BS EN 61285:2015

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Industrial-process control — Safety of analyzer houses

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National foreword

This British Standard is the UK implementation of EN 61285:2015. It is identical to IEC 61285:2015. It supersedes BS EN 61285:2004, which will be withdrawn on 30 March 2018.

The UK participation in its preparation was entrusted by Technical Committee GEL/65, Measurement and control, to Subcommittee GEL/65/2, Elements of systems.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Commande des processus industriels - Sécurité des bâtiments pour analyseurs (IEC 61285:2015)

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Foreword

The text of document 65B/954/FDIS, future edition 3 of IEC 61285, prepared by SC 65B "Measurement and control devices", of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61285:2015.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2015-12-31
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-03-31

This document supersedes EN 61285:2004.

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The text of the International Standard IEC 61285:2015 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60079-0 (mod)	2011	Explosive atmospheres -- Part 0: Equipment - General requirements	EN 60079-0	2012
-	-		+A11	2013
IEC 60079-10-1	2008	Explosive atmospheres -- Part 10-1: Classification of areas - Explosive gas atmospheres	EN 60079-10-1	2009
IEC 60079-20-1	2010	Explosive atmospheres - Part 20-1: Material characteristics for gas and vapour classification - Test methods and data	EN 60079-20-1	2010

CONTENTS

INTRODUCTION

Process analysers measure the characteristics of a process stream continuously and automatically. The process sample is introduced automatically and the system is designed for unattended operation and minimal maintenance.

The placement of devices for process analysis in analyser houses is beneficial for technical and economic reasons:

– in order to facilitate appropriate environmental conditions;

– to simplify servicing and maintenance issues;

– to enable the use of a common infrastructure (see 3.5).

This document is designed to set forth minimum safety requirements for typical analyser houses (AHs). It is superseded in all cases by national, local, or corporate requirements, if other or more stringent requirements will apply.

INDUSTRIAL-PROCESS CONTROL – SAFETY OF ANALYSER HOUSES

1 Scope

This International Standard describes the physical requirements for the safe operation of the process analyser measuring system installed in an analyser house (AH) in order to ensure its protection against fire, explosion and health hazards. This standard applies for analyser houses with inner and/or external potential explosive atmospheres and it applies to hazards caused by toxic substances or asphyxiant gases. (Refer to national guidelines on toxic hazards.)

This standard does not address facilities where solids (dust, powder, fibres) are the hazard.

This standard does not seek to address all functional safety issues related to analyser houses.

Clause 4 addresses the location of the AH and connection within the process plant areas.

Clause 5 addresses the design, construction and layout of the AH. It does not address parts of the analyser measuring system installed in other locations such as sample conditioning rooms (SCR) or switchgear rooms.

Clause 6 addresses measures for reducing the danger of explosion for AHs while permitting maintenance of equipment with the power on and the case open.

For most fluids, the major constraint is that the concentration of vapours, which are toxic for personnel, is lower than the lower explosive (flammable) limit (LEL) (see Clause 7).

Using n-Pentane as an example, the LEL is 1,4 % or 14 000 × 10^{-6}, the level immediately dangerous to life or health (which is the maximum level from which a worker could escape within 30 min without any escape-impairing symptoms or any irreversible health effects) is only 0,5 % or 5 000 × 10^{-6}.

Clause 7 addresses those measures for protecting personnel from materials in the atmosphere of AHs that are hazardous to health.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-0:2011, *Explosive atmospheres – Part 0: General requirements*

IEC 60079-10-1:2008, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

IEC 60079-20-1:2010, *Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data*

3 Terms and definitions

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

3.1
analyser cabinet
small housing in which analysers are installed individually or grouped together

Note 1 to entry: Maintenance is performed from outside the cabinet with the door(s) open.

3.2
analyser shelter
structure with one or more sides open and free from obstruction to the natural passage of air, in which one or more analysers are installed

Note 1 to entry: The maintenance of the analysers is normally performed in the protection of the shelter.

3.3
analyser house
AH
enclosed building or part of a building containing process analysers and associated equipment where streams for analysis are brought in and which is regularly entered by authorized personnel

Note 1 to entry: An AH is not a permanent workplace. Within the scope of this standard, the term AH is used regardless of the structure configuration as either a room, a walk-in cabinet, an analyser container or an analyser building and whether or not it is an integral part of, or attached to, another structure.

3.4
sample conditioning room
SCR
room that is separated from the AH and has modules for sample conditioning, auxiliary material, or sample disposal equipment

3.5
infrastructure
required means and supply with auxiliaries to operate an AH with all equipment therein, for example, instrument air, nitrogen, water, power supply, incidental disposal of waste and disposal of substances introduced to be analysed

Note 1 to entry: The infrastructure occasionally comprises the fundament of an AH, the positioning of gas bottles and containers for gas supply and test gases. The infrastructure comprises in addition the ventilation and climatisation of the AH and the needed alarm devices within and outside of the AH.

3.6
maintenance
servicing, inspection, repair, improvement and weakness analysis of process analyser devices and infrastructure

3.7
toxic substances
gaseous or liquid substances that, if released in a room, will cause a health hazard by contact with the skin or by inhalation from the surrounding atmosphere

3.8
safety back-up
additional personnel, in constant contact with a person or persons in hazardous working condition, who could assist or call for additional help

3.9
external explosion hazard
hazard existing when the AH is erected at a location where flammable substances may ingress from the outside resulting in dangerous concentrations of flammable gases and vapours inside the AH

3.10
internal explosion hazard
hazard existing when a flammable mixture can result from release of samples or auxiliary supplies inside the AH

3.11
lower explosive limit
LEL
volume ratio of the flammable gas or vapour in air below which an explosive gas atmosphere will not be formed

3.12
explosive gas atmosphere
mixture with air, under atmospheric conditions, of a flammable material in the form of gas or vapour in which, after ignition, combustion spreads through the unconsumed mixture

3.13
hazardous area
area in which an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of devices

3.14
non-hazardous area
area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of the analysers

3.15
zone 0
area in which an explosive gas atmosphere is present continuously or for long periods or frequently

[SOURCE: IEC 60079-10-1:2008, 3.6]

3.16
zone 1
area in which an explosive gas atmosphere is likely to occur in normal operation occasionally

[SOURCE: IEC 60079-10-1:2008, 3.7]

3.17
zone 2
area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only

[SOURCE: IEC 60079-10-1:2008, 3.8]

3.18
source of release
a point or location from which a gas, vapour, mist or liquid may be released into the atmosphere so that an explosive gas atmosphere could be formed

[SOURCE: IEC 60079-10-1:2008, 3.9]

3.19
grades of release
there are three basic grades of release, as listed below in order of decreasing frequency and likelihood of the explosive gas atmosphere being present:

a) continuous grade;

b) primary grade;

c) secondary grade.

A source of release may give rise to any one of these grades of release, or to a combination of more than one

[SOURCE: IEC 60079-10-1:2008, 3.10]

3.20
continuous grade of release
release which is continuous or is expected to occur frequently or for long periods

[SOURCE: IEC 60079-10-1:2008, 3.11]

3.21
primary grade of release
release which can be expected to occur periodically or occasionally during normal operation

[SOURCE: IEC 60079-10-1:2008, 3.12]

3.22
secondary grade of release
release which is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods

[SOURCE: IEC 60079-10-1:2008, 3.13]

3.23
release rate
quantity of flammable gas, vapour or mist emitted per unit time from the source of release

[SOURCE: IEC 60079-10-1:2008, 3.14]

3.24
flashpoint
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

3.25
ignition temperature
T-rating
value of ignition temperature as given in IEC 60079-20-1

3.26
equipment protection level
EPL
level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp

[SOURCE: IEC 60079-0:2011, 3.26]

3.27
containment system
parts within the room or building containing the hazardous substance that may constitute an internal source of release

4 Location of AHs and connection within the process plant areas

4.1 General

When determining the location of the AH, the following factors should be considered.

4.2 Response time

Line lengths from sample points to the analysers shall be estimated and the necessary flow rates calculated to determine whether resultant dead times, sample deterioration and flow rates are acceptable.

4.3 Utilities

Connection lengths to all utilities such as air, steam, electricity, sample return, signals, etc. shall be estimated.

4.4 Safety

4.4.1 Location

The AH should preferably be located away from external sources of toxic or flammable release, and in a place where accumulation of these substances is not likely to occur.

4.4.2 Escape

Escape routes shall be determined and remain unobstructed and where possible be oriented away from hazardous areas.

4.4.3 Area classification

Area classification for the AH interior and for the ventilation air source shall be determined by the process plant safety authority or user.

4.4.4 Peripheral hazards

Consideration shall be given to the possibility of analysers or their sample lines creating a hazard in the AH or any adjacent room.

4.5 Access

Access is needed both for maintenance personnel and for supplies. AHs should be located at ground level or with access to an elevator. Consideration should be given to the requirements of heavy supplies such as gas cylinders and safe removal/installation of analysers.

Maintenance access to process equipment such as a heat exchanger shall also be considered. In addition access is needed to isolation valves for auxiliary supplies, sampling points and sampling streams outside the AH, in order to render the AH safe as fast as possible. Access is also needed to an external isolation switch for electrical power to shut the entire AH down.

5 Design, construction and layout of AHs

5.1 General

Analysers and analyser sampling systems require varying degrees of protection depending on the sample and the type of analyser, the importance of the application and the environment in which it has to operate. Where the construction and maintenance requirements are not suitable for the working environment, additional protection such as AHs should be provided. This additional protection is to ensure satisfactory performance of the instrument and to facilitate maintenance.

The selection of the housing depends on a number of factors such as

– classification of the area in which the analyser and/or sample system is to be located;
– range of ambient conditions at the site, including temperature, rain, humidity, snow, wind, dust, sand, direct sunlight, and corrosive atmosphere;
– environment specified by the analyser vendor for reliable, accurate, and safe operation;
– protection required for equipment and personnel during maintenance;
– maintenance and accessibility requirements of the system components;
– process conditions/environment of the area in which the AH is to be located (for example, loading, unloading or transferring of chemicals or equipment, noise, vibration, chemical releases, etc.).

Clause 5 primarily describes AH located in hazardous (classified environments) and/or into which flammable or toxic samples are introduced. Those AH located in an unclassified area and into which no flammable or toxic samples, services, calibration mixtures or air from a hazardous location are introduced need only provide the environment necessary for accurate and reliable operation.

5.2 General requirements

This clause addresses the general requirements for safe operation of an AH regardless of leakage or flammable material (see Clause 6) or material hazardous to health (see Clause 7).

5.3 Dimensions and layout

The size of the AH depends on the number, size and access requirements of the analysers and auxiliary equipment. Allowance shall be made for any ventilation, drainage, spare parts storage, electrical distribution, local recording, etc. Recommended minimum dimensions are 2,4 m length and width and 2,3 m headroom. The absolute minimum unobstructed headroom should be 2,0 m. Spare space of 30 % is recommended to facilitate later equipment addition. Suspended ceilings, cable trenches and other dead air spaces should be avoided.

5.4 Structural requirements

5.4.1 Construction materials

Local requirements such as for anti-static properties, corrosion, fire and weather resistance shall be determined and appropriate material selected.

5.4.2 Walls

Where equipment is supported from the walls, appropriate reinforcement may be required. Wall penetrations should be minimized and sealed where appropriate with materials meeting the relevant structural and safety requirements (for example, watertight, fire-retardant, flame-resistant, mechanical strength, etc.).

5.4.3 Floors and foundation

Floors should be non-porous, non-slip and resistant to materials likely to be spilled on them. Requirements for floor cleaning, such as a slight slope and drain, should be considered. If a floor drain is installed, it should be free draining to the outside of the AH, where the liquid can be properly disposed of. Measures should be taken to prevent the entry of extraneous liquids. Such measures can include raising the floor above the exterior grade level or providing a step or ramp at the entrance or by appropriately sealing the house at the base.

5.4.4 Doors

Doors shall open outwards and be self-closing or controlled with an alarm device. Doors shall be fitted with a "panic bar" so that they may be opened from the inside even if locked for use as emergency escape. The doors shall contain windows with shatter-resistant safety glass. An additional emergency exit, remote from the first, shall be considered depending on the floor area of the AH, if access to the main door can be impeded either internally or externally. Doors used to separate Ex zones are subject to specific requirements as given in IEC 60079-10-1:2008, Clause A.2. Where the AH is part of a building, other safety considerations may override this.

5.4.5 Windows

Windows shall be made of shatter-resistant safety glass and shall be fixed closed. Where Ex-hazards may arise, windows shall be gas-tight. The AH shall have observation windows that assure an unobstructed view into the room. Observation windows in the door(s) are preferable.

5.4.6 Roof

The roof shall be designed for appropriate loads (for example, snow, wind, equipment, people, etc.).

5.5 Equipment

5.5.1 Lighting

Lighting or emergency lights shall be operational at all times. Light level shall be that required for all works or the level specified by authorities having jurisdiction.

5.5.2 Communications

Where safety alarm(s) from the surrounding plant cannot be detected inside the AH, they shall be repeated inside the AH. An appropriate device for communication to a permanently manned location shall be available.

5.5.3 Piping, tubing and valves

Containment systems inside the AH shall be designed such that no hazardous material can escape into the AH under normal operation. The functions and content of piping, tubing and valves shall be clearly marked. Isolation valves shall be external to the AH. Streams for disposal shall be treated according to their hazard, for example, collected in closed systems or transported to facilities outside the AH. Any lines capable of delivering unacceptable high quantities of hazardous material under fault conditions into the AH shall have flow restrictors

or excess flow preventers outside and before the point of entry into the AH. In addition it shall be taken into account if the installation of automatic shut-off valves is appropriate.

5.5.4 Utilities

5.5.4.1 Hazardous quantities

The quantity of hazardous auxiliary substances should be restricted to the minimum necessary to operate the analyser systems.

5.5.4.2 Hazard identification

Any fire, explosion or health hazard should be clearly identified.

5.5.4.3 Asphyxiants (for example nitrogen, carbon dioxide)

5.5.4.3.1 Any asphyxiant line connected into the AH shall have a flow restrictor or excess flow preventer in the line outside the AH, to limit the flow to assist in meeting the requirements of the ventilation system.

5.5.4.3.2 When a potential low oxygen hazard exists (for example, instrument air backed up with nitrogen) or if significant quantities of asphyxiant substances enter the AH under normal operation in the AH, the air inside the AH has to be monitored by low oxygen detectors. They shall be installed with fail-safe alarms, both locally and in a remote permanently manned location.

5.5.4.4 Storage

5.5.4.4.1 Hazardous auxiliary supplies shall be stored outside the AH if possible.

5.5.4.4.2 If the storage of auxiliary gases or calibration gases in pressurized cylinders inside the AH is unavoidable, they shall be protected against rise in pressure when heated by fire. This can be accomplished by storage in insulated and continuously ventilated cabinets or through rupture disks and relief valves, which are installed at the cylinders immediately ahead of the pressure-reducing stations. Gases escaping from the rupture discs shall be safely carried to the outside of the AH. Exceptions to these measures may be made in agreement with local authorities.

5.5.5 Fire extinguishers

An appropriate fire extinguisher shall be located near the door(s).

5.5.6 Ventilation

Ventilation may be installed for climate control, corrosion protection, protection from asphyxiation, explosion protection (see Clause 6) and/or personnel safety (see Clause 7).

The ventilation air source shall be preferably in a non-hazardous area. If this is not available, zone 2 air may be used if the equipment installed in the AH is suitable for a zone 2 or worse location, or if the ventilation air is monitored at the intake point by means of one or more gas detectors, which discontinue ventilation airflow when a value of 20 % or less of LEL is exceeded. Dust filtration should be installed in the ventilation inlet.

If ventilation is applied to prevent the formation of an explosive atmosphere, a minimum of five air changes per hour shall be provided unless a larger flow is required based on calculations as given in IEC 60079-10-1:2008 Annex B. For flammable liquids, special requirements apply, as given in 6.3.4.

The prevention of the formation of a toxic or asphyxiate gas atmosphere requires a risk assessment to define the rate of ventilation and additional measures where required.

5.5.7 Temperature

For safe performance of the monitoring instruments and alarm systems, temperature shall be kept in their recommended operating range.

5.6 Labelling/instructions/documentation

5.6.1 Entrance

An indelible marked sign indicating the type of hazard may be required according to local regulations on the entrance to the AH stating that entering the AH is allowed only for authorized personnel. Information such as the organization responsible for the AH can be included on the sign (e.g. name, department, telephone number, etc.)

5.6.2 Alarms

An appropriate risk assessment shall be used to determine which of the following AH safety-related local alarms/indicators shall be generated and visibly displayed:

a) ventilation failure;

b) shelter pressure failure;

c) flammable gas: concentration exceeds 20 % LEL;

d) toxic gas: concentration exceeds allowable levels;

e) oxygen deficiency: oxygen concentration needs to be above statutory requirements;

f) fire- or smoke-detection;

g) automatic extinguisher released;

h) gas/fire detection instrument fault.

The relative densities of the hazardous substances, size of the AH and the air flow dictate the number and placement of flammable or toxic gas detectors. It may be necessary to detect light gases near the roof level and heavy gases and vapours near the floor level.

Alarms shall be reported at the following locations:

1) inside the AH a common audible alarm or a highly noticeable visual light (for example, strobe lamp);

2) at a continuously manned process location, if possible;

3) discrete alarm lamps shall be provided outside near the entrance of the AH for toxic, asphyxiant, and LEL and should be considered for other alarms.

A positive indication of a non-hazardous condition is recommended.

5.6.3 Safety procedures

The AH safety procedures shall be documented and be kept in a readily accessible location inside the AH. Any person working in the AH shall have adequate training for this location.

5.6.4 Additional data

The following items, as appropriate, should be included in the documentation:

– design data for the ventilation system of the AH (for example, the set point for the ventilation failure alarm);
– design data for the gas detection system (for example, measuring range, measured component, alarm set point and corrective action);
– wiring and logic diagrams for all alarm and shut-down systems;
– design of the toxic process disposal system and information for handling contaminated disposal streams and the exhaust air under upset conditions;
– precise written instructions in clear understandable language about procedures for the personnel that regularly work with toxic material (for example, instructions on filling the supply containers with auxiliary material).

6 Explosion protection of AHs

6.1 General

Clause 6 addresses requirements for AH safety by internal ventilation together with safeguarding systems against either internal or external explosion hazards. In addition, methods of ensuring safety with natural ventilation are also discussed. Other protective measures for the non-hazardous operation of analytical equipment should also be observed but they are not included in this standard.

Additional protective measures can be used at the user's discretion.

This standard does not address hazards that originate from flammable mixtures supplied into the AH and that may ignite inside the line or flammable mixtures discharged back into the plant. For example, flame arresters could be installed at the sampling points whether or not the analyser is installed in the AH.

6.2 General requirements

6.2.1 If a risk assessment does not state otherwise, all equipment installed in the AH shall meet the classification for the interior of the AH.

6.2.2 In the event that hazardous conditions (e.g. ventilation failure or gas detection) arise, any non-explosion-protected equipment shall be disconnected, preferably automatically or manually by an external switch in a permanently manned location. Restarting shall not be possible without appropriate authorization.

6.2.3 An external isolation switch should also be provided to shut the entire AH down in the event of an emergency. Restarting shall not be possible without appropriate authorization.

6.3 Protection of AHs against explosion hazards by means of artificial ventilation

6.3.1 Classification

IEC 60079-10-1 gives additional guidance on the classification of hazardous areas.

Explosion hazards can originate as follows.

a) External explosion hazards (see 6.3.2)

   An external hazard is considered absent for an AH adjacent to a hazardous area of the plant when all openings of the AH lead into non-hazardous areas;

b) Internal explosion hazards due to flammable gases or vapours (see 6.3.3);

c) Internal explosion hazards due to flammable liquids (see 6.3.4);

d) Any combination or permutation of items a), b) and c).

6.3.2 Requirements for AHs where the explosion hazard originates externally

Any entrance connecting the AH with a zone 1 shall have appropriate air lock devices or all internal equipment shall be certified for zone 1. The occurrence of a hazardous atmosphere within an AH can be avoided by a suitable technical implementation of openings, like doors, inlet openings for supply purposes, as given in IEC 60079-10-1:2008, A.2.2. Doors shall close automatically, or shall be monitored for correct closure. The supply of fresh air according to 5.5.6 is used to improve the air quality and can prevent the ingress of hazardous atmosphere as an additional measure. On air intake from zone 2, the ventilation is shut off using a gas detector in the suction line when it reaches a maximum of 20 % of the LEL and sealed with an airtight lid. In this case, a ventilating fan in EPL Gc or higher shall be implemented.

6.3.3 Requirements for AHs where the explosion hazard originates from internal gases or vapours

Inside an AH into which flammable gases or vapours are introduced, there is no danger of explosion

– if the introduced gas flows are restricted, and

– if the AH is ventilated in such a way that in case of leakage, improper handling or breaking of a gas-carrying system, the escaping quantities of flammable gases or vapours cannot exceed 50 % LEL at any location where there is a source of ignition. Ventilation may be improved by installation of an adequate air system with better local dilution.

6.3.3.1 Ventilation

6.3.3.1.1 The AH shall be supplied with fresh air according to 5.5.6 in such a way, that sufficient purging of the room is maintained. The function of ventilation shall be monitored.

6.3.3.1.2 The inlet and outlet openings for ventilation shall be located on the basis of the density of the flammable gases or vapours, i.e. lighter than air on top, heavier than air on bottom. Purge air exits should be located and designed in such a way that at least half of the upper and of the lower exits remain operable under all wind conditions, for example, by means of weighted louvers. They should be protected by screens against the entry of insects and vermin and by other means against the accumulation of blocking debris such as leaves, sand or snow. Reliance exclusively on upper or on lower vents requires careful ventilation design to ensure that all parts of the AH are appropriately purged.

6.3.3.1.3 The airflow rate shall be such that, in the case of a possible leakage of flammable material, the national acceptable maximum design % LEL (normally not above 50 % LEL) is not exceeded by the amount of flammable material released. Permanently installed flow restrictors or high-flow shut-off valves on sample inlet lines and check valves on return lines can minimize any leakage of flammable material resulting from equipment failure. See examples in IEC 60079-10-1:2008, Clause B.8.

In the case of ventilation failure, all sources of ignition shall be rendered safe. Such sources include flames, surfaces above the ignition temperature, and the non-explosion protected electrical and nonelectrical equipment. It has to be considered, that hot surfaces need time to cool down below the ignition temperature. Devices that meet at least the EPL Gc are classified as safe.

The use of explosion-proof coupler sockets does not prevent the connection of non-explosion-protected electrical equipment. Therefore, sockets should be automatically isolated on ventilation failure or gas detection alarm in case non-explosion protected portable test equipment is connected to the sockets.

6.3.3.2 Gas detectors

If appropriate gas-detectors are installed, they may be used to allow a delay in switch-off of non-explosion-protected equipment for a limited time. However, if the gas detectors indicate an appropriate predetermined value, typically 20 % LEL, the non-explosion-protected equipment shall be switched off immediately.

6.3.3.3 Ventilation failure

Ventilation failure and suitable gas detector alarms shall be signalled as described in 5.6.2. Suitable measures shall be introduced.

6.3.3.4 Shut-off valves

All pipes which introduce flammable gases or vapours into the AH shall have clearly labelled and readily accessible externally located shut-off valves operated manually and/or automatically.

6.3.3.5 Pressure-reducing devices

Devices for reducing the pressure and flow (such as excess flow valves, flow restrictors or orifices) of flammable sample and auxiliary gases shall be located outside the AH, if the source of the gas is external.

6.3.4 Requirements for AHs where the explosion hazard originates from internal liquids

6.3.4.1 The flashpoints of all incoming liquids shall be documented.

This standard applies only to liquids with a flashpoint up to 60 °C. Liquids with a flashpoint above 60 °C should be included only if they are, or could be, heated above their flashpoint such as on contact with a hot device. Beside this, it has to be considered that sprays could be ignitable below the flashpoint of the liquid.

6.3.4.2 Hazards of flammable liquids in the AH should be reduced to a minimum, for example by the following measures:

– collecting of liquid leakages and detecting by suitable sensors followed by an automatic shutdown of the inflow;
– accumulated liquids will be manually or automatically discharged to the AH exterior in such a way that no explosion hazard develops inside or outside the AH.

This can be done via a drain in the floor of the AH, which is the outflow at the lowest point of the room. Another possibility is given by the arrangement of trays to potential leakage points, that should be provided with a leak detection and a lockable drain for safe disposal.

Consideration shall be given to prevent migration of vapours from the vent (for example, by a water seal).

6.3.4.3 The AH shall be supplied with fresh air to maintain purging of the room even if the LEL can be exceeded. A potential exceeding of the LEL depends on the vapour pressure, the surface area of the spill, the latent heat of vaporization and the release rate.

6.3.4.4 Fresh air is provided to delay the formation and speed up the safe removal of flammable mixtures. It also facilitates detection by transporting the vapours to strategically located gas detectors. However, air re-circulation is not recommended because it increases the vaporization rate and increases the risk of exceeding the LEL. See calculations in IEC 60079-10-1:2008, Clause B.8.

6.3.4.5 Ventilation air exhausts shall be located like those for heavy vapours. The air exhaust shall be located such as to collect the vapours above the drain, and a gas detector shall be installed close to the exhaust point.

6.3.4.6 In the case of ventilation failure or in the case of detection of leakages, all sources of ignition shall be rendered safe. Such sources include flames, surfaces above the ignition temperature, and the non-explosion-protected electrical equipment. It has to be considered that hot surfaces need time to cool down below the ignition temperature. Devices that meet at least the equipment protection level EPL Gc are classified as safe. See IEC 60079-0:2011, 3.26.5.

The non-explosion-protected equipment shall be switched off immediately, if the gas detectors indicate an appropriate predetermined value, typically 20 % of the LEL. Ventilation failure and gas detector alarms shall be signalled as described in 5.6.2. Suitable measures shall be introduced.

6.3.4.7 In order to reduce the explosion hazard due to leakage from components and equipment contained in the AH, only the minimum amounts of flammable liquids necessary for measurement shall be introduced into the AH. Bypass flows necessary for better time characteristics should be brought only to the outside of the AH. All lines which carry flammable substances into the AH shall have easily accessible shut-off devices located externally to the AH. If automatic devices are used, they shall be manually lockable and reset.

6.3.4.8 To avoid a possible accident and to minimize risks arising from accidental leakages, that portion of the sampling system inside an AH should be as simple as possible with the smallest contained volume and lowest number of joints practicable.

Cabinets containing sampling equipment should preferably be outside the AH and should be fitted with drain holes. Cabinets containing high-pressure fluids that vaporize at atmospheric pressure should be fitted with a rupture disk. All drain holes and rupture disc exits shall be exterior to the AH. For these cabinets, a separate risk assessment and a definition of the explosion protection zone are required according to IEC 60079-10-1.

6.3.5 Requirements for AHs where the explosion hazard originates from any combination of the above

Requirements from the appropriate clauses are added together so that the resultant AH conforms to each individual relevant clause.

6.4 Protection of AHs against explosion hazards by means of natural ventilation

6.4.1 General

Natural ventilation is defined as ventilation induced by external wind forces and/or thermal gradients between the AH and the outside. Natural ventilation does not rely on artificial means. The use of natural ventilation on protection of AHs against explosion hazards shall be in line with the outer boundary conditions like wind, weather, Ex zone of the installation site in agreement with IEC 60079-10-1.

6.4.2 Ventilation requirements

The ventilation rates shall be designed to dilute and dissipate any dangerous release within the AH.

By its very nature, the mechanism of natural ventilation does not give close control over ventilation rates. Statistical data is required on wind speeds, directions and frequencies at the proposed location of the AH. From this data and knowledge of heat dissipated within the AH from equipment (excluding environmental heaters), ventilation areas can be calculated.

The mode of ventilation (wind-induced or thermally induced) that gives the smaller area requirements should be used. Wind calculation should use the minimum average wind speed exceeded for 90 % of the year. Wind- or thermally induced calculations should use as a basis a minimum of 10 exchanges per hour or that necessary to

– dilute escaping vapours from the rupture or failure of the most hazardous sample or service line to less than the national acceptable maximum design % LEL around any point of ignition (particular attention shall be paid to those liquids which vaporize at ambient temperature);
– wind-induced ventilation rates should also be calculated for maximum average wind speeds using a gusting ratio of 1,6. If the resulting ventilation rates exceed 50 exchanges per hour, the comfort factor will deteriorate.

6.4.3 Heating requirements

With the above design procedures, the temperature in the AH will essentially follow ambient temperature. Thermostatically controlled heating can be included to improve temperature control. Fan assistance can be included to aid distribution of the warm air.

6.4.4 Gas detectors

Gas detectors are required to report hazards.

In the case of leakages detected by gas detectors, all sources of ignition shall be rendered safe. Such sources include open flames, surfaces above the ignition temperature, and the non-explosion-protected electrical equipment. It has to be considered that hot surfaces need time to cool down below the ignition temperature. Devices that meet at least the EPL Gc are classified as safe.

The non-explosion-protected equipment shall be switched off immediately, if the gas detectors indicate an appropriate predetermined value, typically 20 % of the LEL. Gas detector alarms shall be signalled as described in 5.6.2. Suitable measures shall be introduced.

7 Measures to prevent health hazards to personnel in AHs

7.1 General

Clause 7 is to be used as a guide for AH in which the possibility of release into the atmosphere of substances hazardous to health (toxic) cannot be eliminated, as a result of detected or undetected leaks or from unavoidable operation during maintenance, calibration or repair. This clause does not address facilities that handle dust, sprays and aerosol, powder or non-volatile materials.

7.2 Guidelines

Clause 7 serves as a guide for the standardization of technical regulations and organizational directions for the protection from health hazards of personnel who enter an AH while performing operating and maintenance functions.

Clause 7 does not address the creation of any hazard to adjoining rooms or process areas due to leakage from the AH.

7.3 General requirements

An AH meeting the requirements of Clause 5 is equipped and operated in such a way that, under normal operating conditions, no toxic or asphyxiant material would spill into the room. No health hazard shall exist for the people being temporarily active inside the AH. Even for abnormal situations and with unusual activities, it is intended that the frequency and extent of

possible leakages shall be limited so that working in the AH is possible with minimal and controlled risk. For this reason, adequate ventilation is required in the AH. The extent of measures additional to ventilation is dependent on

– the identity and quantity of material present in the AH;
– the probability and extent of leakage from the process analyser equipment (see Annex A);
– the effect on personnel of toxic material that might be released.

The determination of these measures has to be done under a risk assessment by those having knowledge of the properties of the hazardous material and of the analyser equipment. This shall be done in cooperation with the appropriate safety personnel.

The decisions arranged hereby determine which of the measures in 7.4 to 7.7 shall be realized.

7.4 Safety measures

7.4.1 Toxic materials should not be stored inside an AH. If storage of such toxic auxiliary material inside the AH cannot be avoided, the procedure outlined below shall be followed.

– A minimum amount of materials shall be stored.
– Liquid containers are to be protected from physical shock, undue heating, or anything else that could result in a release of toxic material. If breakable material is used, an appropriate secondary containment device should be utilized to prevent release within the AH or in the environment.

7.4.2 Lines carrying toxic material into or out of the AH shall have, as a minimum, manual shut-off devices and features (such as double-walled piping, restrictors, and capillaries) preferably also located on the outside of the AH to limit the amount of material that could be introduced into the AH. The amount of toxic material may be minimized by pre-dilution, or such measures as locating the sample inject valve of a chromatograph exterior to the AH with the remainder of the chromatograph inside.

7.4.3 Purge and clean-out connections in the sample lines should be installed at appropriate locations to allow the connection of devices to provide appropriate flushing fluids through safe locking devices. This provision allows flushing of all affected equipment before maintenance.

7.4.4 The AH shall have observation windows that assure an unobstructed view into the room. Observation windows in the door(s) are appropriate.

7.4.5 Components routinely handling toxic substances shall have negligible leakage risk, as best as possible, according to the construction principles described in Annex A. Otherwise it has to be proceeded according to 7.4.6.

7.4.6 Components routinely handling toxic substances in an AH which have unavoidably limited leakage risk shall be inside tight, continuously purged enclosures, or to be operated in the monitored vacuum. The exhaust shall be piped to the outside of the AH, monitored by a flow meter if necessary, and safely disposed of. If possible, the exhaust shall be monitored to identify any leaks in the enclosed modules.

7.4.7 The AH shall be equipped with a stationary gas detection system that can respond to toxic material in the AH air with sufficient sensitivity, speed, and reliability (failure alarm, redundancy), and that can report any excursion above the designated concentration limit.

7.4.8 The AH should be equipped with emergency measures such as a telephone, an emergency call station or a panic button to establish a contact with a location supervised by the staff of the plant. If the process unit in which the AH is installed has a common process warning system (for example, flashing lights, loudspeakers) to warn working personnel of danger, the AH shall be connected to this warning system.

7.4.9 When a system is designed, the toxicity of the substances should be considered.

The air may become unsafe to breathe long before the LEL value is attained.

Analysers handling toxic substances may need to be separately housed and clearly identified.

Attention shall be drawn to the need for the purging of analysers and sampling systems containing toxic or otherwise dangerous substances prior to disassembly. Attention shall be drawn to the need for caution and care prior work on analysers that may contain toxic substances (for example, reagents in wet chemical analysers and certain materials of construction) and care is needed during working. Toxicity is highly unique for different materials and a full risk assessment has to be conducted for each specific installation.

Toxic calibration samples shall preferably be stored and piped from outside the AH.

7.4.10 A warning sign of the possible presence of toxic substances within the housing (cf. risk assessment) shall be given on, above or next to the doors of the AH or the cabinet.

7.4.11 The AH may be equipped with a looped exhaust system that is kept under vacuum (negative pressure) either continuously or as needed. The system should have, at frequent intervals, stubs to connect hoses that are used locally to exhaust toxic substances under upset conditions. Alternatively, equipment may be installed in exhaust hoods. The orderly detoxification of the exhaust system shall be assured, for example, through connection with the process unit vacuum system.

7.5 External hazards

7.5.1 The AH shall be supplied with fresh air according to 5.5.6 in order to avoid enrichment of toxic substances in the interior, as well as to impede the penetration of toxic substances from the outside. An adequate measure for this purpose is a fan mounted in the inlet air ducts and which, on the basis of its performance curve, is capable of producing pressurization of between 25 Pa and 50 Pa at a delivery rate with a minimum of five exchanges per hour. The exchange of air shall be monitored.

7.5.2 Gas detector alarms shall be signalled as described in 5.6.2.

7.6 Additional measures for abnormal working conditions

The measures described above provide safety under intended operating conditions of process analysers in the AH. In abnormal cases, some handling of the system is required for cleaning and repairing parts that require the opening of sample lines and sampling devices or the opening of enclosures or capsules that are continuously supplied with air for the safety of devices. For this purpose, a risk analysis shall be conducted and appropriate protective measures shall be established. The reverse flow of toxic gases in the purge lines shall be prevented by appropriate technical and organisational measures.

Where it could be possible for toxic gases to flow back into purge lines, non-return valves shall be fitted in the purge lines.

7.7 Labelling/instructions/documentation

Operational instructions shall be prepared on the basis of risk assessment.

Content of the documentation:

– operation manual for all components of the analyser system;
– safety data sheet.

The labelling/instructions/documentation items listed in 5.6 are mandatory for all AHs that may present a health hazard to personnel.

Any mandatory instruction leaflets shall be displayed such as

a) attendance record of personnel that work in the AH, kept in a continuously manned process location;
b) written instructions for special safety procedures in unusual circumstances, for example:
   – loss of ventilation according to 6.3.3.3 and establishing the necessary substitute arrangements (for example, auxiliary breathing apparatus);
   – loss of stationary gas monitor according to 7.4.7 and establishing the necessary substitute arrangements (for example, use of portable gas monitor, providing of safety back-up personnel);
   – activation of the stationary gas alarm according to 7.4.7 and establishing the proper breathing device (for example, filtering device, pressure breathing apparatus) and/or activating external shut-off valves.

Documentation relative to training courses and the establishment of auxiliary measures as required under abnormal working conditions (see 7.6) may include the following:

1) descriptions of the rinse procedure and the rinsing medium;
2) type of gas monitor;
3) proper type of breathing device (filtering device, pressure breathing device), providing safety back-up personnel;
4) proper equipment for the safety back-up personnel (for example, breathing device, two-way radios).

Annex A
(normative)

Leakage risk of modules in the AH

A.1 General

Construction principles can often be employed in a combination that will significantly reduce the potential hazard. Components of limited leakage risk may be used in an AH for handling toxic materials, if the additional measure given in column 3 of Table A.1 is applied.

For example, non-metallic hose used in combination with metal armour (and the proper fittings) may be roughly equivalent to metal lines. The correct application of the principle will require careful consideration of each case.

A.2 Modules with negligible leakage risk

On modules with negligible leakage risk, there is a low probability of occurrence of a leak which would release toxic or flammable material in hazardous quantities in the AH. This specifically assumes that appropriate materials are used for the intended functions. Although there are no selection criteria by which to measure intended duties and leakage limits, it is possible to select modules and construction principles with low leakages, for example,

– tightly anchored pipes of proper material;
– welded pipe connections;
– flanged connections with appropriate sealing;
– compression fittings with front and back ferrules;
– elastic seals of tongue and groove construction;
– flow meters with all metal housings or of thermal dissipation measuring principles;
– bellow seals (limited life has to be taken into account).

A.3 Modules with limited leakage risk

A.3.1 General

Devices that do not meet the rigid requirements of Clause A.2 shall be considered as having limited leakage risk.

To identify devices that may allow limited leakage risk, the checklist given below is useful. It is applicable for flexible hoses of non-ferrous material connection with quick connectors or fittings sealed on machine surfaces seals with 0-ring seal chambers, sliding gates, pumps with membranes and flow measuring devices with an open glass cone (variable area). All devices with optical windows and lines or containers made from breakable material should be critically examined. All cases shall be evaluated and a decision made for the particular case and intended application. Leakage risk can be reduced by periodic leakage test of system.

A.3.2 Guidance for evaluating modules

The following list of questions can provide guidance for evaluating modules (see Table A.1):

– which devices in the process analyser measuring instrument can be expected to have:
  - a negligible leakage risk (column 1),
  - a limited leakage risk (column 2),
– which devices may have leakage rates reduced with construction principles from column 2, by means of additional precautions or through a combination of different design principles (column 3).

The final judgment can be made only with the consideration of conditions such as the requirements of the specific application and proper material selection.

Table A.1 – Module evaluation

Module with no or negligible leakage risk	Module with limited leakage risk	Additional measures to reduce leakage risk
Lines		
Rigid metallic	Flexible, non-metallic (hose)	Double pipe, metal armour
Connection		
Welded couplings	Flanged couplings	Check of correct assembly
Compression fittings with front and back ferrules		
Flanged couplings with appropriate sealing		
Seals		
Tongue and groove	0-rings	Plus bellows seal (see note)
Bellows seals (see note)	Packing glands	Plus bellows seal (see note)
		Encapsulation
Flow measuring device		
All metal	Glass cone/plastic	
Pumps		
Eductor	Mechanical seal pumps	Bellows seals (see note)
Magnetically or hydraulically coupled pumps	Peristaltic pumps	Enclosure
Actuators		
Glandless valves	Soft seat ball valves	Soft seat ball valves with optional bellows seals (see note)
Other		
Fibre optics	Optical windows	Encapsulation
NOTE The bellows seals have limited life.		

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