Technical Committee CENELEC TC 31, Electrical apparatus for explosive atmospheres.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50073 on 1998-10-01.

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) 1999-10-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1999-10-01

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1 Scope

This document gives guidance on the selection, installation, use and maintenance of electrically operated Group II¹⁾ apparatus intended for use in industrial and commercial safety applications for the detection and measurement of:

- combustible gases, as described in EN 50054, EN 50057, EN 50058; or
- oxygen as described in EN 50104.

This guide is a compilation of practical knowledge to assist the user. Combustible gas detection apparatus, fixed, transportable or portable, may be used whenever there is the possibility of a risk to life or property caused by the accumulation of a combustible gas-air mixture. Such apparatus can provide a means of reducing the risk by detecting the presence of the combustible gas and issuing suitable audible or visual warnings. It may also be used to initiate specific safety precautions (e.g. plant shutdown, evacuation, operation of fire extinguishing procedures).

It is applicable to all new permanent installations and, where reasonably practicable, to existing permanent installations. It is also applicable to temporary installations, whether new or existing.

This guide is not intended, but may provide useful information, for the following:

- apparatus intended for the measurement of oxygen deficiency which may affect human health;
- apparatus intended only for the detection of non-combustible toxic²⁾ gases;
- apparatus of laboratory or scientific type intended only for analysis or measurement purposes;
- apparatus intended for underground mining applications;
- apparatus intended only for process control applications.

This guide does not apply to the following:

- apparatus for the detection of explosives;
- apparatus intended for the detection of a potentially combustible atmosphere resulting from dust or mist in air;
- open path apparatus not used for point measurement.

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 50014:1997, *Electrical apparatus for potentially explosive atmospheres — General requirements*.

EN 50015:1998, *Electrical apparatus for potentially explosive atmospheres — Oil immersion “o”*.

EN 50016:1995, *Electrical apparatus for potentially explosive atmospheres — Pressurized apparatus “p”*.

EN 50017:1998, *Electrical apparatus for potentially explosive atmospheres — Powder filling “q”*.

EN 50018:1994, *Electrical apparatus for potentially explosive atmospheres — Flameproof enclosure “d”*.

EN 50019:1994, *Electrical apparatus for potentially explosive atmospheres — Increased safety “e”*.

EN 50020:1994, *Electrical apparatus for potentially explosive atmospheres — Intrinsic safety “i”*.

EN 50028:1987, *Electrical apparatus for potentially explosive atmospheres — Encapsulation “m”*.

EN 50039:1980, *Electrical apparatus for potentially explosive atmospheres — Intrinsically safe electrical systems “i”*.

EN 50054:1998, *Electrical apparatus for the detection and measurement of combustible gases — General requirements and test methods*.

EN 50057:1998, *Electrical apparatus for the detection and measurement of combustible gases — Performance requirements for Group II apparatus indicating up to 100 % lower explosive limit*.

EN 50058:1998, *Electrical apparatus for the detection and measurement of combustible gases — Performance requirement for Group II apparatus indicating up to 100 % (V/V) gas*.

EN 50104:1998, *Electrical apparatus for the detection and measurement of oxygen — Performance requirements and test methods*.

EN 60079-10:1996, *Electrical apparatus for potentially explosive atmospheres — Part 10: Classification of hazardous areas*.

IEC 60079-20, *Electrical apparatus for explosive gas atmospheres — Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*.

¹⁾ Group II apparatus are suitable for places with potentially explosive atmospheres, other than mines susceptible to firedamp, see 4.3.

²⁾ For the purpose of this guide, “toxic” covers “toxic”, “very toxic” and “harmful” gases and vapours.

3 Definitions

For the purpose of this standard the following definitions apply.

3.1

type of explosion protection

the measures applied in the construction of electrical apparatus to prevent ignition of a surrounding explosive atmosphere by such apparatus (see 4.3)

3.2

lower explosion limit (LEL)

the volume ratio of combustible gas or vapour in air below which an explosive gas atmosphere will not be formed

3.3

upper explosion limit (UEL)

the volume ratio of combustible gas or vapour in air above which an explosive gas atmosphere will not be formed

3.4

explosive gas atmosphere

a mixture with air, under normal atmospheric conditions, of combustible gases or vapours, in which, after ignition, combustion spreads throughout the unconsumed mixture

3.5

Group II apparatus

electrical apparatus for places with a potentially explosive atmosphere, other than mines susceptible to firedamp (see 4.3)

3.6

firedamp

a combustible gas, consisting mainly of methane, found naturally in mines

3.7

fixed apparatus

an apparatus which is intended to have all its parts permanently installed

3.8

transportable apparatus

an apparatus not intended to be portable, but which can be readily moved from one place to another

3.9

portable apparatus

spot reading or continuously sensing apparatus designed to be readily carried from place to place and to be used whilst being carried. Portable apparatus with integral or separate battery includes, but is not limited to:

- hand-held apparatus, typically less than 1 kg, suitable for single-handed operation;
- personal monitors, similar in size and mass to the hand-held apparatus, that are continuously operating (but not necessarily continuously sensing) whilst attached to the user; and
- larger apparatus up to 5 kg that can be operated by the user whilst suspended by hand, by a shoulder strap or by a carrying harness; it may or may not have a hand directed probe.

3.10

spot reading apparatus

an apparatus intended to be used for short periods of time as required

3.11

continuous duty apparatus

apparatus which is continuously powered but may have continuous or intermittent sensing

3.12

sensor

an assembly in which the sensing element is housed that may contain associated circuit components

3.13 sensing element

that part of a sensor that reacts in the presence of a combustible gas mixture to produce some physical or chemical change that can be used to activate a measuring or alarm function, or both

3.14

catalytic sensor

a sensor, the operation of which depends upon the oxidation of gases on an electrically heated catalytic element (see A.1)

3.15

thermal conductivity sensor

a sensor, the operation of which depends upon the change of heat lost by conduction of an electrically heated element located in the gas to be measured, compared with that of a similar element located in reference gas cell (see A.2)

3.16

infra-red sensor

a sensor, the operation of which depends upon the absorption of infra-red radiation by the gas being detected (see A.3)

3.17

open path infra-red sensor

a sensor that is capable of detecting gas at any location along an open path traversed by an infra-red beam

3.18

semi-conductor sensor

a sensor, the operation of which depends upon changes of the electrical conductance of a semiconductor due to chemisorption of the gas being detected at its surface (see A.4)

3.19

electrochemical sensor

a sensor, the operation of which depends upon changes of the electrical parameters of electrodes placed in an electrolyte due to redox reactions of the gas on the surface of the electrodes (see A.5)

3.20

flame ionization detector (FID)

a sensor, the operation of which depends upon the ionization of the gas being detected in a hydrogen flame (see also A.6)

3.21

flame temperature analyser (FTA)

a sensor, the operation of which depends upon the change of temperature of a flame by the gas being detected (see also A.7)

3.22

photo ionization detector (PID)

a sensor, the operation of which is based on the ionization of gaseous compounds by ultraviolet (uv) radiation (see also A.8)

3.23

paramagnetic oxygen detector

a sensor, the operation of which depends upon the magnetic properties of the gas being detected (see also A.9)

3.24

continuous or quasi-continuous sensing

a mode of operation in which power is applied continuously to the sensing element

3.25

intermittent sensing

a mode of operation in which readings are taken according to a predetermined cycle

3.26

remote sensor

a sensor which is not integral with the main body of the apparatus

3.27

single point sensor

a sensor which is capable of detecting gas at a single point location

3.28

aspirated apparatus

apparatus which obtains the gas by drawing it to the gas sensor, for example, by means of a hand operated or electric pump

3.29

diffusion apparatus

apparatus in which the transfer of gas from the atmosphere to the gas sensing element takes place by diffusion, i.e. there is no aspirated flow

3.30

sampling line

the pipeline by means of which the gas being sampled is conveyed to the sensor including accessories (e.g. filters)

3.31

sampling probe

a separate sampling line that may or may not be supplied with a portable apparatus, that is attached to the apparatus as required

3.32

ambient air

the normal atmosphere surrounding the apparatus

3.33

clean air

air that is free of combustible gases, and interfering contaminating substances

3.34

alarm setpoint

a fixed or adjustable setting of the apparatus that is intended to pre-set the level of concentration at which the apparatus will automatically initiate an indication, alarm or other output function

3.35

drift

the variation in apparatus indication with time at any fixed gas volume ratio (including clean air) under constant ambient conditions

3.36

source of release

a point of location from which a combustible gas, vapour or liquid may be released into the atmosphere such that an explosive gas atmosphere could be formed

3.37

release rate

the quantity of combustible gas or vapour emitted per unit time from the source of release which itself could be a liquid surface

3.38

ventilation

movements of air and its replacement with fresh air due to the effects of wind, temperature gradients, or artificial means (e.g. fans or extractors)

3.39

relative density

the density of gas or vapour relative to the density of air at the same pressure and at the same temperature (air is equal to 1,0)

3.40

flash-point

the lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapours in a quantity such as to be capable of forming an ignitable vapour/air mixture

3.41

volume ratio (V/V)

ratio of the volume of a component to the volume of the gas mixture under specified conditions of temperature and pressure

3.42

dose

the total amount of substance absorbed or trapped, proportional to the concentration and the duration of exposure

3.43

initial calibration

the first calibration for a specific substance, measuring range and application carried out by the manufacturer before delivery or on site before starting the operation

3.44

recalibration

further calibrations carried out periodically to check and adjust the zero signal and the sensitivity of the sensor with a known calibration gas mixture without any changing of the parameters, type of gas, measuring range, specific application, which have been established by the initial calibration

3.45

field check with gas

the application of test gas on the sensor to check the response signal or generating of alarm without adjusting zero signal and sensitivity

3.46

response time

the time interval between the time when an instantaneous increase in gas concentration is produced at the sensor input and the time when the response reaches a stated indication

3.47

recovery time

the time interval between the time when an instantaneous decrease in gas concentration is produced at the sensor input and the time when the response reaches a stated indication

4 Intended application

4.1 General

The physical principles of detection are defined in clause 3 and explained in detail in annex A. Guidance for operation of the most common types of sensors used in apparatus for the detection of combustible gases or oxygen covered by this guide are described in 5.2 to 5.10.

NOTE It is not intended, by means of this guide, to discourage the use of apparatus using detection principles other than those described in 5.2 to 5.10 or to inhibit the development of new detection principles. However, it is of primary importance that the capabilities of the detection principle should be such that the performance of the apparatus is adequate for the intended application. Assessment of the apparatus against the performance requirements specified in EN 50054, EN 50057, EN 50058 and EN 50104 may provide a basis for judgement in appropriate circumstances.

It is normally not possible to determine the concentration of an individual combustible gas within a mixture of combustible gases using the type of apparatus covered by this guide. In general, most of the sensors described in this guide respond to all of the combustible components of a mixture, without discrimination.

When a mixture of gases of known relative concentration is to be monitored, it is recommended that this mixture is used for calibration. When the composition of a mixture is unknown or if a range of gases are likely to be present in the area to be monitored, it is recommended that the sensor is calibrated to the gas to which it is least sensitive. Measurement of oxygen in relation to explosion protection is necessary to:

- ensure the minimum oxygen concentration for correct functioning of apparatus for the detection and measurement of combustible gases and vapours;
- ensure the maximum oxygen concentration in inertisation;
- monitor any increase in oxygen concentration which may increase the upper explosion limit and may decrease the energy required for ignition.

The lower and upper explosive limits of combustible gas in air will vary with temperature, pressure and oxygen concentration. Normal variations in the ambient conditions should not significantly affect the performance of the apparatus. However, if larger variations of temperature or pressure are expected, the manufacturer should be consulted, see also annex D.

According to the specific application, the suitability of the whole system has to be assessed, including the selection and placement of sensors, the alarm levels and response time. It may be appropriate to obtain advice from equipment manufacturers or a suitably trained person.

For apparatus for the detection of combustible gases and oxygen there are two independent categories of test.

- Performance test: to ensure that devices are suitable for the detection of those gases and ranges they are designed for.
- Electrical test: to prevent the ignition of explosive atmospheres by the apparatus itself.

NOTE The EU Directive 94/9/EC covers certification including both categories of test.

4.2 Performance testing

It is recommended that the performance of the apparatus is tested in accordance with EN 50054, EN 50057, EN 50058, EN 50104 or other accepted methods and that the test results are considered for the intended application.

4.3 Electrical testing and certification for use of apparatus in potentially explosive atmospheres

For the use of apparatus in potentially explosive atmospheres, it is a requirement that electrical testing and certification is in accordance with EN 50014 to EN 50020, EN 50028 or EN 50039 or any other type of protection accepted for Group II apparatus.

NOTE Apparatus is required to be endorsed with the “Ex” or “Ex” marking.

The certification is not valid in oxygen enriched atmospheres for example, welding gas mixtures.

4.4 Fixed apparatus and fixed systems

The operation of fixed systems is described in clause 6.

Fixed apparatus should be used where permanent gas monitoring in selected areas of a plant or other installation is required. These areas may be static as in manufacturing plant or mobile as in transport systems. The use of a battery back-up system will increase the availability of the apparatus.

The three main types of fixed apparatus in common use are.

- 1) Apparatus having sensor and control unit situated within the hazardous area. The sensor and control unit may be combined or supplied as separate items.

- 2) Apparatus having sensors separate from the control unit. This type of apparatus usually consists of individual sensors in the hazardous area, connected to the associated control unit which is outside the hazardous area. This is the most common type for the majority of industrial applications.

- 3) Sampling apparatus. This type of apparatus usually has one or more sampling points in the hazardous area, each point connected to the sensor by means of an aspirated sampling line.

Fixed apparatus and systems described here should not be confused with those for process control, which are not covered by this guide.

4.5 Transportable apparatus

The operation of transportable apparatus is described in clause 7.

Transportable apparatus should normally be used for such purposes as monitoring temporary work areas (“hot” work) and areas where combustible liquids, vapours or gases may be transferred.

Care should be taken to avoid condensation in the apparatus and sampling line especially when an apparatus is transferred to an environment with a different ambient temperature.

4.6 Portable apparatus

The operation of portable apparatus is described in clause 7.

Portable apparatus should normally be used for such purposes as leak seeking, verification of combustible gas-free conditions, safety checks and similar applications.

Portable apparatus is normally used in diffusion mode, but where leak seeking is involved or where the apparatus is used for the detection of combustible gas in confined spaces beyond the normal reach of the user, either a static probe or a hand or mechanically aspirated sampling probe will be necessary.

4.7 Sampling lines and sampling probes

Sampling lines are usually permanently installed in fixed installations. Sampling probes are associated with transportable and portable apparatus, are usually short (in the order of 1 m) and rigid, however, they may be telescopic and may be connected to the apparatus by a flexible tube.

Consideration should be given to the effects of condensation occurring with water and high flash point liquids on sampling systems, since condensation may block the sampling line, lower the concentration and hence the reading and may contaminate following samples. To minimize this effect a heating of the sampling line may be necessary; in hazardous areas this heating system shall comply with the relevant regulations, see EN 50014 and related standards.