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On-line analyser systems — Guide to design and installation

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TECHNICAL REPORT

On-line analyser systems – Guide to design and installation

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ON-LINE ANALYSER SYSTEMS – GUIDE TO DESIGN AND INSTALLATION

FOREWORD

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IEC 61831, which is a technical report, has been prepared by subcommittee 65B: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation.

With the kind permission of the Engineering Equipment and Materials Users Association this report is based on and includes extracts from EEMUA Publication 138.

This second edition cancels and replaces the first edition published in 1999. This edition constitutes a technical revision.

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

- Updated references;

- Made consistent with current practices and regulations;
- Incorporating new technologies where applicable.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
65B/744/DTR	65B/793/RVC

Full information on the voting for the approval of this technical report 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 stability 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- withdrawn,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

This Technical Report provides guidance on the design and installation of on-line analyser systems. There are many International standards and documents which are referenced below relating to specific parts of the design and safety of on-line analyser systems. However, there is limited practical guidance available on the overall design concepts, approaches, tools and methodology for the design and installation of on-line analyser systems to ensure they perform with the required reliability and precision which this publication addresses.

The document is divided into eight clauses

1. General
2. Normative references
3. Terms and definitions
4. Remarks and considerations
5. Health, safety and environmental considerations
6. Housings
7. Sampling systems
8. Analyser communications

Individual users of on-line analysers have varying practices but the fundamental approach is generally similar. It is therefore hoped that this document will encourage standardisation within industry and lead to reduction in design and construction costs and to improved safety.

The word "analyser" has been used throughout this document to refer to instruments variously known as on-line analysers, process stream analysers, quality analysers, quality measuring instruments and process quality monitors.

Where reference is made to International standards it should be noted that National authorities may have statutory requirements that are mandatory.

ON-LINE ANALYSER SYSTEMS – GUIDE TO DESIGN AND INSTALLATION

1 Scope

This technical report is a guide applicable to on-line analyser systems. It provides the necessary guidance for the system supplier and user to specify or design a complete analyser system from sample point in the process to the final output for display or control purposes.

2 Normative references

IEC 61285:2004, *Industrial-process control – Safety of analyzer houses*

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

BS 5925:1991, *Code of practice for ventilation principles and designing for natural ventilation*

API (ANSI/ASTM D4177), *Manual of Petroleum Measurement Standards – Part 8: Chapter 8.2 Automatic Sampling of Petroleum Products ()*

EEMUA 175, *Code of Practice for Calibration and Checking Process Analysers (Formerly IP 340)*

3 Terms and definitions

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

3.1

analyser housing

general term including any of the following terms:

3.2

analyser case

enclosure forming part of the instrument

3.3

analyser cabinet

small simple housing in which analysers are installed singly or grouped together. Maintenance is carried out from outside the cabinet

3.4

analyser shelter

structure with one or more sides open and free from obstruction to the natural passage of air, in which are installed one or more analysers. The maintenance of the analyser is normally carried out from within the shelter

3.5

analyser house

enclosed structure in which are installed one or more analysers. Either natural or forced ventilation is used. The maintenance of the analyser is always carried out from within the house

4 Remarks and considerations

4.1 General remarks

The petrochemical, chemical, pharmaceutical and food industries need to be able to control their processes to ensure safety and environmental compliance and to optimise operations for maximum profitability. The use of on-line process analysers is a valuable tool in helping to achieve these objectives. This is because analysers provide frequent (continuous or cyclic) analytical information on key process properties to allow continuous on-line optimisation of the plant and rapid identification and correction of off-spec or undesirable operating conditions. Analyser repeatability is also usually better than a laboratory reference method which allows closer control and targeting to product specification.

However, the correct design and installation of on-line analysers which are addressed in this publication are essential to achieve the full benefits from the analyser systems. Analysers are expensive to install and maintain and should only be installed when there is a clearly defined and quantified benefit. On-line process analysers are usually justified for one or more of the following reasons:

- a) Personnel and plant safety
- b) Pollution measurement, prevention and control
- c) Optimising plant operations for yield and throughput
- d) Control of final products as closely as possible to maintain specification and minimise product quality give-away
- e) Minimising product degradation and reprocessing costs in cases of plant upsets, change in mode of operation and start-ups
- f) Improving energy efficiency of boilers, furnaces, distillation columns and reactors
- g) Corrosion control

4.2 Further considerations

The following considerations are also important in the application of on-line analyser systems:

- a) Analysers and associated sampling systems are often complex installations demanding attention from specialist personnel responsible for their maintenance. Therefore, it is essential that the end user has the appropriate, correctly trained manpower resources and spare parts available to ensure the analysers operate at the required level of performance to capture the anticipated benefits
- b) The justification for analysers is not usually based on the reduction in the cost of laboratory testing as this saving is often offset by the associated increase in analyser maintenance costs. To promote the effective use of analysers by operators it is often beneficial to discontinue the duplication of analyses by laboratory testing. Laboratory facilities are still required for validating and calibrating the on-line analyser systems and for any statutory requirements
- c) Single stream analysers are preferred and are usually essential for continuous automatic control
- d) On-line analysers usually require environmental protection in the form of housings to ensure reliable operation

4.3 Reliability

The following points are important considerations in the design and installation of analyser systems:

- a) Correct location and orientation of sample point
- b) Proper design of the sample transport and sample conditioning systems
- c) Availability of reliable and clean utilities
- d) Environmental protection against heat/cold, humidity, solar radiation, rain, dust and corrosion
- e) Ease of accessibility for maintenance of all the analyser system components
- f) Proper design of validation and calibration facilities
- g) Adequate preventive maintenance

4.4 Design

The design should permit maintenance, adjustments and repairs to be carried out quickly and preferably whilst the analyser is in operation. Components likely to require attention should be accessible without the aid of portable ladders or other temporary means and shall have mountings/fixings located such they are also accessible from the front. The overall design should eliminate or keep to a minimum the emission of hazardous or noxious gases and vapours and the possibility of liquid spillage.

4.5 Centralisation

The grouping together of a number of analysers where practical in a shared analyser house or shelter has a number of advantages:

- a) Single housing
- b) Common multi-core signal cables to control system
- c) Common location for power, water, steam and compressed air supplies. Common drain, vent and purge lines
- d) More efficient for maintenance
- e) Common heating, ventilation and air conditioning (HVAC) systems

4.6 Local mounting

There are, however, cases where local mounting is desirable for the following reasons:

- a) When the cost of centralisation would be disproportionate to the expected benefit
- b) When centralisation would result in excessive sample transport time lags
- c) When sample handling problems are to be expected e.g. waxy samples, trace components

4.7 Pre-assembled systems

Pre-assembled analyser systems supplied by specialist analyser systems contractors or the analyser vendors are generally the most convenient and economical approach to install new analyser systems in the plant. They may include one or more analysers with their associated sample conditioning system and common utility connections mounted together in the appropriate housing(s). There are many advantages to this approach:

- a) Systems designed and factory constructed by a specialist supplier are generally superior to those produced in the field by a contractor on site
- b) Detailed design and field construction by site contractor are reduced
- c) Factory construction is independent of weather and labour conditions at site
- d) Manpower at site is not usually skilled and experienced in this type of work

- e) Systems can be fully tested under simulated operating conditions and major design, equipment and construction faults corrected before delivery to site
- f) Proven designs can be used with consequent savings in costs and improved reliability
- g) All relevant documentation can be incorporated into a single design and operating manual by the specialist supplier

5 Health, safety and environmental considerations

5.1 Overview

Analyser systems shall be designed, installed and operated in such a manner that they are non-hazardous to personnel, to the process plant and to the environment.

The principle hazards are ignition of flammable substances, contact with toxic substances, asphyxiation in enclosed spaces and release of harmful or polluting materials to the environment. It is also important that personnel coming into contact with analyser systems do not suffer injury from additional hazards such as burns, electric shock and cuts from exposed sharp edges.

A number of statutory requirements pertaining to safe design and practices are in force in many countries e.g. the ATEX and PED Directives in Europe. There are also specific standards relating to the safety of analyser systems e.g. IEC 61825. (See Clause 2 for normative references and bibliography for other references.).

5.2 Prevention of explosions and fires

The same conditions apply to the installation of analysers as with installation of any other electrical equipment in electrically classified hazardous areas and the appropriate relevant legal regulations and standards should be followed for the country in which the equipment is being installed.

The extent to which the measures need to be applied can be minimised by restricting the likely size of an internal release in the housing by:

- a) Minimising and restricting the quantity of potentially dangerous materials entering the housing
- b) Reducing the number of joints in sample lines
- c) Using the lowest possible operating pressures
- d) Reducing the power dissipation of the electrical equipment installed within the main enclosure of the equipment
- e) Ensuring that the design does not produce surface temperatures above the ignition temperature of the gases or vapours that may be present

5.3 Prevention of toxic and asphyxiant hazards

When a system is designed, the toxicity of the substances should be considered so that under the worst fault conditions, the legal short-term exposure limits of the substances in the atmosphere are not exceeded. The design shall also ensure that, under the worst fault conditions, the atmosphere inside enclosed spaces which personnel may also enter, cannot reach asphyxiating levels. It should be noted that many substances will reach the short-term exposure limit or asphyxiant levels long before the lower flammable limit value.

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

Sampling systems containing toxic or otherwise dangerous substances should be purged with air or an inert material prior to disassembly. Warning signs shall be provided to alert personnel to possible toxic and asphyxiate hazards.

Certain analysers contain toxic components and care is needed during maintenance e.g. reagents in wet chemical analysers and certain materials of construction. Toxic calibration samples shall be stored and piped from outside analyser housings.

5.4 Radiation hazards

Apparatus and enclosures containing radioactive sources shall be clearly identified and handled in accordance with the relevant statutory regulations.

5.5 Safety facilities

Gas monitoring and alarm systems for flammable, toxic and asphyxiant substances should be installed in enclosed analyser houses and cabinets as necessary. Fire extinguishers and/or fire blankets should be made readily available at housings containing flammable substances. Fire detection and automatic suppression equipment may also be appropriate. Escape facilities should also be provided as necessary.

Housings containing toxic, acid or alkaline materials should have eye baths and showers in a readily accessible nearby location.

5.6 Manual shut-down facilities

Manual shut-down devices for the incoming power, sample, carrier gas and other potentially hazardous utilities should be fitted close to the analysers. In the case of analyser cabinets, shelters or houses, these devices should be clearly identified and located outside the housing.

A separate shut-down device should be fitted for any associated house ventilation fans.

5.7 Noise

Attention should be paid to noise levels within analyser housings to ensure maximum short term and long term noise exposure limits are not exceeded. The most likely sources of noise are from heating air conditioning and ventilation systems, water chiller units, air vortex coolers, purge systems, pneumatic valve switching and sample pumps.

6 Housings

6.1 Overview

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

The selection of the housing required for a particular analyser system depends on a number of factors, such as:

- a) Hazardous area classification of the area in which the analyser is to be located
- b) Special requirements specified by the relevant safety authority, vendor or user
- c) Range of ambient conditions at site (e.g. temperature, rain, humidity, snow, wind, dust/sand, direct sunlight, corrosive atmosphere)
- d) Environment specified by the analyser vendor for reliable, accurate and/or safe operation
- e) Protection required for equipment and personnel during maintenance operations
- f) Maintenance and accessibility requirements of the system components

g) The initial installed cost

This section primarily describes analyser housings located in hazardous areas and/or into which hazardous samples are introduced. Analyser housings located in a non-hazardous area and into which no flammable, asphyxiate or toxic samples, services, calibration mixtures, or air from a hazardous area is introduced are only required to provide the necessary environment for accurate and reliable operation without any special conditions for ventilation.

Four types of housing, as defined in Clause 3 are considered:

- a) Analyser case
- b) Analyser cabinet
- c) Analyser shelter
- d) Analyser house

6.2 Selection of housing

6.2.1 Analyser case

Analysers such as pH meters, electrolytic conductivity meters etc. may be installed directly in the open (enclosed only in the case) provided they comply with the specification of hazardous area classification and environment.

The advantages of this method are that the area around the case is naturally ventilated so there is no risk of accumulating an explosive atmosphere outside the casing. This is the lowest cost method of installation. The disadvantages are that there is no weather protection for equipment or maintenance personnel. Equipment shall be carefully specified to minimize corrosion attack and it may not have as long an operational life as equipment which is installed in a cabinet, shelter or house. This method of housing is not suitable when analysers require heating or extensive maintenance.

6.2.2 Analyser cabinet

Analysers can be installed singly or grouped in cabinets provided that the equipment is installed in accordance with the hazardous area classification. Analyser cabinets provide a low cost means of improving environmental protection for analysers and can help make the equipment more easily accessible for maintenance.

The analyser manufacturers environmental specifications can be met by e.g. including heater in the cabinet if required. Ventilation where necessary is normally achieved by natural means. The advantage of a naturally ventilated method is that ventilation is permanent and independent of mechanical failure.

However, natural ventilation does not change the hazardous area classification inside the cabinet and where a non-certified analyser with cabinet is to be installed in a hazardous area a certified air purge system will be required. The disadvantages of cabinets are that there is a practical limit on the size of analyser installed and no protection is provided for maintenance personnel.

6.2.3 Analyser shelter

This construction can be used when the analysers comply with the hazardous area classification of the location and the ambient environmental conditions comply with the analyser manufacturers specification. A shelter may be conveniently used for equipment requiring minimal protection.

A shelter is advantageous where highly toxic materials are handled. The advantages are that it facilitates the grouping of analysers and affords some protection for maintenance personnel, as well as affording permanent natural ventilation. Its disadvantage is that it does not provide

facility to change the hazardous area classification and affords only minimum environmental protection.

6.2.4 Analyser house

The analyser house is the highest cost installation but is usually justified for analysers, which require a high degree of protection, which are expected to require regular attention and from which a high service factor is required. These analysers may be installed in an analyser house which affords a controlled environment for operations and maintenance, and should reduce long term maintenance costs.

This type of protection is essential where extreme ambient conditions are encountered. The two alternatives for the ventilation system are either the natural ventilation system or the forced ventilation system.

The natural ventilation system provides limited control of the environment and the area classification within the house will always be the same as the surrounding atmosphere.

The advantages are a simpler and cheaper installation, since natural ventilation is permanent and independent of mechanical failure. The forced ventilation system can closely control the environment within the structure and the area classification within the house can be chosen depending on the source of the ventilation air. An advantage is that uncertified equipment can be used in the house provided ventilation air is drawn from a safe area and safety interlocks are included to isolate the equipment when the ventilation system is not operating.

6.3 Area classification and toxic danger

6.3.1 Electrical area classification

The area within the above house, shelter or cabinet should be classified in accordance with the appropriate local regulations. These documents will lay down the type of equipment which is necessary and the precautions which must be taken to achieve the required level of safety within the housings. All equipment used in these housings should be suitable for use in accordance with the area classification.

6.3.2 Toxic and asphyxiate danger

Ventilation requirements for an analyser housing into which toxic materials are introduced should ensure that the relevant occupational exposure limit for those materials is not exceeded under normal or any likely fault condition. Entry into a housing where toxic materials can be present above the occupational exposure limit 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 doors or case.

Ventilation requirements for an analyser housing into which asphyxiate materials are introduced should ensure that dangerous asphyxiate levels are not exceeded under normal or any likely fault condition. A warning sign of the possible presence of an asphyxiate gas within the housing should be given on doors or case.

6.4 Construction and mounting

6.4.1 General

The preference for the type of construction within the options below should be specified by the user.

6.4.2 Analyser housings

The following guidelines are applicable to all types of analyser housing: Materials of construction should be of fire-resisting material and be resistant to attack from oil and chemicals. Other environmental factors such as high humidity, frost, solar radiation, etc. should also be considered. When used as a support for equipment the enclosure should have sufficient rigidity to minimise vibration.

Where necessary, anti-vibration mountings and flexible pipe connections should be used to isolate vibration-sensitive analysers from pipework or structural vibration. Lighting should be provided to give adequate illumination for operations and maintenance. Lighting shall remain operational at all times and shall be suitable for Zone 1 hazardous areas.

Heating and air conditioning should be considered when extreme temperature and/or high-humidity conditions are expected. Heater surface temperature should not exceed the temperature allowed by the area classification and the heater element should be shielded against accidental contact by personnel.

Where ambient conditions or heat release within the analyser house results in unacceptably high temperatures air conditioning should be considered.

Where any form of environmental temperature control is considered within the housing, the wall and roofing materials and construction should be designed to minimise heat loss. This also applies to minimizing heat gain within the housing due to solar radiation. Where cavity walls are used care shall be taken to ensure gas or liquid cannot build up within the cavity.

6.4.3 Analyser houses

The following points are applicable to analyser houses:

- a) Construction is typically of brick, concrete, stainless steel sheet or glass reinforced plastic/marine ply sandwich.
- b) Outward-opening doors should be provided at both ends of the housing to permit easy escape in an emergency. The position and size of doors and the access to them should be arranged to permit removal of equipment housed. Lockable doors should be avoided. Where these are considered essential, the doors must be capable of being opened from the inside in the locked condition and crash bars shall be provided on all doors.
- c) Safety-type windows of a suitable material should be provided in each door unless specifically excluded by the user or safety authority.

There should be unobstructed internal headroom of at least 2 m. Dead corners and trenches that may collect gas should be avoided. Equipment such as, sample conditioning units, gas cylinders, calibration sample containers, and laboratory sampling points shall be located outside the housing with appropriate weather protection, unless otherwise specified by the user.

Roofs shall be inclined to prevent accumulation of water. Suitable vents shall be installed at the highest and lowest points to prevent the accumulation of gas pockets. Where the housing is to be mounted on a concrete base it should be impervious to hydrocarbons, raised at least 0,1 m above the surrounding area and sloped to a suitable point outside the housing for draining of any spillage and cleaning.

6.4.4 Analyser shelters

The following points are applicable to an analyser shelter:

It should have a ventilated roof and the lower edge of the side sheeting terminated at a minimum height of 0,5 m above the ground. Consideration should be given to mounting equipment above the lower edge of the side sheeting.

6.5 Analyser housings with natural ventilation

6.5.1 General

Natural ventilation is defined as ventilation induced by external wind forces and/or thermal gradients between inside the house and outside. Natural ventilation does not rely on mechanical means.

The following subclauses 6.5.2 and 6.5.3 apply only to houses and cabinets.

6.5.2 Ventilation requirements

The ventilation rates should be designed to dilute and dissipate any dangerous release (flammable, toxic or asphyxiate) within the house or cabinet.

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 house. From this data and knowledge of heat dissipated within the house from equipment (excluding environmental heaters) ventilation areas can be calculated.

The mode of ventilation (wind induced or thermally induced) which gives the smaller area requirements should be used. Wind calculations 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 changes/hour or the number of changes necessary to:

- a) dilute escaping vapours from the rupture or failure of the most hazardous sample or service line to less than 20 % Lower Explosive Limit (LEL) around any potential means of ignition. Particular attention shall be paid to those liquids which vapourise at ambient temperatures. Dilute to below the occupational exposure limit any toxic gases/vapours introduced into the house by accidental rupture of any one sample or service line within the house:
- b) dilute to below the asphyxiate level any asphyxiate vapour/gases introduced into the house by accidental rupture of any one sample or service line within the house. Wind induced ventilation rates should also be calculated for maximum average wind speeds using a gusting ratio of 1,6. If resulting ventilation rates exceed 50 changes/hour then comfort factors will deteriorate.

6.5.3 Heating requirements

With the above design procedure the temperatures in the house will essentially follow that of the outside ambient temperatures. To improve temperature control, thermo-statically controlled heating can be included. The heater banks should be sized to give a maximum exit air temperature of between 50 °C and 55 °C with the heater full on.

The air flow across the heater should not exceed the equivalent of 20 to 30 changes/hour in the house. With heating inputs as above it may be found that with a nominal temperature control setting on the thermostat of 20 °C a somewhat lower temperature will be achieved on the coldest days. This low value can be assessed by re-calculating the thermally induced ventilation rates. However, increased heat input is not recommended on the grounds that it would be wasteful.

Fan assistance can be included to aid distribution of the warm air. Warm air should be distributed in the lower half of the house as close to the lower vents as possible.

Annex D shows a worked example.

6.5.4 Analyser shelters

Shelters should be designed to prevent accumulation of gases and liquids.

6.5.5 Analyser cases

The manufacturers' installation requirements should be followed.

6.6 Analyser housings with forced ventilation

6.6.1 General

Forced ventilation is defined as ventilation achieved by mechanical means such as fans. The following paragraphs are applicable to analyser houses. Shelters by definition are naturally ventilated, cabinets and cases are not normally force ventilated.

6.6.2 Ventilation requirements

The house should be ventilated with air to keep flammable or toxic gases, either lighter or heavier than air out of the house, and to dissipate any leakage inside the house. Air should enter and leave the house by entry and exit ports as discussed in 6.6.5. The minimum differential pressure under operating conditions should be 25 pascals (0,25 mbar). It is normal practice to operate at an overpressure of 2 mbar to 5 mbar. The minimum air flow shall be 10 changes/hour (10 changes/hour is recommended but shall be at least 5 changes/hour according to IEC 61285) and sufficient to:

- a) dilute escaping vapours from the rupture or failure of the most hazardous sample or service line to less than 20 % LEL around any potential means of ignition. Particular attention shall be paid to those liquids which vaporise at ambient temperatures;
- b) dilute to below the occupational exposure limit any toxic gases/vapours introduced into the house by accidental rupture of any one sample or service line within the house;
- c) dilute to below the asphyxiate level any asphyxiate gases/vapours introduced into the house by accidental rupture of any one sample or service line within the house;
- d) assist in maintaining the temperature inside the house within limits specified by the user

6.6.3 Air intake system

The air intake should be through a stack provided with a weather protection cowl (rain hood). The air source should be from a non-hazardous area where corrosive or toxic gases do not occur. The design of the intake duct and the diameter of the stack should be sized to limit air velocity to a maximum of 15 m/s. Any ducting to the analyser house which passes through hazardous areas should be leak-tight. Ducting through Zone 1 hazardous areas should be avoided where possible.

In some instances distance to the safe area may be excessive and in these cases air may be drawn from a Zone 2 area in which case the following will apply:

- a) Analyser house equipment shall be certified as suitable for Zone 2 as a minimum
- b) Live maintenance should not be carried out except under a permit. Maintenance equipment should be isolated in the event of ventilation failure or gas detected.

6.6.4 Ventilation fan requirements

The forced ventilation equipment should be mounted outside the building and should be suitably protected. Ventilation should be by means of a centrifugal or axial fan. Motors positioned in the duct shall be suitable for Zone 2 operation. Dual ventilation fan systems should be considered to minimise trips of non-certified equipment on ventilation failure and to ensure continued dilution of leaks of flammable, toxic and asphyxiate materials in the event of failure of one fan. To facilitate maintenance, fans should be fitted in parallel with non-return

valves and have suitable means of mechanical isolation. Power supplies to the fan motor should be independent of each other.

A filter should be installed in the ducting and should be easily accessible for cleaning or replacement. The area of the filter should be sized to require cleaning/ replacement not more frequently than once per month under the worst dust conditions expected on site.

6.6.5 Airflow requirements

The direction of airflow within the housing should be such as to ensure a movement throughout the housing and around all equipment installed inside irrespective of wind direction and strength. The position and number of air entry and exit ports should be dependent on the nature of the hazardous materials handled inside the house (e.g. density heavier or lighter than or equal to that of air, toxicity and the concentration necessary to achieve the lower explosive limit). The air exit ports should be louvers or weight-balanced flaps. At least 50 % of the exit ports should be operable under all wind conditions. See IEC 60079-13 for typical ventilation rate calculations.

6.6.6 Heating requirements

The temperature inside the building should be controlled at a nominal 20 °C. However, any heating and/or cooling systems should be designed to maintain temperatures within the limits of 10 °C and 30 °C under extreme conditions dependent on equipment and/or maintenance restraints.

Under tropical conditions where high humidity may be a problem, the temperature inside should be a minimum of 5 °C above ambient to avoid condensation of moisture on the walls and equipment. If this is not practicable due to high ambient temperatures, consideration should be given to the provision of air conditioning or dehumidifying the air.

Due regard should be paid to heat given off by analysers, sample lines and trace heating as well as solar radiation on the walls and roof when calculating the base temperature inside the building. With the analysers shut down, the temperature shall not fall to less than 5 °C. Heating should be by the installation of electric or steam heaters. Electrical heaters should be of the metal-sheathed tubular type with the surface temperature below 200 °C under any condition of operation including fan failure. Where ventilating air is taken from a Zone 2 Area, then the surface temperature of the heater should not exceed the temperature classification of the gas groups present in the Zone 2 Area.

6.6.7 Safety monitors and alarms

6.6.7.1 Overview

The primary safeguard for the analyser house is the design of the equipment to the required standards, i.e. Zone 1 and 2 and/or their purge system. Flammable and toxic gas detectors should be fitted as an additional safeguard, the detecting heads being located at key points within the analyser house. The detector heads and associated electronics should be suitable for Zone 1 hazardous areas.

Analysers should preferably be certified for use as a minimum in a Zone 2 hazardous area. (This is to allow continued operation even when ventilation and combustible alarms exist.

Any shutdown/alarm logic is usually contained within the analyser house and incorporates all logic indicators, key operated alarm/shutdown override switches and equipment reset switches.

To allow continued operation during ventilation failure and/or gas detection, the analyser house lighting, and equipment associated with the shutdown/alarm system including all initiators, logic and alarm indicators should be certified for use in Zone 1 hazardous areas.

Uninterrupted Power Supplies (UPS) should be used for all of the shutdown system, including gas detectors.

The following alarms/shutdowns should be provided as appropriate.

6.6.7.2 Ventilation failure

A low flow switch positioned to unambiguously detect failure of airflow through the house should be used. Care should be taken to ensure any air flows due to leaks in filtration units, parallel fan re-circulation routes etc. are not monitored. The switch should be set to indicate flow failure when flow falls below the equivalent of 60 % of design flow. A time delay of up to 1 minute may be used to prevent spurious operation during short term disturbances.

Low flow detection should initiate visible and audible alarms in the house and at a manned location elsewhere.

Where equipment other than that suitable for Zone 1 or Zone 2 operation i.e. general purpose is used, the low flow detection shall initiate the following trip functions.

- a) Immediately isolate non certified equipment
- b) Immediately isolate wall sockets
- c) In the absence of flammable gas detection isolate Zone 2 certified equipment after an optional time delay up to a maximum of 24 hours
- d) For Zone 2 purged equipment, purge failure coincident with ventilation failure should initiate isolation of the purged equipment after an optional time delay up to a maximum of 24 hours

Upon restoration of ventilation, power shall not be permitted to be restored to isolated equipment until at least 10 analyser house volumes of air have been exchanged. This should be automatically controlled via a delay-on timer initiated when ventilation airflow is established. Activation of a local manual reset facility will then be allowed to restore power.

Ventilation fans shall have local start/stop switches.

A visual indication of the pressure differential between the analyser house and the external atmosphere should be provided within the analyser house.

6.6.7.3 Flammable gas or vapour detection

If flammable gas detectors are used they should be calibrated and positioned according to the nature of the gases expected to be released within the house either from the analyser systems or via the ventilation system.

Gas detection shall initiate visible and audible alarms in the house and at a manned location elsewhere.

Gas detection should initiate a visual alarm on the outside of the house, normally a yellow flashing beacon.

Gas detectors should give two levels of alarm with trip functions as follows:

- a) Immediately isolate non-certified equipment on 20 % LEL detection.
- b) Immediately isolate wall sockets on 20 % LEL detection.
- c) For Zone 2 purged equipment, purge failure coincident with 60 % LEL detection should initiate isolation of the purged equipment.

The above trip functions should operate independently of ventilation failure trip functions.

Gas detection is an added safeguard and is not a substitute for ventilation failure trips other than allowing for the optional requirement for the time delay on tripping Zone 2 and purged equipment to be removed.

On removal of the hazardous conditions as indicated by the gas detection equipment (below 20 % LEL), power shall not be restored to isolated equipment until at least 10 analyser house volumes of air have been exchanged. This should be automatically controlled via a delay-on timer initiated when flow is established/confirmed and the LEL falls below 20 %. Activation of a local manual reset facility will then be allowed to restore power.

6.6.7.4 Purged equipment

Purging of non-certified equipment with no internal source of release of flammable material is necessary for Zone 2 or Zone 1 hazardous areas. If the analyser house is designated Zone 2, tripping of equipment on purge failure is not required other than trips associated with ventilation failure and/or flammable gas detection as described in paragraphs 6.6.7.2 and 6.6.7.3 .

Purging of equipment with an internal source of release of flammable material has the added function of preventing a build-up, from an internal leak, of a flammable atmosphere within the equipment by dilution or inerting.

All purged equipment should be certified Ex'p'. Purge failure in any circumstances shall initiate visible and audible alarm.

6.6.7.5 Toxic and asphyxiate gas detection

If toxic and asphyxiate gases are handled inside the house, toxic gas and oxygen deficiency detection should be provided. Detection of toxic gas above preset alarm of oxygen below preset limits should initiate a visual and audible alarm in the house and at a manned location elsewhere.

Toxic and low oxygen gas detection should initiate a visual alarm on the outside of the house, normally common with flammable gas using a yellow flashing beacon.

6.6.7.6 Fire detection and protection

Manual call points should be provided on the outside of the house next to the doors. Fire detection may be provided in the form of smoke or heat detectors. They are normally only installed where there is general purpose equipment using large volumes of sample e.g. octane engine comparators or where there are open flame type analysers e.g. Wobbe Index.

Fire suppression may be provided which can be automatically or manually initiated on detection of fire.

Where automatic release is required, initiation should be controlled by smoke detectors, but an independent manual release facility shall be provided. For automatic release, voting systems are preferred to prevent spurious operation of extinguishing.

Fire detection shall initiate a visual and audible alarm in the house and at a manned location elsewhere.

Fire detection should initiate a visual alarm on the outside of the house normally a red flashing beacon.

In the event of fire detection, consideration should be given to automatically initiate the isolation of:

- a) Any pipework entering the house that contains flammable materials
- b) Ventilation fans
- c) All electrical supplies to the house

Where fire suppression systems are fitted, it is necessary that ventilation air is shut off, all ventilation inlet and outlet louvers are automatically isolated and analyser house doors are of the self-closing type.

Extinguishing system status should be indicated over the house door. e.g. Blue - locked off, Green - manual, Amber - automatic, Red - discharged. States other than Red for discharged are optional depending on degree to which the personnel are to be informed.

6.6.7.7 Alarms

The following analyser house related local alarms/indicators should be generated and displayed:

- a) Ventilation flow low *
- b) Combustibles present (more than 20 % LEL) *
- c) Fan 1 not in operation
- d) Fan 2 not in operation
- e) Common alarm for failure of any individual analyser air purge system failure *
- f) Toxic gas present (no more than the long term Occupational Exposure Limit (OEL)) - if applicable *
- g) Low oxygen levels detected*
- h) Fire detected - if applicable *
- i) Extinguishant released - if applicable *
- j) 24 hour timer in operation
- k) 10 air changes completed after restoration of normal conditions
- l) Common shutdown/alarm bypass in operation *

The alarms marked * should also be transmitted to a permanently manned control room, either individually or as a common alarm.

7 Sampling systems

7.1 Overview

Where an analyser is not installed with its sensing element directly into a process line, a sample system will be necessary. A sample system includes all components from, and including, the sample probe up to the analyser inlet inclusive of the sample transport system (sample line).

The purpose of the sample system is to ensure that the analyser receives a sample representative of the process stream with the minimum of delay and in a state (temperature, pressure, cleanliness, flow-rate) such that the analyser will operate within its specification. The system shall include all components necessary for proper and safe operation. Probes, valves, filters, coolers, heaters, pressure regulators, pressure relief valves, space/trace heating, coalescers, piping/tubing, pumps, and all other necessary equipment should be included as required.

Sample systems should be designed to minimise product/material waste through the use of fast circulating systems (fast loops) and sample recovery techniques. A sample system may