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IS/IEC 60079-16 (1990): Electrical apparatus for explosive gas atmospheres, Part 16: Artificial ventilation for the protection of analyzer(s) houses [ETD 22: Electrical Apparatus for Explosive Atmosphere]

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ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES

PART 16 ARTIFICIAL VENTILATION FOR THE PROTECTION OF ANALYZER(S) HOUSES

ICS 29.260.20

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BUREAU OF INDIAN STANDARDS
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NATIONAL FOREWORD

This Indian Standard (Part 16) which is identical with IEC 60079-16 : 1990 'Electrical apparatus for explosive gas atmospheres — Part 16: Artificial ventilation for the protection of analyzer(s) houses' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

Attention is invited to the fact that the manufacture and use of flameproof equipment in the country is controlled by the concerned statutory authorities for the area of their jurisdiction. This standard is not intended to take the place of the various statutes and regulations in force in the country applicable to the installation and use of electrical apparatus in places where there is an explosion hazard.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Only the English language text of the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
Indian Standard

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS
ATMOSPHERES

PART 16 ARTIFICIAL VENTILATION FOR THE PROTECTION OF ANALYZER(S)
HOUSES

1. Scope

1.1 This report provides the general principles of protection, by artificial ventilation, of analyzer(s) houses against the explosion hazards caused by internal release of flammable substances and, if applicable, against the hazards caused by an external explosive gas atmosphere. It also gives the conditions in which electrical apparatus liable to cause ignition may be used in these analyzer(s) houses. These analyzer(s) houses may be situated in a hazardous area or in a non-hazardous area.

1.2 This report contains recommendations for the construction and operation of analyzer(s) houses, for their associated installations, such as air ducts, and for the auxiliary devices necessary for providing and maintaining the conditions for ventilation and, when required, pressure.

This report also specifies the verification and testing necessary to prove that the installation conforms to the above recommendations, and the markings to be placed on such rooms or buildings.

Notes

1. In certain circumstances, the recommendations may be used for other buildings containing similar sources of release.

2. This report does not deal with dangers associated with the toxicity of gases and vapours which may be dealt with by similar techniques. It does not deal with requirements not related to explosion safety.

2. Definitions

For the purpose of this report the following definitions apply:

2.1 Analyzer(s) house

A specific closed room or building containing one or more analyzers for samples of flammable fluids which are or may be connected to a process installation together with electrical equipment and auxiliary devices.

Note: Analytical laboratories are not covered.
2.2 Artificial ventilation

A method of mechanical movement of air to reduce and maintain at a safe level the concentration of flammable gases or vapours in the analyzer(s) house. Such ventilation may also be used to maintain the pressure inside the analyzer(s) house above or below the external ambient pressure.

2.3 Ventilation system

The complete installation required to produce artificial ventilation.

2.4 Forced ventilation

Artificial ventilation used to force air into the analyzer(s) house.

2.5 Induced (exhaust) ventilation

Artificial ventilation used to extract air from the analyzer(s) house.

2.6 Ventilation failure

A situation wherein the required air flow and, if necessary, the required pressure cannot be maintained.

2.7 Purging

The operation of passing a quantity of air through the analyzer(s) house and its associated ducts in order to reduce any concentration of flammable gas or vapour within them to a safe level.

2.8 Alarm

A signal, which may be audible or visible or both, to warn that appropriate action is necessary.

3. General considerations

3.1 General safety considerations

The general safety considerations are:

1) to keep the quantity of flammable materials in the analyzer(s) house to the minimum compatible with the normal operation of the equipment installed in the house;

2) to provide an efficient ventilation system to dilute to a safe level any internal release of flammable gas or vapour;
3) to provide measures of protection which take into account ventilation failure;

4) to provide for the safe disposal of samples.

3.2 Requirements for the analyzer(s) house

The analyzer(s) house should preferably be a separate building. However, it may sometimes be necessary to incorporate the analyzer(s) house in an existing building. In such cases the analyzer(s) house should be completely isolated from other parts of the building except as permitted in Sub-clause 5.3. However, air-locks with appropriate safety provisions may be permitted between the analyzer(s) house and the remainder of the building if the requirements of Sub-clause 5.3 are met. For examples of arrangements see Appendix A.

3.2.1 All analyzer(s) houses in which flammable substances are handled will affect the surrounding atmosphere. These effects should be taken into account when the hazardous areas for the surroundings are defined, especially when the analyzer(s) house is to be located in an otherwise non-hazardous area. In particular, when gas samples have to be released to the atmosphere, the effects of these releases should be taken into account.

Note.- The preferred alternative of connection to a closed collection system or to a flare system may not be possible for functional reasons.

Other effects on the external area classification which depend on the arrangement of the analyzer(s) house are illustrated in Appendix A.

3.2.2 If the analyzer(s) house is situated in a hazardous area, the ingress of the external atmosphere into the analyzer(s) house should be prevented by an internal overpressure produced by forced ventilation.

If the analyzer(s) house is situated in a non-hazardous area, the ingress of the external atmosphere is not important; maintaining an internal overpressure is not, therefore, required and either forced or induced (exhaust) ventilation may be used. The final choice is dependent on factors other than that of explosion hazard. (For further details see Clause 5.)

3.3 Requirements in the event of ventilation failure

When the ventilation system is in operation under the specified conditions and the purging, if any, has been completed, the atmosphere inside the analyzer(s) house should be non-hazardous, irrespective of the external area classification.

Note.- An explosive gas-air mixture may still exist in the immediate vicinity of a source of release.
All electrical equipment which is intended to remain in operation during a ventilation failure should have a type of protection suitable for Zone 1.

Electrical apparatus not constructed to operate in explosive atmospheres should be switched off in the event of a ventilation failure. Depending on the external area classification and on the characteristics of the internal sources of release, a time delay may be incorporated in the safety measures.

Electrical apparatus not constructed to operate in explosive atmospheres should only be re-energized if the internal atmosphere is non-hazardous. This will normally require appropriate purging. Purging may be omitted if it is established by calculation or verified by measurements that the atmosphere inside the analyzer(s) house and its associated ducts is non-hazardous.

It is necessary to take into account the characteristics of non-explosion protected apparatus, which may affect the safety of analyzer(s) houses after ventilation failure (for example, apparatus containing heaters).

3.4 Requirements for equipment installed in an analyzer(s) house

The installation of the analyzers should be such that as much as possible inside the analyzer(s) house the length of piping, the number of joints and other components containing flammable materials are kept to a minimum. As much as possible of the piping and equipment for sample conditioning, as well as all reserves of non-inert gas or liquid, should be mounted outside or in an adjoining building classified appropriately.

The diameters of the gas sample inlet and outlet pipes should be the minimum necessary to provide the maximum flow of gas needed by the analyzer but having adequate mechanical strength.

The total system from sample take-off point to final return point or point of discharge should be designed with the consequence of component failure in mind. Pressure relief devices and flow restrictors should be incorporated whenever necessary to limit to a minimal value any resulting escape of flammable substances into the analyzer(s) house.

All pipes which lead flammable substances into the analyzer(s) house should be capable of being isolated outside the analyzer(s) house.

Sampling operations which involve the intentional release of flammable substances should be carried out in a suitable location outside the analyzer(s) house.
4. Construction requirements for the building

4.1 The building should not be larger than necessary, in order to reduce the required supply of ventilation air. On the other hand, the building should be large enough to ensure safe operation of the instrumentation and safe access and exit.

4.2 Precautions should be taken if highly insulating materials are being used in the construction of the analyzer(s) house, auxiliary equipment and ventilation system, so as to avoid any potential electrostatic hazards.

4.3 The building and the arrangement of the analyzer(s), auxiliary equipment and ventilation system should be so designed that accumulation of flammable substances does not occur inside the analyzer(s) house.

False ceilings and floors should be avoided but if used particular care should be taken with regard to the purging and ventilation of the spaces created.

Cable trenches in the floor should be avoided but if they are used they should be completely filled and adequately covered and sealed.

If floor drainage facilities are provided, measures should be taken to prevent the exchange of atmosphere between the inside and the outside of the analyzer(s) house.

The number of openings in the walls and roof should be restricted to that necessary for ventilation ducting, cables, sample piping, etc. The size of the openings should not be larger than necessary for the intended purpose and they should be sealed.

4.4 The number of doors should be kept to a minimum to reduce air loss. Two sets of doors forming an airlock may aid in further reducing air loss.

Note.- For personnel safety, two doors opening outwards should normally be provided.

Additional measures that can be taken for maintaining the integrity of the protection system are, for example:

- fitting door locks to control entry of unauthorized personnel;

Note.- Such doors should be fitted with a crash bar to enable them to be opened from inside even when they are locked.

- fitting an automatic door-closing mechanism;
- installing position switches on the door for alarm annunciation.
An inspection window of clear armoured glass or an equivalent material should be provided. If fitted in a door, it should be provided with protection bars on each side.

Windows should not be capable of being opened.

Generally, no windows other than inspection windows should be provided.

5. Construction requirements for ventilation systems

The purpose of using artificial ventilation is to dilute and expel the explosive gas atmosphere caused by an escape of flammable substances within the analyzer(s) house.

If the ventilation system incorporates facilities for heating or cooling the air, these should not adversely affect the safety and integrity of the analyzer(s) house.

5.1 Requirements for all ventilation systems

5.1.1 The ventilation air should be taken from a non-hazardous area and should not, by virtue of any chemical products or impurities which it may contain, produce deleterious effects or introduce a risk of reduced safety.

Note: The possibility of contamination with flammable substances may be monitored by an automatic gas-detecting device with local and remote alarms.

5.1.2 The ventilation system should be capable of diluting any normal leakage of flammable substances from all analyzers and sampling systems and, in addition, the abnormal leakage caused by a foreseeable failure of the components of the analyzers and sampling systems which will create the most dangerous situation, to a concentration below the maximum accepted level.

Note: Appendix C of IEC Publication 79-2 gives guidelines for assessing the type of release.

For the gases or vapours involved, a generally accepted maximum concentration is 25% of the lower explosive limit.

Note: It is also necessary to take into account the toxicity of the gases or vapours.

The ventilation air flow should be such that it ensures good mixing without any dead volumes.

5.1.3 Normally, a single fan supplied from a reliable source is sufficient but in certain circumstances, such as the necessity to maintain non-explosion protected equipment in operation, it is necessary to provide two fans with independent sources of supply and so installed that one can immediately and automatically take over from the other.
In other systems it may also be advisable to provide two fans but without the need for automatic switching.

The fan should be constructed so that the possibilities of sparking due either to mechanical friction or to electrostatic charging are reduced to a minimum, for example by the use of brass, plastic-coated steel or any construction in plastic conforming with Sub-clause 16.4 of IEC Publication 79-0.

The fan motor and associated control equipment should preferably be located outside the air ducting and protected by a type of protection appropriate to their location. If they are placed inside the ducting, they should be protected by a type of protection suitable for Zone 1.

5.1.4 The position, dimensions and number of air ducts should provide, at the specified ventilating air flow rate, effective purging and dilution throughout the analyzer(s) house including enclosures not individually ventilated (see, for example, Appendix C).

Inlet and outlet openings should be arranged so as to be unaffected by outside weather conditions such as wind direction and rain.

Duct openings for the escape of gases and vapours should be at floor and ceiling level to allow escape of gases and vapours heavier or lighter than air.

The ventilation air ducts and their connections should be capable of withstanding 1.5 times the maximum overpressure specified for normal operation with a minimum of 200 Pa (2 mbar).

The material of the ducts should be chemically and physically suitable for the use intended.

The inlet ducts should not normally pass through a hazardous area. Where this cannot be avoided, the pressure in the ducts should be higher than the external pressure, or adequate precautions should be taken to ensure that the ducts are free from leaks.

A flow-detecting device should be installed in the duct for the detection of ventilation failure and should be located near the analyzer(s) house.

5.2 Specific requirements for forced ventilation

In the case of forced ventilation, the fan blows air into the analyzer(s) house via a supply duct and inlet opening and the contaminated air leaves the analyzer(s) house via outlet ducts or defined openings. An example of such an arrangement is shown in Appendix B.
Where the analyzer(s) house is located in a hazardous area, the outlet openings should be so adjusted that, under minimum ventilation flow conditions, an overpressure of at least 25 Pa (0.25 mbar) above the external atmosphere is maintained.

Note: This overpressure will prevent the ingress of the external atmosphere for wind speeds up to approximately 3.5 m/s.

5.3 **Specific requirements for Induced (exhaust) ventilation**

In the case of induced (exhaust) ventilation, the fan extracts air from the analyzer(s) house and discharges it into the surrounding atmosphere. This technique is only applicable where the analyzer(s) house is in a non-hazardous area. The fan creates an underpressure in the analyzer(s) house. Clean air is then drawn into the analyzer(s) house through inlet openings which are designed for satisfactory air distribution.

Where an analyzer(s) house is located in or forms part of another building, the source of air may be the existing air-conditioned atmosphere of that building. Inlet openings should be so adjusted that, under normal operating conditions, a pressure below that of the surrounding area is maintained. An example of such an arrangement is shown in Figure A2 of Appendix A.

Special precautions should be taken to avoid the risk of contamination of other parts of the building in the event of ventilation failure.

6. **Safeguarding system**

The analyzer(s) house should have a safeguarding system to guard against hazardous situations during a ventilation failure. All detection devices should have a type of protection appropriate for their location.

6.1 A ventilation failure should be detected by a flow detection device mounted in the air duct. One or more of the following devices may be fitted to give additional information on ventilation failure:

1) a differential pressure switch;
2) a fan motor-starter interlock switch if the fan is directly coupled to the motor;
3) a rotation detecting device on the fan;
4) any other suitable device (e.g. gas detector).

Ventilation failure should initiate an alarm. After an alarm the electrical supply to apparatus not suitably protected for use in hazardous areas should be automatically disconnected with or without delay.
Where doors are not automatically self-closing, means such as differential pressure switches or door switches should be used to initiate an alarm if a door is left open too long. If the house is in a hazardous area the alarm should initiate the automatic disconnection of the electrical supply with or without delay.

The automatic disconnection may be delayed for a specified period after the alarm has been initiated, provided measures have been taken to ensure that the safety of the analyzer(s) house is not adversely affected. Such a delay period will depend on the safety measures taken, the external area classification and the characteristics of the internal releases.

An induced (exhaust) ventilation failure should in addition initiate the closing of the air inlets to the analyzer(s) house when necessary to prevent contamination of the atmosphere in the vicinity of these inlets (see Appendix A, Figures A2 and A3).

The alarm initiated for the ventilation failure may be indicated locally or remotely at a suitable location. Restoration of the electricity supply should only be possible after adequate purging, unless it can be verified that the atmosphere inside the analyzer(s) house is below the maximum accepted concentration (see Sub-clause 5.1.2).

Note. — Before energizing, an adequate purge can be carried out within the time t necessary to pass a volume of protective gas equivalent to at least five times the volume of the analyzer(s) house associated ducts. Because of the internal release, the purging time may need to be longer than the time t.

6.2 A manual disconnecting device should be provided in addition to the automatic system required in Sub-clause 6.1.

7. Verification and tests

The following verification and tests should be carried out:

1) verification of compliance of the design documentation with the recommendations of this report;
2) verification of compliance of the installation with the design documentation;
3) a test to prove that the air flow is in accordance with the specification and that the purging is efficient, unless the latter has been proved by calculation;
4) a test to prove that the pressure in the analyzer(s) house is maintained at the recommended value (see Sub-clause 5.2);
5) a test to prove that the operation of the safeguarding system is satisfactory (see Clause 6);
6) verification that the flow restrictors in sample lines are correctly installed, with tests if necessary (see Sub-clause 3.4).
8. Marking and records

8.1 Marking

The analyzer(s) house should be marked at a readily visible location as follows:

1) the wording: "Analyzer(s) house protected by artificial ventilation";

2) the name of the manufacturer or agent responsible for the installation;

3) the name or designation of the analyzer(s) house;

4) the highest and lowest apparatus grouping and temperature class of explosion-protected equipment in the analyzer(s) house;

Note.- Highest and lowest categories are required because the most dangerous situation may arise from circumstances outside or inside the analyzer(s) houses.

5) the volume of the analyzer(s) house, the minimum purge flow rate and minimum purge duration;

6) the minimal flow rate in operation.

8.2 Warning notice

In addition to any operating instructions, the following warning notices should be fitted:

1) At each entrance door:

"WARNING"

a) "Doors shall be kept closed".

b) "Flammable or combustible materials shall only be introduced into the analyzer(s) house if specifically permitted and entered in the record book".

2) Near the location of the power supply controls:

"WARNING"

"Operate the ventilation fan for t minutes before switching on the installation, unless it has been verified that the atmosphere in the analyzer(s) house is non-hazardous".

Note.- See Sub-clause 6.1.
8.3 Records

A record book (or dossier) should be prepared to contain the relevant details of the analyzer(s) house. Such details should include at least:

a) all the details given in Sub-clause 8.1;

b) a list of analyzer(s) equipment installed inside the analyzer(s) house and, where applicable, the type of protection, apparatus grouping and temperature class of each;

c) details of any national authority certificate for all explosion-protected equipment installed in it (where applicable);

d) the certificates and manufacturers' test results for the analyzers installed;

e) the manufacturers' safety instructions for all installed equipment;

f) the settings of all protective devices;

g) details of the ventilation system and operational instructions;

h) the minimum operating pressure and air flow;

i) results of test measurements of pressures within the analyzer(s) house under purge and normal operating conditions;

j) values of the minimum purge flow rate and minimum purge duration time for the analyzer(s) house;

k) such characteristics of non-explosion protected apparatus as may affect safety (see Sub-clause 3.3);

l) date of installation and of commissioning tests;

m) date and nature of any modification (see Sub-clause 8.4).

8.4 Modifications

The instructions given in Sub-clauses 8.1, 8.2 and 8.3 should be revised when any modifications are made to the analyzer(s) house after construction and commissioning and after any changes affecting the specifications.
Introduction

There are many possible designs of ventilation systems for analyzer(s) houses.

From all possible examples, the following are chosen to illustrate the application of the principles described in this report.

Legend

Zone 1: hazardous area

Zone 2: hazardous area

Non-hazardous area

Notes

1.- The hazardous areas shown in all the figures are intended to indicate in a simple manner the different effects of an analyzer(s) house upon the surrounding atmosphere. They are not area classification drawings. Such drawings should be produced in accordance with Publication 79-10 by area classification specialists and the analyzer(s) house designers after consideration of the parameters of each installation.

2.- Zone 2 areas shown in Figures A1 and A2 may alternatively be Zone 1.

3.- In Figures A3 and A4, the reverse air flow direction is also possible (see Sub-clause 3.2.2).
A1. When the analyzer(s) house is located in an existing hazardous area (Zone 1 or Zone 2), or when it is acceptable that the analyzer(s) house creates a Zone 2 hazardous area in an otherwise non-hazardous area, the sample conditioning equipment should preferably be located outside the analyzer(s) house. This will result in a considerable reduction of the ventilation air flow required for dilution of internal releases of flammable substances.

During a ventilation failure, it is not normally necessary to close the sample streams containing flammable substances which could enter the analyzer house. For an example of the arrangement see Figure A1.

FIG. A1. - Analyzer(s) house in a hazardous area.
A2. Where the analyzer(s) house is incorporated in an existing building, special precautions should be taken to avoid contamination of the building in the event of ventilation failure. All systems liable to cause leakages of flammable liquids or gases inside the analyzer(s) house and all air inlet openings should therefore be closed automatically and immediately when the ventilation fails. The number of precautions to be taken will be reduced if the auxiliary equipment can be located outside the analyzer(s) house, in an adjacent hazardous area. For a typical arrangement, see Figure A2.

![Diagram of Analyzer(s) house incorporated in an existing building]

**FIG. A2.** - Analyzer(s) house incorporated in an existing building.

*Note* - The air inlet may be placed in the wall between the analyzer(s) house and the offices, provided that the special precautions referred to in Sub-clause 5.3 have been taken.
A3. If the analyzer(s) house is situated in an otherwise non-hazardous area, one possible arrangement is to have all potential leakages of flammable substances inside the analyzer house where they will be diluted by the ventilation system.

In the event of ventilation failure, all sample streams containing flammable substances should be closed to reduce the leakage; the air inlets should also be closed. The remaining small but unavoidable leakages will, however, cause a gradual increase of gas concentration inside the analyzer(s) house and consequently there will be an explosive gas atmosphere around the air outlet openings during a ventilation failure and during the initial stage of the purging period. For a typical arrangement, see Figure A3.

Note.- If the air inlets are not closed during the ventilation failure, there may be a small hazardous area around them.

FIG. A3. - Analyzer(s) house in a non-hazardous area with induced (exhaust) ventilation.
A4. Where the arrangement in Figure A3 is not acceptable, all sources of potential leakage (including sample stream shut-off valves) should be located outside the analyzer(s) house. When these are closed during ventilation failure there will be no internal leakages and purging will not be a fundamental requirement. It should be realized, however, that there will now be hazardous areas around the equipment outside the analyzer(s) house.

As the internal leakages are smaller than in Figure A3, the required air flow will also be lower. For an example of an arrangement, see Figure A4.

FIG. A4. - Analyzer(s) house in a non-hazardous area (forced ventilation).
APPENDIX B
EXAMPLE OF AN ARRANGEMENT FOR A FORCED VENTILATION SYSTEM

[Diagram showing an arrangement for a forced ventilation system with labeled sections A-A and B-B.]
APPENDIX C

EXAMPLE OF AN ARRANGEMENT FOR AN INDUCED (EXHAUST) VENTILATION SYSTEM

A = Analyzers enclosures connected to the air outlet ducts

N = Not used connections to the air outlet ducts for more analyzers.

Note.- Arrows with continuous lines indicate directions of air flows.
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Amendments Issued Since Publication

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BUREAU OF INDIAN STANDARDS

Headquarters:
Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones: 2323 0131, 2323 3375, 2323 9402
Website: www.bis.org.in

Regional Offices:
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110 002
{ 2323 7617
{ 2323 3841

Eastern : 1/14, C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi
KOLKATA 700 054
{ 2337 8499, 2337 8561
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Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160 022
{ 260 3843
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Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600 113
{ 2254 1216, 2254 1442
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