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Second edition
2004-10

## Industrial-process control – Safety of analyser houses



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## Industrial-process control – Safety of analyser houses





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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# INDUSTRIAL-PROCESS CONTROL – SAFETY OF ANALYSER HOUSES

## FOREWORD

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International Standard IEC 61285 has been prepared by subcommittee 65D: Analysing equipment, of IEC technical committee 65: Industrial-process measurement and control.

This second edition cancels and replaces the first edition published in 1994. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

a) incorporation of previously issued corrigendum;
b) minor updates to several sections and references

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 65D/107/FDIS | 65D/110/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

# 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.

This document is designed to set forth minimum safety requirements for typical analyser houses (AHs). It shall be superseded in all cases by national, local, or corporate requirements, which may be more stringent.

The measured output is transmitted continuously for process control, operator action or documentation. Process analysers are used for

– environmental analysis;
– personnel protection;
– equipment protection;
– quality measurement/control;
– process control (plant optimization);
– energy conservation.

In the simplest case, the analyser sensor is mounted directly in the material to be measured, and there is no need to extract a sample. In other cases, a sample is extracted from the main stream and transported to the analyser. The system may include many functional elements such as

– sample extraction;
– sample transport;
– sample conditioning;
– sample stream disposal and/or return to process;
– utilities and auxiliary materials supply;
– stream switching;
– automatic or manual calibration and validation system;
– signal processing;
– performance monitoring and control.

(See IEC 61115.)

Analyser elements can be arranged modularly and located separately. There are advantages in grouping analysers and systems and further advantages in enclosing them. Advantages include

– lower cost of installation of utilities and signals;
– protection of personnel and complex modules and equipment from adverse ambient conditions;
– ease of maintenance;
– safety.

Analysers are constructed to various standards: some are ex-proof, some intrinsically safe, some suitable for Zone 2 and some suitable only for a non-hazardous area. Not all analysers are available in all variants.

Process plants usually include all zones – 0, 1, 2 and non-hazardous.

The selection of the AH location, the source of ventilation air, and the classification of the house interior and its analysers is an economic exercise.

Factors include the distance from the sample point to the AH , classification of the area around the AH, distance from the AH to the source of non-hazardous air, and the cost of analysers of classification appropriate to the house interior.

# 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 AH in order to ensure its protection against fire, explosion and health hazards. This standard extends beyond IEC 60079-16 to include houses with Zone 2 interiors and to apply to toxic hazards. (Appropriate national guidelines on toxic hazards are to be followed.)

This standard does not address facilities where dust is the hazard.

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.

NOTE For most fluids, the major constraint is that the concentration of vapours, which are hazardous 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 × $10^{-6}$.

Classification of a house interior as Zone 1 may imply that no technician can enter without protective equipment such as breathing gear. Placing an AH in a Zone 1 area would usually imply that no technician could approach the house without wearing protective equipment.

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 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.

IEC 60079-16:1990, *Electrical apparatus for explosive gas atmospheres – Part 16: Artificial ventilation for the protection of analyser(s) houses*

## 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. 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. 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 Within the scope of this standard, the term AH is used regardless of the structure configuration as either a room, cabinet or 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**
**toxic material**
material that is a health hazard by inhalation from the surrounding atmosphere. Atmospheric routes such as skin absorption or ingestion are not addressed

**3.6**
**safety back-up**
additional personnel, in constant contact with a person or persons in dangerous working conditions, who could assist or get additional help

**3.7**
**external and internal hazards**
distinction is made between "external" and "internal" explosion hazards. An external explosion hazard exists when the AH is erected at a location where flammable material can be introduced from the outside resulting in dangerous concentrations of flammable gases and vapours inside the AH. An internal explosion hazard exists when a flammable mixture can result from the leakage of samples or auxiliary supplies inside the AH

**3.8**
**lower explosive limit**
**LEL**
**lower flammable limit**
**LFL**
volume ratio of the flammable gas or vapour in air below which an explosive gas atmosphere will not be formed

**3.9**
**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

**3.10**
**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 the analysers (includes Zones 0, 1, and 2 – Division 1 and 2 are also utilized as hazardous area definitions in many regions – refer to appropriate authorities and standards for detail definitions)

**3.11**
**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

**3.12**
**Zone 0**
area in which an explosive gas atmosphere is present continuously or for long periods

**3.13**
**Zone 1**
area in which an explosive gas atmosphere is likely to occur in normal operation

**3.14**
**Zone 2**
area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only

**3.15**
**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

**3.16**
**ignition temperature (T-rating)**
lowest temperature of a heated surface at which, under specified conditions, the ignition of a flammable substance in the form of a gas or vapour mixture with air will occur

## 4 Location of AHs and connection within the process plant areas

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

### 4.1 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.

### 4.2 Utilities

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

### 4.3 Safety

#### 4.3.1 Location

The AH should be located a safe distance from sources of toxic or flammable release, and in a place where accumulation of these materials is not likely to occur.

#### 4.3.2 Escape

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

#### 4.3.3 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.

#### 4.3.4 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.

### 4.4 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.

## 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.).

This clause 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 2,5 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

Construction materials should be fire-retardant and resistant to attack from substances with which they could come into contact.

#### 5.4.2 Walls

Local requirements such as for anti-static properties, corrosion, fire and weather resistance shall be determined and appropriate material selected. 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. Doors shall be fitted with a "panic bar" so that they may be opened from the inside even if locked. The doors shall contain windows with shatter-resistant safety glass. A second door or emergency exit such as a kick-out panel, remote from the first, should be considered, if access to the main door can be impeded either internally or externally.

NOTE Where the AH is part of a building, other safety considerations may override this.

#### 5.4.5 Windows

Unless the AH is classified non-hazardous and is located in a non-hazardous area, any windows should be fixed closed and vapour-tight.

#### 5.4.6 Roof

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

### 5.5 Equipment

#### 5.5.1 Lighting

Lighting or emergency lights shall be operational at all times. Minimum light level should be that required for maintenance work 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. Consideration should be given to the installation of a verbal communications link to a permanently manned location.

### 5.5.3 Piping and valves

Under normal operation, piping, containers and apparatus in the AH shall not have any openings that would permit hazardous material to escape into the AH. The functions and content of piping and valves shall be clearly marked. Isolation valves shall be external to the AH. Streams for disposal should be 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 automatic shut-off valves, flow restrictors or excess flow preventers outside and before the point of entry into the AH.

### 5.5.4 Utilities

#### 5.5.4.1 Hazardous quantities

The quantity of hazardous auxiliary materials 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) 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** Hazardous auxiliary supplies should be stored outside the AH.

**5.5.4.5** 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 should be located at 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).

#### 5.5.6.1 General

All ventilation shall provide a minimum of five air changes per hour. The ventilation air source should 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 it 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.

#### 5.5.6.2 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 is to be posted on the entrance to the AH stating that entering the AH is allowed only for authorized personnel. Information as to the organization responsible for the AH is to be included on the sign (name, department, telephone number, etc.).

#### 5.6.2 Alarms

If required, the following AH safety-related local alarms/indicators shall be generated and displayed as applicable:

a) ventilation failure (purge and/or overpressure);

b) flammable gas (concentration shall not exceed 20 % LEL);

c) toxic gas (concentration exceeds allowable levels);

d) oxygen deficiency

NOTE Oxygen concentration needs to be above 18 % or statutory requirements;

e) fire or smoke;

f) automatic extinguisher released;

g) gas/fire detection instrument fault.

NOTE The relative densities of the hazard(s) and the air flow dictate the placement of flammable or toxic gas detectors. It may be necessary to detect light gases near the roof level and heavy gases near the floor level.

NOTE The records from the gas detectors provide assurance that the house interior requirements have been met.

Alarms shall be reported at the following locations:

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

b) at a continuously manned process location;

c) 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.

NOTE 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

This clause 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.

NOTE 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** All electrical equipment installed in the AH shall meet the electrical classification as defined for the interior of the AH.

**6.2.2** In the event that hazardous conditions arise, any non-explosion-protected electrical 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

NOTE IEC 60079-10:2002 gives additional guidance on the classification of hazardous areas.

Explosion hazards can originate as follows.

##### 6.3.1.1 **External explosion hazards** (see 6.4.2)

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

##### 6.3.1.2 **Internal explosion hazards due to flammable gases or vapours** (see 6.3.3)

**6.3.1.3 Internal explosion hazards due to flammable liquids** (see 6.3.4)

**6.3.1.4 Any combination or permutation of 6.3.1.1, 6.3.1.2 and 6.3.1.3**

### 6.3.2 Requirements for AHs where the explosion hazard originates externally

**6.3.2.1** Any entrance connecting the AH with a Zone 0 or Zone 1 classified location shall have an air lock.

The AH shall be supplied with clean air according to 5.5.6 in such a way that forced ventilation produces an internal overpressure to prevent the ingress of the external atmosphere. 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 an overpressure of between 25 Pa and 50 Pa at a delivery rate equal to at least five exchanges per hour. 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 equipment.

NOTE Utility outlets may be fitted with Ex-e or Zone 2 sockets, but this does not prevent the connection of non-explosion-protected equipment. All such utility outlets shall be switched off if a hazardous atmosphere is likely.

**6.3.2.2** If gas detectors known to be suitable are installed, they may be used to allow a delay in switch-off for a limited time. The non-explosion-protected equipment should be immediately switched off if the suitable gas detectors find an appropriate predetermined value, typically 20 % LEL, unless loss of the equipment will create a more hazardous condition in the plant.

**6.3.2.3** Ventilation failure and gas detector alarms shall be signalled as described in 5.6.2.

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

NOTE 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

NOTE IEC 60079-16:1990 gives additional guidance for the ventilation requirements for houses.

**6.3.3.1.1** The AH shall be supplied with clean air according to 5.5.6 in such a way that sufficient purging of the room is maintained.

**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 greater than 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 calculations in Annex B.

In the case of ventilation failure, all sources of ignition shall be rendered safe unless loss of the equipment will create a more hazardous condition in the plant. Such sources include flames, surfaces above the ignition temperature, and the non-explosion protected electrical equipment.

**6.3.3.2** If gas detectors are installed, they may be used to allow a delay in switch-off 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 unless loss of the equipment will create a more hazardous condition in the plant.

**6.3.3.3** Ventilation failure and suitable gas detector alarms shall be signalled as described in 5.6.2.

**6.3.3.4** 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** 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.

**6.3.3.6** Equipment containing flammable gases or vapours shall be installed to the maximum extent outside the AH.

### 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.

NOTE This standard applies only to liquids with a flashpoint below 55 °C. Liquids with a flashpoint over 55 °C should be included only if they are, or could be, heated above their flashpoint such as on contact with a hot device.

**6.3.4.2** The floor of the AH shall be self-draining. A drain shall be installed at the lowest point.

Accumulating liquids shall be discharged to the AH exterior in such a way that no explosion hazard develops inside or outside the AH. 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 clean air to maintain purging of the room even if the LEL can be exceeded. This depends on the vapour pressure, the surface area of the spill, the latent heat of vaporization and the release rate.

Clean air is provided to delay the formation and speed 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 vapour volume and increases hazard. See calculations in Annex B.

**6.3.4.5** Purge air exhaust shall be as 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, all sources of ignition shall be rendered safe unless loss of the equipment will create a more hazardous condition in the plant. Such sources include flames, surfaces above the ignition temperature, and the non-explosion- protected electrical equipment.

If, compared to 6.3.4.5, additional gas detectors are installed, they may be used to allow a delay in switch-off for a limited time. However, if the gas detectors indicate an appropriate predetermined value, typically 20 % the non-explosion-protected equipment shall be switched off immediately unless loss of the equipment will create a more hazardous condition in the plant. Ventilation failure and gas detector alarms shall be signalled as described in 5.6.2.

**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 pipes which carry flammable substances into the AH shall have shut-off devices that can be actuated from outside the AH.

**6.3.4.8** 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.

Piping of the sampling system should be designed to limit the flow of the sample into the AH.

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.

Use of electrical equipment inside cabinets may necessitate increased purging requirements.

### 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. Subclauses 6.4.2 and 6.4.3 apply only to houses and cabinets.

### 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.

That 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

It is necessary to use gas detectors which set off alarms and which disconnect electrical equipment not approved for the current hazardous situation unless loss of equipment will create a more hazardous condition in the plant. They shall also isolate lines carrying hazardous material into the AH.

## 7 Measures to prevent health hazards to personnel in AHs

### 7.1 General

This clause is to be used as a guide for AH in which the possibility of release into the atmosphere of material 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

This clause 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.

NOTE This clause 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 material would spill into the room and no health hazard exist for the people working inside the AH. Even for abnormal situations and with unusual activities, the frequency and extent of possible leakages should 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 should be carried out by those having knowledge of the properties of the hazardous material and of the analyser equipment. This should 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 environmental release.

**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.

NOTE Observation windows in the door(s) are appropriate.

**7.4.5** Modules routinely handling toxic material should have negligible leakage according to the construction principles described in Annex A.

**7.4.6** Modules routinely handling toxic material in an AH which have unavoidably limited leakage shall be inside tight, continuously purged enclosures. The exhaust shall be piped to the outside of the AH, metered 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 so that, under the worst-fault conditions, dangerous amounts, for example, greater than the occupational exposure limits (OEL) of the substance in the atmosphere, are not exceeded.

NOTE 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 to maintenance on analysers containing toxic components (for example, reagents in wet chemical analysers and certain materials of construction) and care is needed during maintenance. Toxicity is highly unique for different materials and a full safety analysis has to be conducted for each specific installation.

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

**7.4.10** Entry into an AH where toxic materials can be present in hazardous concentrations (refer to local regulations) should be prohibited without supervision and appropriate means of detection and protection. A warning sign of the possible presence of a highly toxic gas within the housing should be given on the doors or on the case.

**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. 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** Any entrance connecting the AH with a continuously toxic location shall have an air lock.

**7.5.2** The AH shall be supplied with clean air according to 5.5.6 in such a way that sufficient pressurization is maintained to prevent the formation of a hazardous concentration of toxic materials entering the AH when it occurs in the surrounding area. 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 equal to five exchanges per hour.

**7.5.3** 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 normal operating conditions, such as manipulation 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. This will increase leakage risks in the AH. For this procedure, all lines and enclosures are to be purged and are to be blocked out from parts carrying process material. When opening the devices or lines, it is necessary

– to use an appropriate breathing device;
– to provide safety personnel with a portable gas monitor;
– to apply the looped exhaust system according to 7.4.11 to the point to be opened;
– to use a permanent or temporary exhaust hood.

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

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 must 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 7.5.2 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:

– descriptions of the rinse procedure and the rinsing medium;

– type of gas monitor;

– proper type of breathing device (filtering device, pressure breathing device), providing safety back-up personnel;

– 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

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.1 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 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;
– pipe connections for welded pipe;
– flanged connections or compression couplings;
– 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.2 Modules with limited leakage risk

Devices that do not meet the rigid requirements of Clause A.1 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.2.1 Guidance for evaluating modules

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

– 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)?