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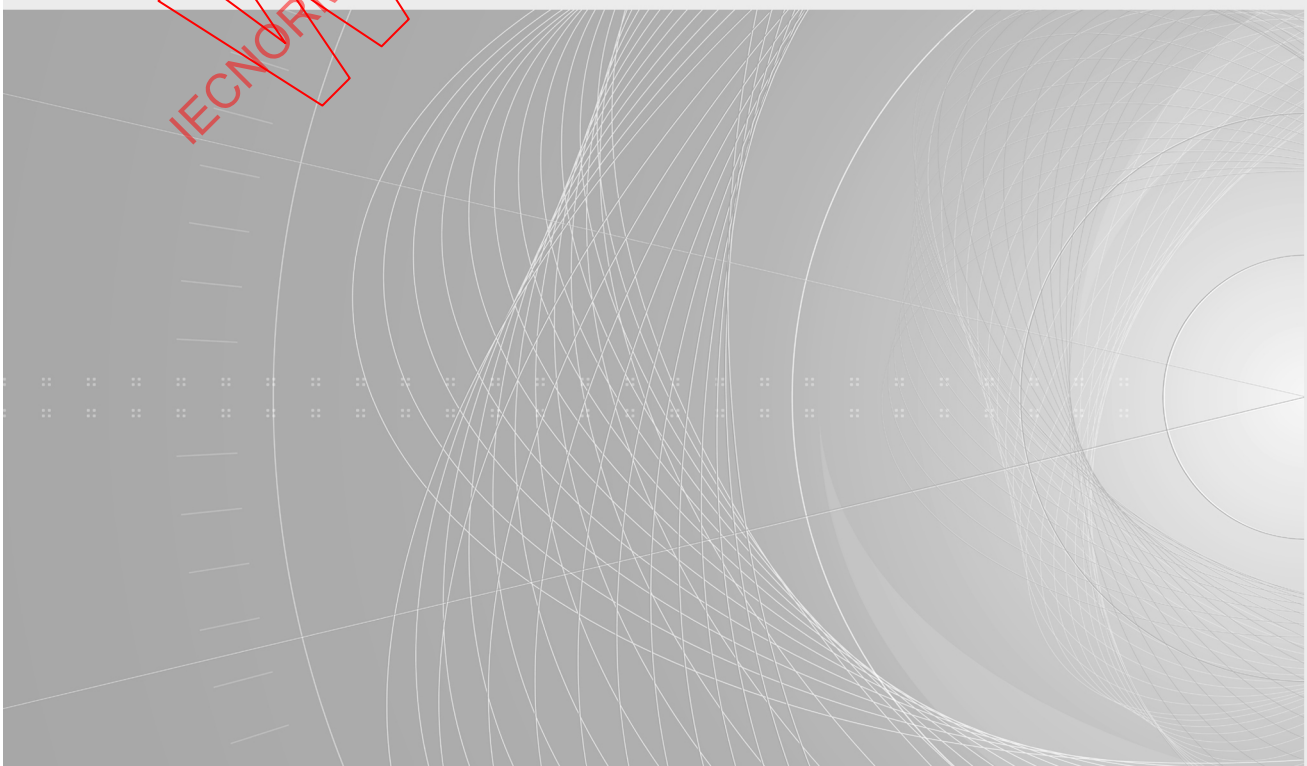
Edition 2.0 2007-11

INTERNATIONAL STANDARD

Mobile and fixed offshore units – Electrical installations – Part 7: Hazardous areas



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Tel.: +41 22 919 02 11
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 7: Hazardous areas

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61892-7 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This second edition cancels and replaces the first edition published in 1997. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the clauses regarding area classification have been updated based on changes in IEC 60079-10;
b) the clauses regarding emergency shut down have been updated, based on current industry practice;
c) the clauses regarding installation have been updated based on changes in IEC 60079-14;
d) a new clause regarding ventilation of battery compartment for valve regulated batteries has been added.

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

FDIS	Report on voting
18/1066/FDIS	18/1072/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.

A list of all parts of the IEC 61892 series, under the general title *Mobile and fixed offshore units – Electrical installations*, can be found on the IEC website.

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.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

IEC 61892 forms a series of International Standards intended to ensure safety in the design, selection, installation, maintenance and use of electrical equipment for the generation, storage, distribution and utilization of electrical energy for all purposes in offshore units which are used for the exploration or production of petroleum resources.

This part of IEC 61892 also incorporates and co-ordinates, as far as possible, existing rules and forms a code of interpretation, where applicable, of the requirements laid down by the International Maritime Organization, and constitutes a guide for future regulations which may be prepared and a statement of practice for offshore unit owners, constructors and appropriate organizations.

This standard is based on equipment and practices which are in current use, but it is not intended in any way to impede development of new or improved techniques.

The ultimate aim has been to produce a set of International Standards exclusively for the offshore petroleum industry.

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 7: Hazardous areas

1 Scope

This part of IEC 61892 contains provisions for hazardous areas classification and choice of electrical installation in hazardous areas in mobile and fixed offshore units, including pipeline, pumping or 'pigging' stations, compressor stations and exposed location single buoy moorings, used in the offshore petroleum industry for drilling, processing and for storage purposes.

It applies to all installations, whether permanent, temporary, transportable or hand-held, to a.c. installations up to and including 35 000 V and d.c. installations up to and including 750 V.(a.c. and d.c. voltages are nominal values).

This standard does not apply to electrical installations in rooms used for medical purposes, or in tankers.

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 60079-0:2007, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-1:2007, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosure "d"*

IEC 60079-2:2007, *Explosive atmospheres – Part 2: Equipment protection by pressurized enclosure "p"*

IEC 60079-5:2007, *Explosive atmospheres – Part 5: Equipment protection by powder filling "q"*

IEC 60079-6:2007, *Explosive atmospheres – Part 6: Equipment protection by oil immersion "o"*

IEC 60079-7:2006, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC 60079-11:2006, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-14:2002, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines)*

IEC 60079-15:2005, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, test and marking of type of protection "n" electrical apparatus*

IEC 60079-18:2004, *Electrical apparatus for explosive gas atmospheres – Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus*

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

IEC 60079-26:2006, *Explosive atmospheres – Part 26: Equipment with equipment protection level (EPL) Ga*

IEC 61892-1, *Mobile and fixed offshore units – Electrical installations – Part 1: General requirements and conditions*

IEC 61892-2, *Mobile and fixed offshore units – Electrical installations – Part 2: System design*

IEC 61892-3, *Mobile and fixed offshore units – Electrical installations – Part 3: Equipment*

IEC 61892-4, *Mobile and fixed offshore units – Electrical installations – Part 4: Cables*

IEC 61892-5, *Mobile and fixed offshore units – Electrical installations – Part 5: Mobile units*

IEC 61892-6, *Mobile and fixed offshore units – Electrical installations – Part 6: Installation*

IMO MODU code*: Code for the construction and equipment of mobile offshore drilling units*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 61892-1 through IEC 61892-6 and the following apply.

3.1
appropriate authority
governmental body and/or classification society with whose rules a unit is required to comply

3.2
area classification
assessed division of a facility into hazardous and non-hazardous areas, and the subdivision of the hazardous areas into zones

3.3
enclosed area
any room or enclosure within which, in the absence of artificial ventilation, the ventilation will be limited and any flammable atmosphere will not be dispersed naturally

3.4
enclosure
all the walls which surround the live parts of electrical apparatus including doors, covers, cable entries, rods, spindles and shafts, ensuring the protection of the electrical apparatus

3.5
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, mist or dust, in which, after ignition, combustion spreads throughout the unconsumed mixture

[IEV 426-02-02, modified]

3.6
explosive gas atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour in which, after ignition, combustion spreads throughout the unconsumed mixture

[IEV 426-02-03, modified]

NOTE Although a mixture which has a concentration above the upper explosive limit (UEL) is not an explosive gas atmosphere, it can readily become so and, in certain cases for area classification purposes, it is advisable to consider it as an explosive gas atmosphere.

3.7
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 apparatus

[IEV 426-03-01, modified]

3.8
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 apparatus

[IEV 426-03-02, modified]

3.9
zones
hazardous areas are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

3.10
zone 0
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently

[IEV 426-03-03, modified]

NOTE The MODU code definition is “Zone 0: in which an explosive gas/air mixture is continuously present or present for long periods.”

3.11
zone 1
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally

[IEV 426-03-04, modified]

NOTE The MODU code definition is “Zone 1: in which an explosive gas/air mixture is likely to occur in normal operation.”

3.12
zone 2
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only

[IEV 426-03-05, modified]

NOTE 1 In this definition, the word "persist" means the total time for which the flammable atmosphere will exist. This will normally comprise the total of the duration of the release, plus the time taken for the flammable atmosphere to disperse after the release has stopped.

NOTE 2 Indications of the frequency of the occurrence and duration may be taken from codes relating to specific industries or applications.

NOTE 3 The MODU code definition is “Zone 2: in which an explosive gas/air mixture is not likely to occur, or in which such a mixture, if it does occur, will only exist for a short time.”

3.13
source of release
point or location from which a flammable gas, vapour, or liquid may be released into the atmosphere in such a way that an explosive gas atmosphere could be formed

[IEV 426-03-06, modified]

3.14
grades of release
there are three basic grades of release, as listed below in order of decreasing frequency and likelihood of the explosive gas atmosphere being present:

a) continuous grade;

b) primary grade;

c) secondary grade.

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

3.15
continuous grade of release
release which is continuous or is expected to occur frequently or for long periods

3.16
primary grade of release
release which can be expected to occur periodically or occasionally during normal operation

3.17
secondary grade of release
release which is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods

3.18
release rate
quantity of flammable gas or vapour emitted per unit time from the source of release

3.19
normal operation
situation when the equipment is operating within its design parameters

NOTE 1 Minor releases of flammable material may be part of normal operation. For example, releases from seals which rely on wetting by the fluid which is being pumped are considered to be minor releases.

NOTE 2 Failures (such as the breakdown of pump seals, flange gaskets or spillages caused by accidents) which involve urgent repair or shutdown are not considered to be part of normal operation nor are they considered to be catastrophic.

NOTE 3 Normal operation includes start-up and shutdown conditions.

3.20
air lock
compartment connecting two different environments, usually at different pressures, that enables personnel to transfer from one environment to the other

3.21
ventilation
movement of air and its replacement with fresh air due to the effects of wind, temperature gradients, or artificial means (for example, fans or extractors)

3.22
explosive limits

NOTE The terms "explosive limit" and "flammable limit" are equivalent. IEC 60079-20 and IEC 61779-1 use the term "flammable limit" whilst all the other standards use the more widely accepted term "explosive limit".

3.23
lower explosive limit
concentration of flammable gas or vapour in air, below which the gas atmosphere is not explosive

[IEV 426-02-09, modified]

3.24
upper explosive limit
concentration of flammable gas or vapour in air, above which the gas atmosphere is not explosive

[IEV 426-02-10, modified]

3.25
relative density of a gas or a vapour
density of a gas or a vapour relative to the density of air at the same pressure and at the same temperature (air is equal to 1,0)

3.26
flammable material (flammable substance)
material which is flammable of itself, or is capable of producing a flammable gas, vapour or mist

3.27
flammable liquid
liquid capable of producing a flammable vapour under any foreseeable operating conditions

3.28
flammable gas or vapour
gas or vapour which, when mixed with air in certain proportions, will form an explosive gas atmosphere

3.29
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

[IEV 426-02-14]

3.30
boiling point
temperature of a liquid boiling at an ambient pressure of 101,3 kPa (1 013 mbar)

NOTE The initial boiling point that should be used for liquid mixtures is to indicate the lowest value of the boiling point for the range of liquids present, as determined in a standard laboratory distillation without fractionation.

3.31
vapour pressure
pressure exerted when a solid or liquid is in equilibrium with its own vapour. It is a function of the substance and of the temperature

3.32
ignition temperature
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

[IEV 426-02-01, modified]

NOTE IEC 60079-4 and IEC 60079-4A standardize a method for the determination of this temperature.

3.33
extent of zone
distance in any direction from the source of release to the point where the gas/air mixture has been diluted by air to a value below the lower explosive limit

3.34
exposed conductive part
conductive part which can readily be touched and which may become alive under fault conditions.

NOTE Typical exposed conductive parts are walls of enclosures, operating handles, etc.

3.35
extraneous conductive part
conductive part not forming a part of the electrical installation and liable to propagate a potential, including earth potential

3.36
inspection
action comprising careful scrutiny of an item carried out either without dismantling, or with the addition of partial dismantling as required, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of an item

3.37
gas-tight door
solid, close fitting door designed to resist the passage of gas under normal atmospheric conditions

3.38
maintenance
combination of any actions carried out to retain an item in or restore it to, conditions in which it is able to meet the requirements of the relevant specification and perform its required functions

3.39
natural ventilation
movement of air and its replacement with fresh air due to the effects of wind and/or temperature gradients

3.40
opening
any aperture, door, window or non-gas-tight fixed panel

3.41
purging
passing of sufficient volume of protective gas through a pressurized room or enclosure and its ducts before the application of voltage to the apparatus to reduce any explosive gas atmosphere to a concentration well below the lower explosive limit

3.42
room or building
enclosure (or enclosures) provided with doors, cable ducts, conduits, etc. containing electrical apparatus and of sufficient size to permit the entry of a person who may be expected to work or remain inside the enclosure for a prolonged period

3.43
semi-enclosed
semi-enclosed locations are locations where natural conditions of ventilation are notably different from those on open decks due to the presence of structures such as roofs, windbreaks and bulkheads and which are so arranged that the dispersion of gas may not occur

3.44
sheltered or obstructed open area
area within or adjoining an open area, which may include a partially open building or structure, where owing to obstruction natural ventilation may be less than in a true open area, and this may enlarge the extent of the hazard zone

3.45
valve regulated cell
a secondary cell which is closed under normal conditions but has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive addition to the electrolyte

4 Area classification

4.1 General

All mobile and fixed offshore units shall be assessed with regard to any potential explosive gas atmosphere in accordance with the provisions set out below. The results shall be documented in area classification drawings to allow the proper selection of all electrical components to be installed.

The general principles for area classification are given in IEC 60079-10. This standard gives an interpretation of the principles when used for area classification of mobile and fixed offshore units.

Area classification shall be carried out at an early stage of planning, before any construction work starts and confirmed before start-up of the installation. Reviews should be carried out during the life of the installation.

The area classification should be carried out by those who have knowledge of the properties of flammable materials, the process and the equipment, in consultation with, as appropriate, safety, electrical, mechanical and other engineering personnel.

NOTE 1 Analysis and classification of the environment where explosive gas may occur should be carried out in accordance with the IMO MODU code for the Construction and Equipment of Mobile Offshore Drilling Units (for mobile drilling units) or, IEC 60079-10 (for fixed offshore units).

NOTE 2 Further guidance for area classification given in any National Codes of Practice or similar publications may be adopted, provided they reduce the level of safety below that specified by the IMO MODU code or IEC 60079-10.

NOTE 3 For documentation of requirements for area classification, see 10.1.

NOTE 4 Examples of source of release are given in Annex A.

NOTE 5 A schematic approach to the classification of hazardous areas is given in Annex B.

NOTE 6 Examples of data sheets for use during area classification study are given in Annex C.

4.2 Safety principles

Installations in which flammable materials are handled or stored should be designed, operated and maintained so that any releases of flammable material, and consequently the extent of hazardous areas, are kept to a minimum, whether in normal operation or otherwise, with regard to frequency, duration and quantity.

It is important to examine those parts of process equipment and systems from which release of flammable material may arise and to consider modifying the design to minimize the likelihood and frequency of such releases and the quantity and rate of release of material.

These fundamental considerations should be examined at an early stage of the design development of any process plant and should also receive prime attention in carrying out the area classification study.

In the case of maintenance activities other than those of normal operation, the extent of the zone may be affected but it is expected that this would be dealt with by a permit-to-work system.

In a situation in which there may be an explosive gas atmosphere, the following steps should be taken

a) eliminate the likelihood of an explosive gas atmosphere occurring around the source of ignition, or

b) eliminate the source of ignition.

Where this is not possible, protective measures, process equipment, systems and procedures should be selected and prepared so that the likelihood of the coincidence of a) and b) is so small as to be acceptable. Such measures may be used singly, if they are recognized as being highly reliable, or in combination to achieve an equivalent level of safety.

4.3 Sources of release

The basic elements for establishing the hazardous zone types are the identification of the source of release and the determination of the grade of release.

Since an explosive gas atmosphere can exist only if a flammable gas or vapour is present with air, it is necessary to decide if any of these flammable materials can exist in the area concerned. Generally speaking, such gases and vapours (and flammable liquids and solids which may give rise to them) are contained within process equipment which may or may not be totally enclosed. It is necessary to identify where a flammable atmosphere can exist inside a process plant, or where a release of flammable materials can create a flammable atmosphere outside a process plant.

If it is established that the item may release flammable material into the atmosphere, it is necessary, first of all, to determine the grade of release in accordance with the definitions, by establishing the likely frequency and duration of the release. It should be recognized that the opening-up of parts of enclosed process systems (for example, during filter changing or batch filling) should also be considered as sources of release when developing the area classification. By means of this procedure, each release will be graded either "continuous", "primary" or "secondary".

Having established the grade of the release, it is necessary to determine the release rate and other factors which may influence the type and extent of the zone.

If the total quantity of flammable material available for release is "small", for example, laboratory use, whilst a potential hazard may exist, it may not be appropriate to use this area classification procedure. In such cases, account shall be taken of the particular risks involved.

The area classification of process equipment in which flammable material is burned, for example, fired heaters, furnaces, boilers, gas turbines etc., should take into account purge cycle, start-up and shut-down conditions.

4.4 Type of zone

The likelihood of the presence of an explosive gas atmosphere and hence the type of zone depends mainly on the grade of release and the ventilation.

NOTE 1 A continuous grade of release normally leads to a zone 0, a primary grade to zone 1 and a secondary grade to zone 2 (see annex A).

NOTE 2 Where zones created by adjacent sources of release overlap and are of different zonal classification, the higher risk classification will apply in the area of overlap. Where overlapping zones are of the same classification, this common classification will normally apply.

However, care needs to be taken where the overlapping zones relate to flammable materials which have different apparatus groups and/or temperature class. So, for example, if a zone 1 IIA T3 area overlapped a zone 2 IIC T1 area, then classifying the overlap as zone 1 IIC T3 may be over-restrictive, but classifying it as zone 1 IIA T3 or zone 1 IIC T1 would not be acceptable. In this situation, the area classification should be recorded as zone 1 IIA T3 and zone 2 IIC T1.

NOTE 3 Hazardous areas can be limited in extent by construction measures, for example by walls or dams. Ventilation or application of protective gas can reduce the probability of the presence of an explosive gas atmosphere so that areas of greater hazard can be transformed to areas of lesser hazard or to non-hazardous areas.

4.5 Relative density of the gas or vapour when it is released

If the gas or vapour is significantly lighter than air, it will tend to move upwards. If significantly heavier, it will tend to accumulate at ground level. The horizontal extent of the zone at ground level will increase with increasing relative density and the vertical extent above the source will increase with decreasing relative density.

NOTE 1 For practical applications, a gas or vapour which has a relative density below 0,8 is regarded as being lighter than air. If the relative density is above 1,2, it is regarded as being heavier than air. Between these values, both of these possibilities should be considered.

NOTE 2 With gases or vapours lighter than air, an escape at low velocity will disperse fairly rapidly upwards; the presence of a roof will, however, inevitably increase the area of spread under it. If the escape is at high velocity in a free jet the action of the jet, although entraining air which dilutes the gas or vapour, may increase the distance over which the gas/air mixture remains above its lower flammable limit.

NOTE 3 With gases or vapours heavier than air, an escape at low velocity will tend to flow downward and may travel long distances over the ground before it is safely dispersed by atmospheric diffusion. Special regard therefore needs to be paid to the layout of any installation under consideration. If the escape is at high velocity in a free jet the jet-mixing action by entraining air may well reduce the gas/air mixture to below its lower flammable limit in a much shorter distance than in the case of a low-velocity escape.

NOTE 4 Care needs to be taken when classifying areas containing cryogenic flammable gases such as liquefied natural gas. Vapours emitted can be heavier than air at low temperatures and become lighter than air on approaching ambient temperature.

4.6 Mobile drilling units

Area classification of mobile drilling units shall be in accordance with the IMO MODU code.

Hazardous areas which normally apply on drilling units include the following.

4.6.1 Zone 0

Zone 0 normally includes:

the internal spaces of closed tanks and pipes for active drilling mud, as well as oil and gas products, for example escape gas outlet pipes, or spaces in which an oil/gas/air mixture is continuously present or present for long periods.

NOTE Active drilling mud is considered as being mud in the system which is between the well and the final degassing discharge.

4.6.2 Zone 1

Zone 1 normally includes:

a) enclosed spaces containing any part of the mud circulating system that has an opening into the spaces and is between the well and the final degassing discharge;

b) enclosed spaces or semi-enclosed locations that are below the drill floor and contain a possible source of release such as the top of a drilling nipple;

c) enclosed spaces that are on the drill floor which are not separated by a solid floor from the spaces in item b) above;

d) in outdoor or semi-enclosed locations, except as provided for in item b) above, the area within 1,5 m from the boundaries of any opening to apparatus which is a part of the mud system as specified in item a) above, any ventilation outlets of zone 1 spaces or any access to a zone 1 space;

e) pits, ducts or similar structures in locations which would otherwise be zone 2 but which are arranged so that dispersion of gas may not occur.

4.6.3 Zone 2

Zone 2 normally includes:

a) enclosed spaces which contain open sections of the mud circulating system from the final degassing discharge to the mud pump suction connection at the mud pit;

b) outdoor locations within the boundaries of the drilling derrick up to a height of 3 m above the drill floor;

c) semi-enclosed locations below and contiguous to the drill floor and up to the boundaries of the derrick or to the extent of any enclosure which is liable to trap gases;

d) outdoor locations below the drillfloor and within a radius of 3 m from a possible source of release such as the top of a drilling nipple;

e) the areas 1,5 m beyond the zone 1 areas specified in 4.6.2 d) above and beyond the semi-enclosed locations specified in 4.6.2 b);

f) outdoor areas within 1,5 m of the boundaries of any ventilation outlet from or access to a zone 2 space;

g) semi-enclosed derricks to the extent of their enclosure above the drill floor or to a height of 3 m above the drill floor, whichever is the greater;

h) air locks between a zone 1 and a non-hazardous area.

4.6.4 Well test facilities

Area classification relevant to well test facilities shall be carried out in accordance with the requirements of 4.7 and 4.8.

4.7 Fixed production units

Analysis and classification of the environment where explosive gas may occur should be carried out in accordance with IEC 60079-10. Further guidance for area classification given in national recommendations may be adopted in accordance with 4.1.

NOTE Unless national requirements apply, recommendations of the IMO MODU code should be applied.

Hazardous areas which normally apply on fixed offshore units include the following.

4.7.1 Zone 0

Zone 0 include, for example:

a) areas within process apparatus developing flammable gas or vapours;
b) areas within enclosed pressure vessels or storage tanks;
c) areas around vent pipes which discharges continually or for long periods;
d) areas over/near surface of flammable liquids in general.

4.7.2 Zone 1

Zone 1 include, for example:

a) areas above roofs and outside sides of storage tanks;
b) areas with a certain radius around the outlet of vent pipes, pipelines and safety valves;
c) rooms without ventilation, with direct access from a zone 2 area;
d) rooms or parts of rooms containing secondary sources of release, where internal outlets indicate zone 2, but where efficient dilution of an explosive atmosphere cannot be expected because of lack of ventilation;
e) areas around ventilation openings from a zone 1 area;
f) area around flexible pipelines and hoses;
g) area around sample taking points (valves, etc.);
h) areas around seals of pumps, compressors, and similar apparatus, if primary source of release.

4.7.3 Zone 2

Zone 2 include, for example:

a) area around flanges, connections, valves, etc.;
b) areas outside of zone 1, around the outlet of vent pipes, pipelines and safety valves;
c) areas around vent openings from the zone 2 area.

4.7.4 Drilling facilities

For drilling facilities, see 4.6.

4.8 Mobile production units

Analysis and classification of the environment where explosive gas may occur should be carried out in accordance with IEC 60079-10. Further guidance for area classification given in national recommendations may be adopted in accordance with 4.1.

NOTE 1 Unless national requirements apply, reference should be made to IEC 60092-502 Tankers, for the tanker part of the vessel. For the process unit the requirements of 4.7 apply.

The area between the main deck and the production/facilities deck need to be specially considered. This shall at least be classified as zone 2, unless installations on the deck result in a zone 1 area classification.

NOTE 2 Ventilation in this area may be limited due to stiffeners, pipes and other objects installed in the area.

4.9 Provisions regarding mobile and fixed offshore units

The following provisions are to be taken into account.

a) Pipelines without flanges, connections, valves or other similar fittings shall not be regarded as a source of release.

b) Certain areas and rooms shall, if so indicated by the circumstances, be classified as a more hazardous zone than set out in these examples.

c) Certain areas and rooms may under certain circumstances and/or when special precautions are taken, be classified as a less hazardous zone than indicated by these examples. Such special circumstances may be, for example, shielding or reinforced ventilation arrangements.

d) Enclosed rooms, without ventilation, with openings to an area with explosion risks, shall be designated as the same, or as a more hazardous zone than such an area.

4.10 Openings, access and ventilation conditions affecting the extent of hazardous areas

4.10.1 General

Except for operational reasons, access doors or other openings shall not be provided between a non-hazardous space and a hazardous area or between a zone 2 space and a zone 1 space. Where such access doors or other openings are provided, any enclosed space not referred to under 4.6.2, 4.6.3, 4.7.2 or 4.7.3 and having a direct access to any zone 1 or zone 2 location becomes the same zone as that location with the exceptions which follow.

4.10.2 Enclosed space with direct access to any zone 1 location

An enclosed space with a direct access to any zone 1 location can be considered as zone 2 if:

a) the access is fitted with a self-closing gas-tight door opening into the zone 2 space;

b) ventilation is such that the air flow with the door open is from the zone 2 space into the zone 1 location;

c) loss of ventilation sets off an alarm at a manned station.

4.10.3 Enclosed space with direct access to any zone 2 location

An enclosed space with direct access to any zone 2 location is not considered hazardous if:

a) the access is fitted with a self-closing gas-tight door that opens into the non-hazardous space, and

b) ventilation is such that the air flow with the door open is from the non-hazardous space into the zone 2 location, and

c) loss of ventilation sets off an alarm at a manned station.

4.10.4 An enclosed space with direct access to any zone 1 location

An enclosed space with direct access to any zone 1 location is not considered hazardous if:

a) the access is fitted with two self-closing gas-tight doors forming an air lock;

b) the space has ventilation overpressure in relation to the hazardous space;

c) loss of ventilation overpressure sets off an alarm at a manned station.

Where ventilation arrangements of the intended non-hazardous space are considered sufficient by the appropriate authority to prevent any ingress of gas from the zone 1 location, the two self-closing doors forming an air lock may be replaced by a single self-closing gastight door which opens into the non-hazardous location and has no hold-back device.

4.10.5 Notices

Notices warning that the doors are to be kept closed shall be fitted whenever any of the above arrangements are adopted.

5 Electrical systems

5.1 Sources of electrical power

Sources of electrical power and their section boards and distribution boards, etc., shall normally not be located in hazardous areas.

The generating plant, switchboards and batteries shall be separated from any zone 0 by cofferdams or equivalent spaces and from other hazardous areas by gas-tight steel divisions. Access between such spaces shall comply with 4.10.

5.2 Distribution systems

5.2.1 General

Distribution systems for electrical installations in offshore units shall comply with provisions stated in IEC 61892-2. Additional provisions for distribution systems in hazardous areas are given below.

5.2.2 Earth fault detection

A device, or devices, shall be installed to monitor continuously the insulation resistance to earth of every insulated primary and secondary distribution systems and to give audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance.

Systems fed by single transformers supplying one consumer or a control circuit do not require an earth fault detection.

For impedance earthed systems, earth leakage monitoring and an alarm or automatic disconnection via earth leakage protection devices shall be provided.

5.3 Electrical protection

Electrical circuits and apparatus in hazardous areas, except intrinsically safe circuits and apparatus, shall be provided with means to ensure disconnection in the shortest practical time in the event of overload or short circuit.

The system shall further be protected against earth fault as follows:

– IT system without neutral: Alarm or automatic disconnection;

– IT system with impedance earthed neutral: Automatic disconnection in the shortest practical time;

– TN system: Automatic disconnection in the shortest practical time.

The protective systems shall be arranged so that automatic reconnection under fault conditions is prevented (for example manual reset). In zone 2 the overload protective devices may have an automatic reset. Suitable protection shall be fitted where danger could result from the possibility that three-phase electrical apparatus may be subject to excess current during single-phase operation.

In circumstances where automatic disconnection of the electrical apparatus may introduce a safety risk which is more dangerous than that arising from the risk of ignition alone, a warning device (or devices) may be used as an alternative to automatic disconnection, provided that

operation of the warning device (or devices) is immediately apparent so that prompt remedial action will be taken.

5.4 Emergency conditions due to drilling operations – Mobile drilling units

5.4.1 In view of exceptional conditions in which the explosion hazard may extend outside the zones specified in 4.6, special arrangements shall be provided to facilitate the selective disconnection or shutdown of

a) ventilation systems, except fans necessary for supplying combustion air to prime movers for the production of electrical power;

b) main generator prime movers, including the ventilation systems for these;

c) emergency generator prime movers.

5.4.2 Disconnection or shut-down shall be possible from at least two strategic locations, one of which shall be outside hazardous areas.

5.4.3 Shutdown systems that are provided to comply with 5.4.1 shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and the risk of inadvertent operation of a shutdown are minimized.

5.4.4 Apparatus which are located in spaces other than enclosed spaces and which is capable of operation after shut-down shall be suitable for installation in zone 2 locations. Such apparatus which is located in enclosed spaces shall be suitable for its intended application to the satisfaction of the relevant authority.

At least the following facilities shall be operable after an emergency shut-down:

– emergency lighting as required by IMO MODU code for half an hour;

– blow-out preventer control system;

– general alarm system;

– public address system;

– battery supplied radio communication installations;

– fire and gas detection systems and their alarm systems.

5.5 Emergency switch-off – Ignition source control – Fixed production units

5.5.1 In the event of an emergency situation such as a gas leakage, the hazardous areas can under certain conditions extend beyond those described in 4.6 and in 4.7 and any apparatus which needs to be operated during such conditions shall be explosion protected in accordance with national recommendations.

Arrangements are to be provided to ensure the selective disconnection of:

a) ventilation systems;

b) non-essential electrical apparatus;

c) essential electrical apparatus;

d) main generator prime movers;

e) emergency apparatus including the emergency generator, except that mentioned in 5.4.4.

An automatic emergency switch-off is to be initiated when gas has been detected in non-hazardous area or in ventilation intakes to HVAC systems. Any equipment which is live after such switch-off is to be certified for installation in zone 1. Emergency equipment in LQ and other areas may be left live subject to special considerations.

Examples of equipment that can be accepted without certification for zone 1 areas are the following equipment located inside or in the vicinity of the living quarter:

- emergency generator;
- emergency switchgear;
- equipment in central control room required for control of the situation;
- equipment necessary during such emergency situations for internal/external communication;
- equipment in the living quarter connected to the main power system.

A “low gas alarm” detection anywhere on the installation shall isolate all high-risk ignition sources located in naturally ventilated areas. This includes temporary equipment e.g. combustion engines and electrical sockets including welding sockets, and non-Ex equipment operated under hot work permit.

NOTE 1 “Low gas alarm” means detection on one detector only.

Confirmed gas detection at HVAC air intake to local electrical/instrument rooms or emergency generator room shall close inlet dampers, shut down fan(s), shut down heater(s) and isolate all non-Ex equipment inside the respective room. For above mentioned circuits, no hot conductors shall be found outside their feeding switchboards when isolated.

NOTE 2 The meaning of ”confirmed gas detection” may vary. However, in this context it means that either a high alarm is indicated on one detector or low alarm is indicated on two or more detectors in one area (voting system).

5.5.2 In addition to the requirements of 5.5.1, it shall be possible to de-energize electrical apparatus from an appropriate location, e.g. the units central control room, if its continued energization would lead to hazards (e.g. spreading of fire). Electrical apparatus which shall continue to operate to prevent additional danger shall not be included in the emergency switch-off circuit.

5.6 Protection from dangerous sparking

5.6.1 Dangers from live parts

In order to avoid the formation of sparks liable to ignite the explosive gas atmosphere, any contact with bare live parts other than intrinsically safe parts shall be prevented.

Where this requirement is not met by construction, other precautions shall be taken. In certain cases a warning label may be sufficient.

5.6.2 Dangers from exposed and extraneous conductive parts

It is impracticable to cover all possible systems in this standard, but the basic principles on which safety depends are the limitation of earth fault currents (magnitude and/or duration) in frameworks or enclosures and the prevention of elevated potentials on equipotential bonding conductors.

NOTE Guidance on permissible power systems is given in IEC 61892-2.

5.6.2.1 If a power system with an earthed neutral is used, the type TN-S system, with separate neutral (N) and protective conductor (PE) throughout the system shall be used.

The neutral and the protective conductor shall not be connected together, or combined in a single conductor, in a hazardous area.

A power system of type TN-C, having combined neutral and protective functions in a single conductor throughout the system, is not allowed in hazardous areas.

5.6.2.2 For an IT power system (neutral isolated from earth or earthed through impedance), an insulation monitoring device shall be used to indicate the first earth fault. An installation in zone 0 shall be disconnected instantaneously in case of the first earth fault, either by the insulation monitoring device or by a residual current device.

5.6.2.3 For power systems at all voltage levels installed in zone 0, attention shall be paid to the limitation of earth fault currents in magnitude and duration. Instantaneous earth fault protection shall be installed.

NOTE It may also be necessary to provide instantaneous earth fault protection for applications in zone 1.

5.6.3 Potential equalization

To avoid dangerous sparking between metallic parts of structures, potential equalization is always required for installations in zone 1 and may be necessary for installations in zone 2. Therefore, all exposed and extraneous conductive parts shall be connected to the equipotential bonding system. The bonding system may include protective conductors, conduits, metal cable sheaths, steel wire armouring and metallic parts of structures, but shall not include neutral conductors. Connections shall be secure against self-loosening.

Exposed conductive parts need not be separately connected to the equipotential bonding system if they are firmly secured to and are in metallic contact with structural parts or piping which are connected to the equipotential bonding system. Extraneous conductive parts which are not part of the structure or of the electrical installation need not be connected to the equipotential bonding system, if there is no danger of voltage displacement, for example frames of doors or windows.

Metallic enclosures of intrinsically safe apparatus need not be connected to the equipotential bonding system, unless required by the apparatus documentation or to prevent accumulation of static charge.

Installations with cathodic protection shall not be connected to the equipotential bonding system unless the system is specifically designed for this purpose.

Potential equalisation shall be arranged where insulated flanges are used to connect piping.

Enclosures need not be separately connected to the equipotential bonding system if they are firmly secured to and are in metallic contact with structural parts or piping which are connected to the equipotential bonding system.

NOTE 1 For additional information see 411.3 of IEC 60364-4-41. However, there are certain parts of electrical installations, for example some intrinsically safe electrical apparatus, which are not intended to be connected to the equipotential bonding system.

NOTE 2 Special consideration should be given to potential equalization between electrically separate structures, for example between a fixed unit and a vessel, or where insulated flanges are used to connect pipelines.

5.6.4 Static electricity

In the design of electrical installations, account shall be taken of effects due to static electricity.

NOTE 1 In the absence of international codes on protection against static electricity, national or other standards should be followed. IEC 60079-1 gives a guideline for maximum impedance.

NOTE 2 CENELEC CLC/TR 50404 gives guidelines for static electricity.

5.6.5 Lightning protection

In the design of electrical installations, account shall be taken of the effects due to lightning activity. Requirement to lightning protection is given in IEC 61892-6 of this publication.

NOTE Further information can be found in IEC 62305.

5.6.6 Cathodically protected metallic parts

Cathodically protected metallic parts located in hazardous areas are live extraneous conductive parts, which shall be considered potentially dangerous (especially if equipped with the impressed current method) despite their low negative potential. No cathodic protection shall be provided for metallic parts in zone 0 unless it is specially designed for this application.

The insulating elements required for the cathodic protection, for example insulating elements in pipes and tracks, should, if possible, be located outside the hazardous area. If this is not possible, national requirements should be followed.

NOTE In the absence of IEC standards on cathodic protection, national or other standards should be followed.

5.6.7 Electromagnetic radiation

Account shall be taken of the effects due to strong electromagnetic radiation. Care must be taken to prevent electromagnetic waves radio-frequency transmitters (e.g. radio, television and radar to induce electric currents and voltages in any conducting structure.

NOTE Guidance can be obtained in IEC 60533.

5.7 Danger from rotating parts

Consideration shall be given to the possibility of sparking between rotating parts of electrical fans and their enclosures.

6 Electrical equipment

6.1 General

General requirements for equipment are stated in IEC 61892-3 and provisions set out below are additional requirements for apparatus in hazardous areas.

6.2 Selection of electrical apparatus

In order to select the appropriate electrical apparatus for hazardous areas the following information is required:

a) classification of the hazardous area, see clause 4;

b) the ignition temperature of the gas or vapour involved, see 6.2.2;

c) where applicable, the gas or vapour classification in relation to the group of the electrical apparatus according to 6.2.3;

NOTE For some types of protection, for example pressurization, oil-immersion, sand-filling and increased safety, only the area classification and ignition temperature are required.

d) external influences and ambient temperature, see 6.2.4 and 6.2.5.

6.2.1 Selection with respect to area classification

Electrical apparatus shall be selected according to the hazardous zones in which it is to operate. Clause 4 provides guidance for the area classification.

6.2.2 Selection with respect to ignition temperature of the gas or vapour

The electrical apparatus shall be so selected that its maximum surface temperature will not reach the ignition temperature of any gas or vapour which may be present.

Symbols for the temperature classes which may be marked on the electrical apparatus have the meaning indicated in table 1 hereafter.

Table 1 – Relationship between the temperature classes, surface temperatures and ignition temperatures

Temperature class of electrical apparatus	Maximum surface temperature of electrical apparatus	Ignition temperature of gas or vapour
T1	450 °C	>450 °C
T2	300 °C	>300°C
T3	200 °C	>200 °C
T4	135 °C	>135 °C
T5	100 °C	>100 °C
T6	85 °C	>85 °C

6.2.3 Selection according to apparatus grouping

Selection according to apparatus grouping shall be according to IEC 60079-14.

6.2.4 External influences

Electrical apparatus shall be protected against the external influences (e.g. chemical, mechanical and thermal stresses) to which it may be subjected. This protection shall be such that the type of protection is maintained when the electrical apparatus is used under the specified external influences.

Electrical apparatus shall be selected and installed so that it is protected against external influences (e.g. chemical, mechanical, vibrational, thermal, electrical and humidity) which could adversely affect the explosion protection.

Precautions shall be taken to prevent foreign bodies falling vertically into the ventilation openings of vertical rotating electrical machines.

The integrity of electrical apparatus may be affected if it is operated under temperature or pressure conditions outside those for which the apparatus has been constructed. In these circumstances, further advice should be sought.

NOTE Attention is drawn to the risks that can arise when process fluids become introduced into apparatus, e.g. pressure switches or canned electric motor pumps. Under fault conditions, e.g. a diaphragm or can failure, the fluid may be released inside the apparatus under considerable pressure which may cause any or all of the following to occur:

a) rupture of the apparatus enclosure;

b) risk of immediate ignition;

c) transmission of the fluid along the inside of the cable into a non-hazardous area.

Preferably such apparatus should be designed so that process fluid containment is in a separate enclosure from the electrical apparatus. Where this is not possible, apparatus designed to be vented is acceptable. Failing this, a special sealing joint should be introduced into the cable run or an ‘epoxy’ joint should be inserted.

Particular consideration shall be given to the location of apparatus that incorporate light metals in their external construction as it has been well established that such materials give rise to sparking that is incentive under conditions of frictional contact.

6.2.5 Ambient temperature

The electrical apparatus shall be used within the limits of ambient temperature for which it is designed.

If the marking or the instruction manual for the electrical apparatus does not include an ambient temperature range the apparatus shall be used only within the ambient temperature range from –20 °C to +40 °C.

If the marking of the electrical apparatus includes an ambient temperature range, this apparatus shall be used only within this range.

6.3 Electrical apparatus in hazardous areas

Electrical apparatus shall, as far as possible, be located in non-hazardous areas. Where it is not possible to do this it shall be located in the least hazardous area.

Electrical installations in hazardous areas shall also comply with applicable requirements for installations in non-hazardous areas.

6.3.1 Equipment for zone 0

Only the following equipment may be considered for zone 0:

a) intrinsically-safe equipment of category “ia” according to IEC 60079-11;

b) equipment specially certified for zone 0 according to IEC 60079-26.

6.3.2 Equipment for zone 1

Only the following equipment may be considered for zone 1:

a) any type that may be considered for zone 0;

b) flameproof enclosures "d" according to IEC 60079-1;

c) pressurized enclosures "p" according to IEC 60079-2;

d) powder filling "q" according to IEC 60079-5;

e) oil immersion "o" according to IEC 60079-6;

f) increased safety "e" according to IEC 60079-7;

g) intrinsic safety "i" according to IEC 60079-11;

h) encapsulation "m" according to IEC 60079-18.

NOTE 1 The use of Ex o should be limited. Other types of protection should be used to the extent possible.

NOTE 2 Regarding use of Ex e motors in Zone 1, reference is made to IEC 60079-7:2006, 5.2 and Annex G."

6.3.3 Equipment for zone 2

The following equipment may be considered for zone 2:

a) any type that may be considered for zone 1; or

b) electrical apparatus designed specially for zone 2 (for example, type of protection “n” according to IEC 60079-15), or

c) electrical apparatus complying with the requirements of a recognized standard for industrial electrical apparatus which does not, in normal operation, have ignition-capable hot surfaces; and

   1) does not, in normal operation, produce arcs or sparks, or

   2) in normal operation produces arcs or sparks but the values, of the electrical parameters (*U*, *I*, *L* and *C*) in the circuit (including the cables) do not exceed the values specified in IEC 60079-11 with a safety factor of unity. The assessment shall be in accordance with the specification for energy limited apparatus and circuits given in IEC 60079-15.

   Unless safety is demonstrated by test, a surface is presumed to be ignition-capable if its temperature exceeds the ignition temperature of the explosive gas atmosphere concerned.

   This electrical apparatus shall be in an enclosure with a degree of protection and mechanical strength at least suitable for non-hazardous areas with a similar environment. It requires no special marking, but it shall be clearly identified, either on the apparatus or in the documentation, that it has been assessed by a person who shall

   – be familiar with the requirements of any relevant standards and codes of practice and their current interpretations,

   – have access to all information necessary to carry out the assessment,

   – where necessary, utilize similar test apparatus and test procedures to those used by national authorities;

d) apparatus in accordance with 6.4.

In the case of rotating electrical machines in accordance with items b), c) or d) above, incentive sparking shall not occur during start-up unless precautions are taken to ensure that an explosive gas atmosphere is not present. Further requirements to rotating machines for installation in zone 2 is given in IEC 60079-15

6.3.4 Apparatus with multiple types of protection

Where apparatus incorporates a number of types of protection, it is to be ensured that all are suitable for use in the zone in which the apparatus is located.

6.4 Selection of apparatus not available in accordance with IEC standards

In order to ensure the correct selection and installation of such apparatus (for example equipment marked “s” and identified with the zone of use in accordance with IEC 60079-0), reference should be made to the relevant national standard or code of practice that deals with these aspects.

6.5 Portable apparatus

6.5.1 For portable and transportable apparatus type of protection Ex o ‘oil immersion’ shall not be used.

6.5.2 All hand-held apparatus shall be equipped with a built-in switch. However, switch is not required for intrinsically safe apparatus.

NOTE Because of the likelihood of damage which may destroy its safety features, portable or transportable electrical apparatus should be subject to frequent inspections. Guidance regarding inspection can be found in IEC 60079-14.

6.5.3 Portable apparatus used in hazardous areas shall comply with the requirement for installation in zone 1.

NOTE 1 Portable apparatus should be used in hazardous areas only when its use cannot reasonably be avoided.

Ordinary industrial portable apparatus should not be used in a hazardous area unless the specific location has been assessed to ensure that potentially flammable gas or vapour is absent during the period of use ("gas-free" situation). If plugs and sockets are present in a hazardous area, they should be suitable for use in the particular zone and have mechanical and/or electrical inter-locking to prevent an ignition source occurring during insertion or removal of the plug. Alternately, they should only be energized in a "gas-free" situation.

NOTE 2 Whenever portable electrical apparatus is used in a hazardous area, extreme care should be taken to avoid unnecessary risks. Unless specifically permitted by the certification documents for portable electrical apparatus or unless other suitable precautions are taken, spare batteries should not be taken into the hazardous area.

If electrical testing, for example continuity testing, is necessary to facilitate the installation of hazardous area electrical apparatus, care shall be taken to ensure that the testing operation is safe for the hazardous area. This may be achieved in various ways including the appropriate use of test equipment which is certified for hazardous area use. Alternatively, testing shall be carried out in a "gas-free" situation.

7 Installation

7.1 General

The requirements in this clause are additional to the general requirements of IEC 60079-14.

Electrical apparatus shall, as far as possible, be located in non-hazardous areas. Where it is not possible to do this it shall be located in the least hazardous area.

Electrical installations in hazardous areas shall comply with applicable requirements for installations in non-hazardous areas.

NOTE 1 For documentation requirements, see 10.4 and 10.5.

7.2 Selection of apparatus

Selection of electrical apparatus with respect to

– classification of the hazardous area,
– the ignition temperature of the gas or vapour involved,
– where applicable, the gas or vapour classification in relation to the electrical apparatus,
– external influences and ambient temperature,

shall be in accordance with 6.2.

7.3 Wiring system – General

7.3.1 When the design of a wiring system and its components are being considered, due account shall be taken of the hazardous area environment, including mechanical, chemical and thermal factors.

Cables and wiring systems shall comply with the general requirements given in IEC 61892-4, and with the special requirements given in 7.10.

NOTE Typical circuits for which fire resistant cables may be required include

– fire and gas detection systems,
– fixed fire fighting systems,
– general alarms and public address systems,
– emergency shut down systems,
– emergency switch-off systems,
– emergency lighting,

– installation status indicators.

The use of fire resistant cables may be waived subject to the approval of the appropriate authority.

7.3.2 Cable systems and accessories should be installed, so far as is practicable, in positions that will prevent them being exposed to mechanical abuse damage and to corrosion or chemical influences (for example solvents), and to the effects of heat. Where exposure of this nature is unavoidable, protective measures, such as installation in conduit, shall be taken or appropriate cables selected.

In situations where there is an exceptional risk of mechanical damage, for example in storage, cargo landing area etc., cables shall be protected by steel casing, trunking or conduits, even when armoured, if the unit's structure or attached parts do not afford sufficient protection for the cables.

Where cable or conduit systems are subject to vibration, they shall be designed to withstand that vibration without damage.

7.4 Connections

The connection of cables and conduits to the electrical apparatus shall be made in accordance with the requirements of the relevant type of protection.

7.5 Unused openings

Unused openings for cable or conduit entries in electrical apparatus shall be closed with blanking elements suitable for the relevant type of protection. With the exception of intrinsically safe apparatus, the means provided for this shall be such that the blanking element can be removed only with the aid of tools.

7.6 Circuits traversing a hazardous area

Where circuits traverse a hazardous area in passing from one non-hazardous area to another, the wiring system in the hazardous area shall be appropriate to the zone(s).

7.7 Unused cores

The hazardous area end of each unused core in multi-core cables shall either be connected to earth or be adequately insulated by means of suitable terminations.

7.8 Cable surface temperature

The surface temperature of cables shall not exceed the temperature class for the installation.

NOTE Consideration should be given to the maximum cable temperature during a short circuit.

7.9 Jointing

Cable runs in hazardous areas should, where practicable, be uninterrupted. Where discontinuities cannot be avoided, the joint, in addition to being mechanically, electrically and environmentally suitable for the situation, shall be

– made in an enclosure with a type of protection appropriate to the zone, or
– of a method which maintains the electrical and mechanical integrity of the unspliced cable and is accepted by the appropriate authority,
– providing the joint is not subject to mechanical stress, be 'epoxy' filled, compound-filled or sleeved with heat-shrunk tubing or cold-shrunk tubing, in accordance with the manufacturer's instructions appropriate to the zone,
– of a method which maintains the electrical and mechanical integrity of the unspliced cable and is accepted by the appropriate authority.

Conductor connections, with the exception of those in flameproof conduit systems or intrinsically safe circuits, shall be made only by means of compression connectors, secured screw connectors, welding or brazing.

Compression connectors and lugs should be affixed to conductors with compression tools specifically recommended by the manufacturer for the type of connector being used.

Ground paths and mechanical protection should be restored to their equivalent original integrity.

7.10 Cable wiring systems

7.10.1 All cables installed in hazardous areas shall be sheathed with a non-metallic impervious sheath in combination with braiding or other metallic covering for earth fault detection and mechanical protection.

NOTE 1 Where necessary for operational reasons, the use of cables suitable for flexing service without metallic braiding or other metallic covering may be considered for use in zone 1 and zone 2.

NOTE 2 Braiding and other metallic covering may be excluded from cables installed in zone 2.

7.10.2 All metallic protective coverings of power and lighting cables passing through a hazardous zone, or connected to apparatus in such a zone, shall be earthed at least at their ends. The metallic covering of all other cables shall be earthed at least at one end.

NOTE Special consideration should be given to single core cables for a.c. and d.c. semiconductor controlled, rectifier or similar systems; in such cases earthing at a single point within the hazardous area may be preferable.

7.10.3 Cables associated with intrinsically safe circuits shall comply with 7.15.

NOTE All necessary steps should be taken when selecting the types of cables and when installing them to prevent the intrinsically safe characteristics of the circuits being jeopardized by induction phenomena.

7.11 Conduit systems

7.11.1 The following requirements apply to conduit systems for connection of flameproof enclosures where the conduits are intended to withstand the explosion pressure.

NOTE The use of conduit systems is, in some countries, subject to national approval.

7.11.2 Rigid threaded metal conduit shall be used. It shall be solid drawn or continuous seam welded and of adequate strength to withstand the explosion pressure. To reduce the pressure-piling effect of some gasses, it shall be provided with sealing fittings as follows:

a) where it enters or leaves a hazardous area;

b) immediately at the wall of the enclosure, unless otherwise stated in the enclosure certificate, of all enclosures containing a source of ignition in normal operation;

c) at any enclosure containing taps, splices, joints or terminations where the conduit diameter is 50 mm or greater.

7.11.3 A minimum of five threads shall be provided on the conduit to permit the engagement of five threads between the conduit and flameproof enclosure or conduit and coupling. The conduit shall be pulled up tight at all of the threaded connections.

7.11.4 Where the conduit system is used as the protective conductor, the threaded junction shall be suitable to carry the fault current which would flow when the circuit is appropriately protected by fuses or circuit-breakers.

7.11.5 In the event that the conduit is installed in a corrosive area, appropriate protection of the conduit shall be provided.

7.11.6 After the cables are installed in the conduit, sealing fittings shall be filled with a compound which does not shrink on setting and is impervious to, and unaffected by, chemicals found in the hazardous area.

NOTE The sealing fittings and compound are used to limit the pressure piling effect, to prevent hot gases from entering the conduit system from an enclosure containing a source of ignition, and to prevent the entrance of the hazardous gas into the non-hazardous area.

The depth of the compound in the sealing fitting shall be equal to the internal diameter of the conduit, but in no case less than 16 mm.

7.11.7 Non-sheathed insulated single or multicore cables may be used in conduit. However, when the conduit contains three or more cables the total cross-sectional area of the cables, including insulation, shall be not more than 40 % of the cross-sectional area of the conduit.

7.12 Mixed systems

7.12.1 A mixed system is an electrical installation consisting of electrical apparatus or enclosures specifically designed for connection to wiring in conduit but connected to cables, or specifically designed for connection to cables but connected to wiring in conduit.

7.12.2 Enclosures specifically designed to be connected by wiring in conduit may, for example, be connected to cables in accordance with one of the following installation methods (see Figure 1).

Method 1

The rigid threaded metal conduit B may be threaded into the threaded entry of the enclosure A. Flameproof enclosures shall have at least five threads fully engaged. A sealing fitting C shall be installed as close as possible to the enclosure A. A rigid threaded metal conduit B is installed between the sealing fitting C and the terminal box D having one of the recognized types of protection (e.g. flameproof enclosure, increased safety). If the distance between the sealing fitting C and terminal box D is greater than 450 mm, an additional sealing fitting shall be installed. The cable shall be connected to the terminal box D in a way that is appropriate to the specific type of protection of the terminal box D (see Figure 1a).

Method 2

An adaptor G, with a length of conduit B not longer than 150 mm, may be threaded into the conduit entry of the enclosure A provided the adaptor G has the same type of protection as enclosure A. Flameproof enclosures shall have at least five threads fully engaged. The cable F is connected to the terminal box D according to the requirements of the type of protection of the terminal box D (see Figure 1b).

Method 3

The cable F may be connected by means of a cable entry E with a transition fitting I, where necessary, made to adapt cable to the threaded conduit entry of the enclosure A. When a cable enters a flameproof enclosure A, a sealing fitting C may be required (see Figure 1c).

7.12.3 Enclosures specifically designed to be connected by cables may be connected to wiring in conduit. This may be achieved, for example, by threading a rigid metal conduit into the hole in the enclosure intended for the mounting of a threaded cable entry. The thread characteristics of the conduit shall be compatible with those of the enclosure.

However, conduit shall only be connected to a flameproof enclosure where specifically permitted by the apparatus certification, or via a component-certified flameproof conduit sealing device.

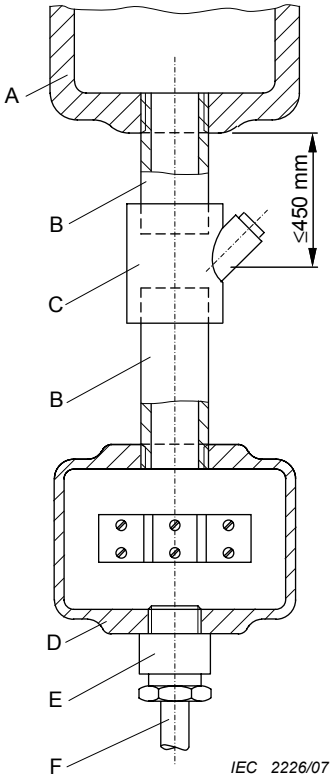


Figure 1a – Method 1

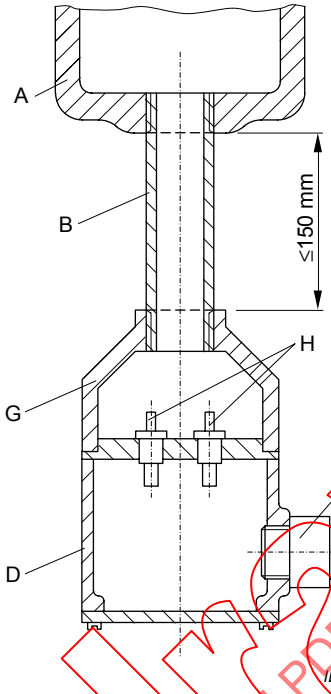


Figure 1b – Method 2

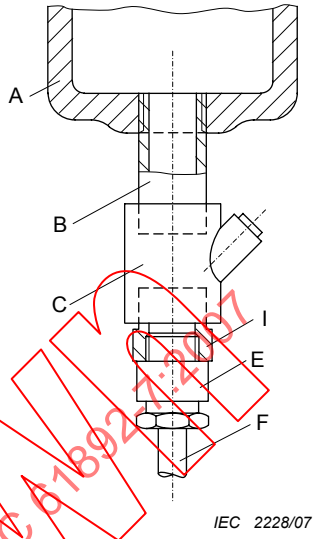


Figure 1c – Method 3

A Enclosure with a recognized type of protection according to the IEC 60079 series, for example ''flameproof enclosure''
B Conduit according to 7.11
C Sealing according to 7.11
D Terminal box with a recognized type of protection according to the IEC 60079 series, for example type of protection "e" or "d"
E Cable entry
F Cable
G Adapter with bushing H and terminal box D
I Transition fitting made to adapt a cable entry where these are different

Figure 1 – Examples of mixed wiring systems

7.13 Apparatus in hazardous areas

Apparatus in hazardous areas shall be in accordance with the requirements of clause 6.

7.14 Wiring system in zone 0

Wiring systems in zone 0 shall comply with the following:

7.14.1 Intrinsically safe systems shall be installed in accordance with the general requirements specified in 7.3 and 7.15 but, in addition, special requirements may apply for zone 0.

7.14.2 For installations which are not intrinsically safe, the following requirements apply:

The probability in zone 0 of harmful effects due to the environment is such that cables shall not be used without additional protection. The additional protection required may be mechanical, electrical or environmental according to the conditions of use.

Special attention shall be given to the effects of lightning discharges and differences in earth potential.

Conduit systems installed in accordance with 7.11 are suitable for zone 0, subject to approval by the appropriate authority.

7.15 Intrinsically safe electrical installations

A fundamentally different installation philosophy has to be recognized in the installation of intrinsically safe circuits. In comparison with all other type of installations, where care is taken to confine electrical energy to the installed system as designed so that a hazardous environment cannot be ignited, the integrity of an intrinsically safe circuit has to be protected from intrusion of energy from other electrical sources so that the safe energy limitation in the circuit is not exceeded, even when breaking, shorting or earthing of the circuits occurs.

As a consequence of this principle the aim of the installation rules for intrinsically safe circuits is to maintain separation from other circuits.

7.15.1 Intrinsically safe circuits may be:

a) isolated from earth, or

b) connected at one point to the equipotential bonding system if this exists over the whole area in which the intrinsically safe circuits are installed.

The installation method shall be chosen with regard to the functional requirements of the circuits according to the manufacturer's instructions.

More than one earth connection is permitted on a circuit, provided that the circuit is galvanically separated into subcircuits, each of which has only one earth point.

If the circuit is isolated from earth, particular attention shall be given to any possible danger due to electrostatic charging. A connection to earth across a resistance of between 0,2 MΩ and 1 MΩ, for example for the dissipation of electrostatic charges, is not deemed to be earthing.

7.15.2 In intrinsically safe circuits, the earthing terminals of safety barriers without galvanic isolation (for example Zener barriers) shall be

a) connected to the equipotential bonding system by the shortest practicable route, or

b) for TN-S systems only, connected to a high-integrity earth point in such a way as to ensure that the impedance from the point of connection to the main power system earth point is less than 1 Ω. This may be achieved by connection to a switch-room earth bar or by the use of separate earth rods. The conductor used shall be insulated to prevent invasion of the earth by fault currents which might flow in metallic parts with which the conductor could come into contact (for example control panel frames). Mechanical protection shall also be provided in places where the risk of damage is high.

The cross-section of the earth connection shall consist of

– at least two separate conductors each rated to carry the maximum possible current, which can continuously flow, each with a minimum of 1,5 mm^2 copper, or

– at least one conductor with a minimum of 4 mm^2 copper.

NOTE The provision of two earthing conductors should be considered to facilitate testing.

If the prospective short-circuit current of the supply system connected to the barrier input terminals is such that the earth connection is not capable of carrying such current, then the cross-sectional area shall be increased accordingly or additional conductors used.

If the earth connection is achieved via junction boxes, special care should be taken to ensure the continued integrity of the connection.

7.15.3 In electrical installations where intrinsically safe circuits are used, for example in measuring and control cabinets, the terminals shall be reliably separated from the non-intrinsically safe circuits (for example by a separating panel, or a gap of at least 50 mm or increased insulation level) in compliance with IEC 60079-11. The terminals of the intrinsically safe circuits shall be marked as such. All terminals shall satisfy the requirements of IEC 60079-11.

Where terminals are arranged to provide separation of circuits by spacing alone, care shall be taken in the layout of terminals and the wiring methods used to prevent contact between circuits should a wire become disconnected.

7.15.4 Enclosures and wiring of intrinsically safe circuits shall meet the requirements which would be applied to similar types of electrical apparatus which are intended to be installed in non-hazardous areas otherwise having the same environmental conditions.

If an enclosure contains both intrinsically safe circuits and non-intrinsically safe circuits, the intrinsically safe circuits shall be clearly identified.

In installations containing both intrinsically safe apparatus and electrical apparatus having another type of protection, the intrinsically safe circuits shall be clearly marked.

7.15.5 Marking may be achieved by labelling or colour coding of enclosures, terminals and cables. Where a colour is used for this purpose it shall be light blue.

7.15.6 Where intrinsically safe circuits may be exposed to disturbing magnetic or electric fields, special attention shall be given to transposition or shielding so that these fields do not adversely affect the intrinsic safety of the circuit.

7.15.7 Conductors of intrinsically safe circuits and non-intrinsically safe circuits shall not be in the same bundle or duct unless separated by an intermediate layer of insulating material or by an earthed metal partition. No separation is required if metal sheaths or screens are used for the intrinsically safe or non-intrinsically safe circuits.

For multicore cables fault considerations shall be carried out as required by IEC 60079-14.

7.15.8 A flexible cable may contain more than one intrinsically safe circuit if the cable installation is such as to minimize the risk of damage which could cause interconnection between different circuits.

7.15.9 The installation of intrinsically safe circuits shall be such that the extreme permitted values, for example capacitance, inductance and inductance to resistance ratio, are not exceeded.

The permissible values shall be taken from the certificate, the marking on the electrical apparatus, or from the installation instructions.

7.16 Simple apparatus

The following apparatus shall be considered to be simple apparatus:

a) passive components, for example switches, junction boxes, resistors and simple semiconductor devices;

b) sources of stored energy consisting of single components in simple circuits with well defined parameters, for example capacitors or inductors, whose values shall be considered when determining the overall safety of the system;

c) sources of generated energy, for example thermocouples and photocells, which do not generate more than 1,5 V, 100 mA and 25 mW.

Simple apparatus shall conform to all relevant requirements of IEC 60079-11. The manufacturer or intrinsically safe system designer shall demonstrate compliance with this clause, including material data sheets and test reports, if applicable.

Further requirement is given in IEC 60079-11.

7.17 Verification of intrinsically safe circuits

Unless a system certificate is available defining the parameters for the complete intrinsically safe circuit, then the system must be verified as required by IEC 60079-14.

When installing intrinsically safe circuits, including cables, the maximum permissible inductance, capacitance or L/R ratio and surface temperature shall not be exceeded. The permissible values shall be taken from the associated apparatus documentation or the marking plate.

7.18 Additional requirements for type of protection "d" – Flameproof enclosures

7.18.1 General

Flameproof enclosures, with only an Ex component certificate (marked with 'U') shall not be installed. They shall always have an equipment certificate for the complete assembly.

Alteration to the disposition of the internal components of an already certified piece of apparatus is not advisable without re-assessment because conditions may be created inadvertently which lead to pressure-piling.

NOTE Apparatus according to IEC 60079-1 will be marked with apparatus group IIA, IIB, IIB + H_2 or IIC. Apparatus marked 'IIB + H_2' should be installed as IIC apparatus.

7.18.2 Solid obstacles

When installing apparatus, care shall be exercised to prevent the flameproof flange joint approaching nearer than the distance specified in table 2 to any solid obstacle which is not part of the apparatus, such as steelwork, walls, weatherguards, mounting brackets, pipes or other electrical apparatus, unless the apparatus has been tested at a smaller distance of separation.

Table 2 – Minimum distance of obstacles from the flameproof flange joints related to the gas/vapour subgroup of the hazardous area

Gas/vapour subgroup	Minimum distance
IIA	10
IIB	30
IIC	40

7.18.3 Protection of flameproof joints

Flameproof joints shall be protected against corrosion. The gaps shall be protected against ingress of water. The use of gaskets is only permissible when specified in the apparatus documentation. Joints shall not be treated with substances which harden in use.

NOTE 1 A suitable protection method for joints consists of the application of non-setting grease or anti-corrosive agents. Silicone based greases are often suitable for this purpose but care needs to be taken concerning use with gas detectors. It cannot be too strongly emphasized that extreme care should be exercised in the selection and application of these substances to ensure the retention of the non-setting characteristics and to allow subsequent separation of the joint surfaces.

NOTE 2 Non-hardening grease-bearing textile tape may also be employed outside of a straight flanged joint but only where the apparatus is used in conjunction with gases allocated to group IIA. The tape should be restricted to one layer surrounding all parts of the flange joint with a short overlap. New tape should be applied whenever existing tape is disturbed.

NOTE 3 Non-hardening grease-bearing textile tape may be applied to straight flanged joints of group IIB enclosures but should not be applied to group IIC (or IIB + H_2) enclosures used in conjunction with gases allocated to group IIC. When tape is applied to a group IIB enclosure, the gap between the joint surfaces should not exceed 0,1 mm, irrespective of the flange width.

NOTE 4 Flanged faces should not be painted before assembly. Painting of the enclosure after complete assembly is permitted.

7.18.4 Cable entry system

7.18.4.1 General

It is essential that cable entry systems comply with all the requirements referred to in the appropriate apparatus standard, that the cable entry device is appropriate to the type of cable employed, maintains the respective method of protection and is in accordance with 7.3.

7.18.4.2 Cable entry for flameproof equipment – General

Where cables enter into flameproof apparatus via flameproof bushings through the wall of the enclosure which are part of the apparatus (indirect entry), the parts of the bushings outside the flameproof enclosure will be protected in accordance with one of the types of protection listed in IEC 60079-0. Normally, the exposed part of the bushings will be within a terminal compartment which will either be another flameproof enclosure or will be protected by protection type “e”. Where the terminal compartment is Ex “d”, then the cable system shall comply with 7.18.4.3. Where the terminal compartment is Ex “e”, then the cable system shall comply with 7.19.1.

Where cables enter into flameproof apparatus directly, the cable system shall comply with 7.18.4.3.

Flameproof cable entry devices may be fitted with a sealing washer between the entry device and the flameproof enclosure providing that after the washer has been fitted, the applicable thread engagement is still achieved. For parallel threads, the thread engagement is normally five full threads or 8 mm, whichever is the greater.

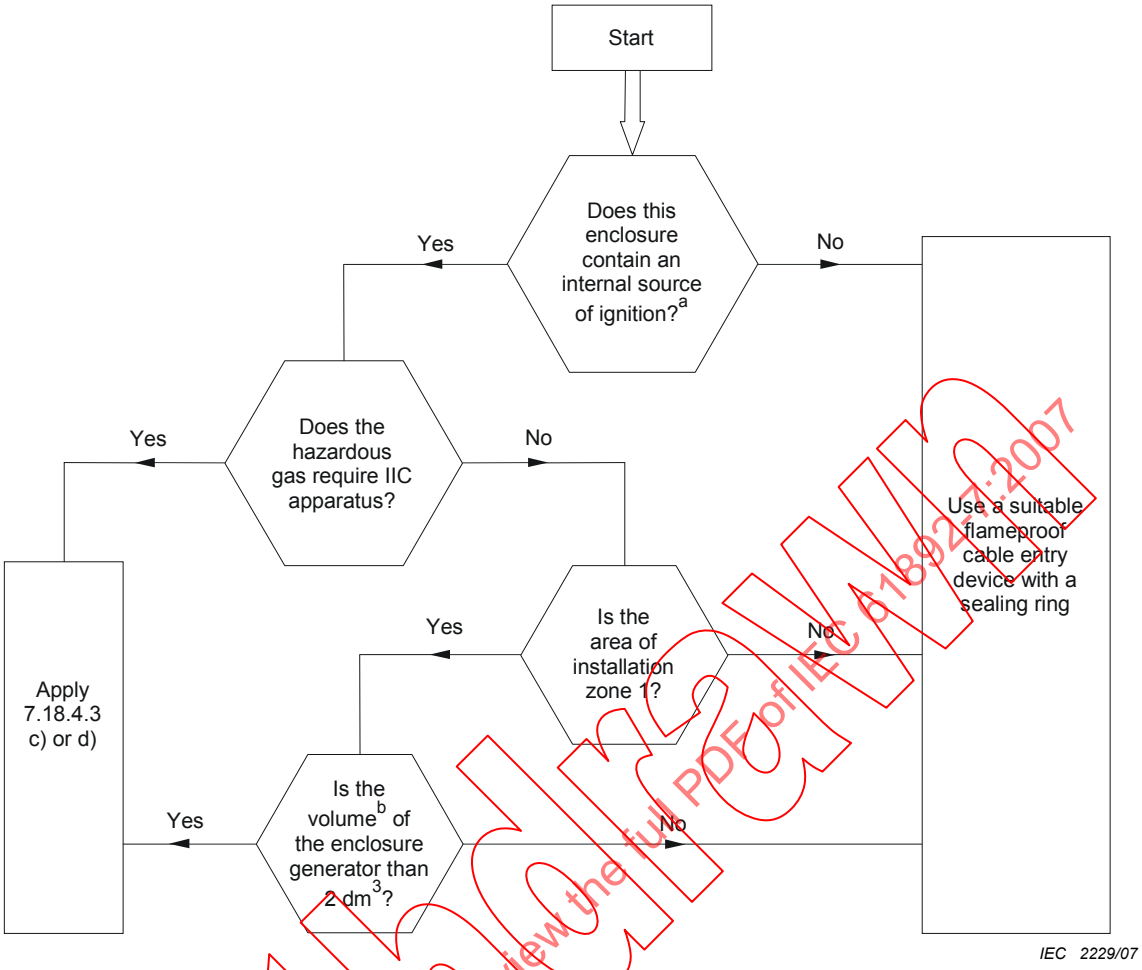
7.18.4.3 Selection of cable entry for flameproof equipment

The cable entry system shall comply with one of the following:

a) cable entry device in compliance with IEC 60079-1 and certified as part of the apparatus when tested with a sample of the particular type of cable;

b) thermoplastic, thermosetting or elastomeric cable which is substantially compact and circular, has extruded bedding and the fillers, if any, are non-hygroscopic; may utilize flameproof cable entry devices, incorporating a sealing ring selected in accordance with Figure 2;

NOTE 1 If it has been shown that the use of a particular type of cable with a cable entry device in accordance with IEC 60079-1, and incorporating a sealing ring, does not result in ignition through external damage to the cable (caused by flame erosion) when subjected to repeated ignition of the flammable gas present in an enclosure, than full compliance with Figure 2 may not be necessary.



a Internal sources of ignition include sparks or equipment temperatures occurring in normal operation which can cause ignition. An enclosure containing terminals only or an indirect entry enclosure is considered not to constitute an internal source of ignition.

b The term "volume" is defined in IEC 60079-1.

Figure 2 – Selection chart for cable entry devices into flameproof enclosures for cables complying with item b) of 7.18.4.3

c) flameproof sealing device (for example a stopping box or sealing chamber) specified in the apparatus documentation or having component approval and employing cable entry devices appropriate to the cables used. The sealing devices such as stopping boxes or sealing chambers shall incorporate compound or other appropriate seals which permit stopping around individual cores. Sealing devices shall be fitted at the point of entry of cables to the apparatus;

d) flameproof cable entry devices incorporating compound filled seals around the individual cores or other equivalent sealing arrangements;

e) other means which maintain the integrity of the flameproof enclosure.

NOTE 2 Where a factory-made termination of the encapsulated type is used, no attempt should be made to interfere with the connection to the apparatus or to replace the cable.

7.19 Additional requirements for type of protection “e” – Increased safety

7.19.1 Cable entry for Ex e equipment

The connection of cables to increased safety apparatus shall be effected by means of cable entry devices appropriate to the type of cable used. They shall maintain protection type “e”, incorporate a suitable sealing component to achieve the required degree of protection of the terminal enclosure (minimum IP54) and meet the mechanical impact strength requirements of IEC 60079-0.

NOTE 1 To meet the ingress protection requirement it may also be necessary to seal between the cable entry device and the enclosure (for example by means of a sealing washer or thread sealant).

NOTE 2 In order to meet the minimum requirement of IP54, threaded cable entry devices into threaded cable entry plates or enclosures of 6 mm or greater thickness need no additional sealing between the cable entry device and the entry plate or enclosure providing the axis of the cable entry device is perpendicular to the external surface of the cable entry plate or enclosure.

7.19.2 Cage induction motors – Overload protection

An inverse-time delay overload protective device shall be such that not only is the motor current monitored, but the stalled motor will also be disconnected within the time t_E stated on the marking plate. The current-time characteristic curves giving the delay time of the overload relay or release as a function of the ratio of the starting current to the rated current shall be held by the user.

The curves will indicate the value of the delay time from the cold state related to an ambient temperature of 20 °C and for a range of starting current ratios (I_A/I_N) of at least 3 to 8. The tripping time of the protective devices shall be equal to these values of delay ±20 %.

The properties of delta wound machines in the case of the loss of one phase should be specifically addressed. Unlike star wound machines, the loss of one phase may not be detected, particularly if it occurs during operation. The effect will be current imbalance in the lines feeding the machine and increased heating of the motor. A delta wound motor with a low torque load during start-up might also be able to start under this winding failure condition and therefore the fault may exist undetected for long periods. Therefore, for delta wound machines, phase imbalance protection shall be provided which will detect machine imbalances before they can give rise to excessive heating effects.

In general, motors designed for continuous operation, involving easy and infrequent starts which do not produce appreciable additional heating, are acceptable with inverse-time delay overload protection. Motors designed for arduous starting conditions or which are to be started frequently are acceptable only when suitable protective devices ensure that the limiting temperature is not exceeded.

Arduous starting conditions are considered to exist if an inverse-time delay overload protective device, correctly selected as above, disconnects the motor before it reaches its rated speed. Generally, this will happen if the total starting time exceeds 1,7 t_E.

NOTE 1 Operation

Where the duty of the motor is not S1 (continuous operation at constant load), the user should obtain the appropriate parameters for the determination of suitability given a definition of operation.

NOTE 2 Starting

It is preferred that the direct on-line starting time for the motor is less than the t_E time so that the motor protection device does not trip the motor during start-up. Where the starting time exceeds 80 % of the t_E time, the limitations associated with starting whilst maintaining operation within the machine certification should be ascertained from the motor manufacturer.

As the voltage dips during a direct on-line start, the starting current decreases and the run-up time increases. Although these effects may tend to cancel out for small voltage dips, for voltages less than 85 % of U_N during startup, the motor manufacturer should declare the associated limitations on start-up.

Motors may be limited by the manufacture to a fixed number of start attempts from a running temperature condition.

NOTE 3 Protection relay

The protection relay for machines in accordance with type of protection “e” should

a) monitor the current in each phase,

b) provide close overload protection to the fully loaded condition of the motor,

c) have an allowance for tolerance, drift and the thermal condition of the motor; the tolerance of the tripping time should be within ±20 %.

Inverse-time delay overload protection relays may be acceptable for machines of duty type S1 which have easy and infrequent starts. Where the starting duty is arduous or starting is required frequently, the protection device should be selected so that it ensures limiting temperatures are not exceeded under the declared operational parameters of the machine. Where the starting time exceeds 1,7 t_E, an inverse-time relay would be expected to trip the machine during start-up.

Under some circumstances, e.g. for duty types other than S1, the motor may be certified with the temperature detection and protection. If this is the case, the t_E time may not be identified.

7.19.3 Motors – Varying frequency and voltage

Motors supplied at varying frequency and voltage by a convertor shall have been type tested for this duty as a unit in association with the convertor specified in the descriptive documents according to IEC 60079-0 and with the protective device provided or shall be evaluated in accordance with IEC 60079-7.

NOTE Additional information on the application of convertor-fed motors can be found in IEC 60034-17. Major concerns include over-temperature, high frequency and over-voltage effects, and bearing currents.

7.20 Additional requirements for type of pressurization “p” – Pressurized apparatus

7.20.1 General

Unless it has been assessed as a whole, the complete installation shall be checked by an expert with sufficient knowledge of the system for compliance with the requirements of the apparatus documentation and the requirements of this standard.

The coding shown on a certificate relating to apparatus certified as conforming to one of the pressurization apparatus standards will always include “Ex p”. It may also contain the letter “p” in conjunction with other letters, e.g. a certified flameproof enclosure containing a certified pressurization control system might be marked (according to IEC 60079-2) as “Ex d [p]”.

NOTE 1 The [p] indicates either

a) that the flameproof enclosure contains a component certified pressurization control system whose certificate number will end in the letter “U”, or

b) that the flameproof enclosure contains a pressurization control system certified for use with a specific pressurized enclosure. In this case separate assessment or certification needs to be carried out if the system is to be used on a different pressurized enclosure design.

NOTE 2 The fitting of a certified pressurization control system onto an uncertified pressurized enclosure does not confer certification on the pressurized enclosure or its contents.

NOTE 3 An empty pressurized enclosure may or may not have a separate component certificate. Electrical equipment installed inside even a component certified pressurized enclosure is not fully certified unless a separate certificate of conformity refers to the actual contents fitted.

NOTE 4 This clause is compatible with the requirements of IEC 60079-2. This standard includes types of protection px, py, and pz and may conflict with some of the requirements shown herein.

7.20.2 Ducting

All ducts and their connecting parts shall be able to withstand a pressure equal to

– 1,5 times the maximum overpressure, specified by the manufacturer of the pressurized apparatus, for normal operation, or

– the maximum overpressure that the pressurizing source can achieve with all the outlets closed where the pressurizing source (for example a fan) is specified by the manufacturer of the pressurized apparatus,

with a minimum of 200 Pa (2 mbar).

The materials used for the ducts and connecting parts shall not be adversely affected by the specified protective gas or by the flammable gas or vapours in which they are to be used.

The points at which the protective gas enters the supply duct(s) shall be situated in a nonhazardous area, except for cylinder supplied protective gas.

Ducting should be located in a non-hazardous area as far as is reasonably practicable. If ducting passes through a hazardous area and the protective gas is at a pressure below atmospheric then the ducting shall be free from leaks.

Ducts for exhausting the protective gas should preferably have their outlets in a non-hazardous area. Consideration shall otherwise be given to the fitting of spark and particle barriers (i.e. devices to guard against the ejection of ignition-capable sparks or particles) as shown in Table 3.

NOTE During the purge period a small hazardous area may exist at the duct outlet.

Table 3 – Use of spark and particle barrier

Zone of exhaust duct outlet	Apparatus	
	A	B
Zone 2	Required	Not required
Zone 1	Required [a]	Required [a]
A Apparatus which may produce ignition-capable sparks or particles in normal operation B Apparatus which odes not produce ignition-capable sparks or particles in normal operation		
[a] If the temperature of the enclosed apparatus constitutes a hazard upon failure of pressurization, a suitable device shall be fitted to prevent the rapid entry of the surrounding atmosphere into the pressurized enclosure.		

Pressurizing apparatus, such as an inlet fan or compressor, that is used to supply protective gas should preferably be installed in a non-hazardous area. Where the drive motor and/or its control equipment are located within the supply ducting, or where the installation in a hazardous area cannot be avoided, the pressurizing apparatus shall be suitably protected.

7.20.3 Action to be taken on failure of pressurization – Apparatus without an internal source of release

Pressurization control systems are sometimes fitted with override devices or “maintenance switches” which are intended to allow the pressurized enclosure to remain energized in the absence of pressurization, e.g. when the enclosure door has been opened.

Such devices should be used in a hazardous area only if the specific location has been assessed to ensure that potentially flammable gas or vapour is absent during the period of use (“gas-free” situation).

NOTE 1 It is only necessary to re-purge the enclosure after pressurization has been re-established if flammable gas was detected in the area while the manual override was in operation.

An installation comprising electrical apparatus without an internal source of release shall comply with Table 4 when the pressurization with the protective gas fails.

NOTE 2 Pressurized enclosures protected by static pressurization should be moved to a non-hazardous area for refilling if pressurization is lost.

The pressure monitoring devices lock out if pressure is lost and should only be reset after pressure has been restored following refilling.

Table 4 – Action to be taken when the pressurization with protective gas fails for electrical apparatus without an internal source of release

Area classification	Enclosure contains apparatus not suitable for zone 2 without pressurization	Enclosure contains apparatus suitable for zone 2 without pressurization
Zone 2	Alarm [a]	No action
Zone 1	Alarm and switch-off [b]	Alarm [a]
NOTE Restoration of pressurization should be completed as soon as possible, but in any case within 24 h. During the time that the pressurization is inoperative, action should be taken to avoid the entry of flammable material into the enclosure. Provided that pressurized apparatus is switched off automatically upon pressurization failure, an additional alarm may not be necessary for safety, even in a zone 1 hazardous area. If power is not switched off automatically, e.g. in a zone 2 hazardous area, an alarm is the minimum action that is recommended if combined with immediate action by the operator to restore the pressurization or switch off the apparatus. Apparatus within the enclosure suitable for the external zone need not be switched off when pressure fails.		
[a] If the alarm operates, immediate action should be taken, for example to restore the integrity of the system. [b] If automatic switch-off would introduce a more dangerous condition, other precautionary measures should be taken, for example duplication of protective gas supply.		

7.20.4 Purging

The minimum purge time specified by the manufacturer, for the pressurized enclosure shall be increased by the minimum additional purging duration per unit volume of ducting, specified by the manufacturer, multiplied by the volume of the ducting.

In zone 2, providing that it is established that the atmosphere within the enclosure and associated ducting is well below the lower flammable limit (for example 25 % LEL) purging may be omitted. Additionally, gas detectors may be used to check whether the gas in the pressurized enclosure is flammable.

The protective gas used for purging, pressurization and continuous dilution shall be non-combustible and non-toxic. It shall also be substantially free from moisture, oil, dust, fibres, chemicals, combustibles and other contaminating material that may be dangerous or affect the satisfactory operation and integrity of the apparatus. It will usually be air, although an inert gas may be used. The protective gas shall not contain more oxygen by volume than that normally present in air.

Where air is used as the protective gas, the source shall be located in a non-hazardous area and usually in such a position as to reduce the risk of contamination. Consideration shall be given to the effect of nearby structures on air movement and of changes in the prevailing wind direction and velocity.

The temperature of the protective gas should not normally exceed 40 °C at the inlet of the enclosure. (In special circumstances, a higher temperature may be permitted or a lower

temperature may be required, in which case the temperature will be marked on the pressurized enclosure.)

Where necessary, to prevent the ingress of combustible gas or vapour by diffusion, or to prevent leakage of protective gas, wiring systems shall be sealed.

NOTE This does not preclude a cable duct or a conduit being purged with the apparatus.

Cable entry devices into pressurized enclosures shall be in accordance with the apparatus documentation.

7.21 Resistance-heating devices

To limit the maximum surface temperature of resistance-heating devices, the heating devices and protective devices, where required, shall be installed in accordance with the requirements of the manufacturer and the documentation.

The temperature protective device, if required, shall de-energize the resistance-heating device either directly or indirectly. It shall be of a type that has to be manually reset.

In addition to the overcurrent protection, and in order to limit the heating effect due to abnormal earth-fault and earth-leakage currents, the following protection shall be installed:

a) in a TN type system, a residual current device (RCD) with a rated residual operating current not exceeding 100 mA shall be used. Preference should be given to RCDs with a rated residual operating current of 30 mA. The device shall have a maximum break time not exceeding 5 s at the rated residual operating current and not exceeding 0,15 s at five times the rated residual operating current;

   NOTE Additional information on RCDs is given in IEC 60755.

b) in an IT system, an insulation monitoring device shall be used to disconnect the supply whenever the insulation resistance is not greater than 50 Ω per volt of rated voltage.

NOTE 1 The above additional protection is not required if the resistance-heating device (for example an anticondensation heater in an electric motor) is intended to be protected by the manner in which it is installed in an electrical apparatus.

NOTE 2 Requirement for trace heating is given in IEC 60079-30-1 and IEC 60079-30-2.

8 Ventilation

8.1 General

8.1.1 All hazardous areas shall be ventilated to reduce the accumulation of explosive gas. Where possible, it shall eliminate the hazardous area or lessen the area classification, (for example from zone 0 where an explosive atmosphere is present continuously or for long periods, to zone 1 where it is likely to occur in normal operation).

8.1.2 To ensure that gas concentrations below the lower explosive limit (LEL) are likely,

– open areas with natural ventilation shall have a sufficient air flow-through,

– sheltered or obstructed open areas with natural ventilation shall be provided with sufficient openings in decks, bulkheads or ceilings,

– enclosed areas, where sufficient ventilation cannot be achieved through natural ventilation, mechanical ventilation with a ventilation rate of at least six air changes per hour with no stagnant areas shall be provided.

NOTE 1 In some countries, a ventilation rate of 12 air changes per hour is required.

NOTE 2 The different types and levels of ventilation of open areas, sheltered areas or obstructed areas and enclosed areas effect the extent of hazardous areas. The design of ventilation is therefore an important factor in achieving optimal ventilation conditions in the hazardous area.

NOTE 3 For documentation requirements, see 10.2.

8.1.3 Further advice on ventilation is found in IEC 60079-10.

8.2 Ventilation of spaces containing electrical apparatus

8.2.1 Hazardous enclosed spaces shall be ventilated; any ducting which is used for normal ventilation shall be separate from that used for the ventilation of non-hazardous areas. Where artificial ventilation is applied it shall be such that the hazardous enclosed spaces are maintained with underpressure in relation to the less hazardous spaces and non-hazardous enclosed spaces are maintained in overpressure in relation to the adjacent hazardous spaces.

8.2.2 All air supply for hazardous enclosed spaces shall be taken from non-hazardous areas. Where the supply duct passes through a more hazardous space, the supply duct is to have overpressure in relation to this space.

8.2.3 All air outlets from hazardous enclosed spaces shall be located in an outdoor area which, in the absence of the considered outlet, would be of the same or lesser hazard than the ventilated space.

8.2.4 All air inlets for non-hazardous enclosed spaces shall be taken from non-hazardous areas and as far as practicable from the boundaries of any hazardous area. Where the inlet duct passes through a hazardous area the inlet duct is to have overpressure in relation to this area.

8.2.5 All air outlets from non-hazardous enclosed spaces shall be located in a non-hazardous outdoor area.

8.3 Ventilation and operation of rooms or buildings protected by pressurization

8.3.1 Electrical apparatus, liable to cause an ignition, may be used in a room or building located in a hazardous area, provided the ingress of the explosive atmosphere is prevented by maintaining inside it a protective gas at a higher pressure than that of the outside atmosphere.

8.3.2 During initial start-up, or after shutdown, and whatever the classification of the hazardous area, it is necessary, before energizing any electrical apparatus in the room which is not suitably protected for the classification of the area to

a) either ensure that the internal atmosphere is not hazardous (see note 1), or proceed with prior purging of sufficient duration that the internal atmosphere may be considered as non-hazardous (see note 2),

b) pressurize the room.

NOTE 1 An atmosphere is considered non-hazardous when, at all points in the room, the enclosures and associated ducts, the concentration of explosive gases or vapours is below 25 % of the lower explosive limit. The place of measurement should be judiciously chosen to determine the highest concentration of gas.

NOTE 2 Generally, the volume of protective gas required for purging is estimated as at least five times the internal volume of the room and its associated ducts.

8.3.3 Fixed gas detectors shall be installed at the ventilation air intake; in the event of gas detection, visible and audible alarms shall be actuated in a location where they will immediately be perceived by the responsible personnel.

8.3.4 In the event of detection of an explosive gas concentration at 25 % LEL (lower explosion limit), responsible personnel shall take necessary actions for safeguarding personnel and process.

8.3.5 In the event of detection of an explosive gas concentration at 60 % LEL, an automatic shut-down of process and apparatus which is not certified safe type, shall be initiated.

NOTE 1 It may well be necessary, to avoid false indications and possible inadvertent shutdown, to apply a coincidence voting arrangement where monitoring is carried out employing three detectors, in which operation of any detector at low level will sound alarm and where coincidence operation of two out of three at high level will activate the shutdown.

NOTE 2 A manual override should be installed in Drillers Cabin if this is not designed for operation in hazardous area without pressurization.

8.4 Values of overpressure and of protective gas flow

8.4.1 The pressurization system shall be capable of ensuring a sufficient outward protective gas speed through the openings of the room when all these openings are open at the same time. The velocity shall be greater than that of external air currents but shall not lead to so great a pressure in the room as to make it difficult to open and close the doors.

NOTE Where doors, windows and openings are provided with airlocks, these should be closed when checking this requirement.

8.4.2 A minimum overpressure of 25 Pa (0,25 mbar) with respect to the outer atmosphere shall be maintained at all points inside the room and its associated ducts at which leaks are liable to occur, all doors and windows being closed.

NOTE This overpressure will prevent the ingress of the external atmosphere for wind speed up to approximately 3,5 m/s.

8.4.3 If there is any air-consuming apparatus inside the pressurized room, the flow through the pressurization system shall be capable of covering all needs; if not, the extra air required shall be supplied by a separate system.

NOTE 1 The pressurization system may also include heating, ventilation and air-conditioning devices over and above the apparatus necessary to fulfil the above requirements.

NOTE 2 The design of a pressurized room will also need to consider

– the number of persons expected to stay in the room in order to ensure the necessary renewal of the air,

– the type of apparatus to be installed in the room and their need for cooling air if any.

8.5 Failure of the pressurization

8.5.1 For monitoring the satisfactory functioning of the pressurization, either a pressure monitoring device or a flow monitoring device or both shall be used.

NOTE 1 Electrical interlock on the fan motors is not suitable to indicate failure of pressurization. They do not give an indication in the event of, for example, the fan belt slipping, the fan becoming loose on the shaft or reverse rotation of the fan.

NOTE 2 Pressure monitoring devices should be certified for the group of gases they might be operating in.

8.5.2 Following loss of pressurization, visible and audible alarms shall be actuated; they shall be located where they will immediately alert the responsible personnel who will take the necessary action, see Table 5.

Table 5 – Summary of protective measures to be taken in the event of failure of pressurization

Classification of the interior of the room[a]	Electrical apparatus installed		
	Apparatus suitable for zone 1	Apparatus suitable for use in zone 2	Apparatus not protected for any hazardous area
Zone 1	No action necessary	Suitable alarm (visible or audible or both) Immediate action to restore pressurization Programmed disconnection of power supplies if the pressurization cannot be restored for an extended period or if the concentration of flammable gas is rising to a dangerous level	Suitable alarm (visible or audible or both) Immediate action to restore pressurization Automatic interruption of the power supplies as rapidly as practicable within a prescribed delay time having regard to the needs of a programmed shutdown
Zone 2	No action necessary	No action necessary	Suitable alarm (visible or audible or both) Immediate action to restore pressurization Programmed disconnection of power supply if the pressurization cannot be restored for an extended period or if the concentration of flammable gas is rising to a dangerous level
[a] Classification in the event of absence of pressurization.			

8.6 Ventilation of battery compartments

8.6.1 Stationary batteries – Vented and valve regulated types

8.6.1.1 The purpose of ventilating a battery location or enclosure is to maintain the hydrogen concentration below the 4 % $_{vol}$ hydrogen lower explosion limit (LEL) threshold and limit the oxygen content to normal level. Battery locations and enclosures are to be considered as safe from explosions, when by natural or forced (artificial) ventilation the concentration of hydrogen is kept below this limit.

NOTE There is no test requirement or results for increased Oxygen content in battery locations/compartments. Charging should be stopped by loss of ventilation if there is any risk for increased O_2 content.

Particular attention shall be given to the fact that the gas emitted is lighter than air and will tend to accumulate in any pockets at the top of the space. When batteries are arranged in two or more tiers, all shelves shall have not less than 50 mm space, front and back, for circulation of air.

8.6.1.2 Natural ventilation may be employed if ducts can be run directly from the top of the room or locker to the open air above, with no part of the duct more than 45° from the vertical. These ducts shall not contain appliances (for example for barring flames) which may impede the free passage of air or gas mixtures.

Where lockers are provided for batteries, the duct shall terminate not less than 0,9 m above the top of the battery enclosure.

If natural ventilation is impracticable or insufficient, artificial extract-ventilation shall be provided with exhaust at the top of the room. Adequate openings, whether connected to ducts

or not, for air inlets shall be provided near the floor of battery rooms or the bottom of lockers or boxes.

If natural ventilation is employed the battery rooms or enclosures require an air inlet and an air outlet with a minimum free area of opening calculated by the following formula:

$$\mathbf{A = 28 \times Q}$$

where Q = ventilation flow rate of fresh air (m^3/h), according to 8.6.1.3.

A = free area of opening in air and outlet (cm^2)

NOTE For the purpose of this calculation the air velocity is assumed to be 0,1 m/s.

The air inlet and outlet shall be located at the best possible location to create best conditions for exchange of air, i.e.

– openings on opposite walls,
– minimum separation distance of 2 m when openings on the same wall.

8.6.1.3 In every case the quantity of the expelled air shall be at least equal to

$$\mathbf{Q = 0{,}05 \times n \times I_{gas} \times C_{rt} \times 10^{-3}\ [m^3/h]}$$

n = number of cells

I_{gas} = current producing gas in mA per Ah rated capacity for the float charge current I_{float} or the boost charge current I_{boost} according to Table 6.

Crt = capacity C10 for lead acid cells (Ah), Uf = 1,80 V/cell at 20 °C or capacity C5 for NiCd cells (Ah), Uf = 1,00 V/cell at 20 °C

Table 6 – Values for current I when charging with constant current / constant voltage chargers

	Lead-acid batteries vented cells Sb < 3 % [a]	Lead-acid batteries valve regulated cells	NiCd batteries vented cells [b]
Typical float charge current I_{float} mA per Ah	1	1	1
Current (float) I_{gas} mA per Ah	5	1	5
Typical boost charge current I_{boost} mA per Ah	4	8	10
Current (boost) I_{gas} mA per Ah	20	8	50
[a] For higher antimony (Sb) content contact the manufacturer for suitable values. [b] For recombination type NiCd cells consult the manufacturer.			

The values of float and boost charge current increase with temperature. The consequence of any increase in temperature up to a maximum of 40 °C has been accommodated in the values in Table 6.

In case of use of recombination vent plugs (catalyst) the gas producing current I_{gas} can be reduced to 50 % of the values for vented cells.

8.6.1.4 Rooms, lockers and boxes for batteries connected to a charging device with a power output calculated from the maximum obtainable charging current and the nominal voltage of the battery, shall be ventilated as follows:

– power more than 2 kW, according to 8.6.1.2 and 8.6.1.3 above, shall be by forced extract, independent of ventilation systems for other spaces;

– power between 0,2 kW and 2 kW, according to 8.6.1.2 and 8.6.1.3 above, except for batteries located open in the engine room or in similar well ventilated compartment;

– power less than 0,2 kW, boxes require openings near the top to permit escape of gas;

– deck boxes may be naturally ventilated. Natural ventilation by means of a duct of ample dimensions, terminating at least 1,25 m above in a goose-neck, mushroom head or equivalent will be sufficient. Holes for air inlet shall be provided on at least two opposite sides of the box.

For degree of protection, see clause 4 of IEC 61892-1.

8.6.2 Hermetically sealed lead-acid batteries

Compartments containing lead acid batteries of the hermetically sealed types shall be ventilated to avoid accumulation of flammable gas.

NOTE 1 In the absence of international codes on ventilation of hermetically sealed batteries, national or other standards should be followed.

NOTE 2 If no provisions for ventilation of hermetically sealed type batteries exist at national level, the ventilation should be based on manufacturer's recommendations. Battery rooms where only hermetically sealed types of batteries are installed can, based on approval by the national authority be considered non-hazardous. It is recommended to install a hydrogen gas detector in the room.

8.6.3 Fans and ducts

8.6.3.1 Fans of accumulator compartments shall be so constructed and be of a material such as to render sparking impossible in the event of the impeller touching the fan casing. Steel or aluminium impellers shall not be used.

8.6.3.2 Ducts shall be made of a corrosion-resistant material or their interior surfaces shall be painted with corrosion-resistant paint.

8.6.3.3 Any fan motor associated with a duct used to exhaust the air from an accumulator space shall be placed external to the duct. Adequate means shall be provided to prevent entrance of gas into the motor. The duct shall be arranged to discharge into the open air.

8.7 Ventilation of other hazardous spaces

Rooms such as paint rooms, welding gas storage rooms, etc. shall be ventilated to avoid accumulation of flammable gas.

9 Inspection and maintenance

9.1 General

Electrical installations in hazardous areas possess features specially designed to render them suitable for operations in such atmospheres. It is essential for safety reasons in those areas that, throughout the life of such installations, the integrity of those special features is preserved.

NOTE 1 For further information, see IEC 60079-17.

NOTE 2 General requirements on inspection and maintenance for all types of electrical systems are given in IEC 61892-6; requirements set out in this clause are additional provisions for inspection and maintenance for electrical installations located in hazardous areas.

9.2 Inspection

9.2.1 Before the plant or apparatus is brought into service it shall be given an initial inspection and then, periodically re-inspected to ensure that the installation is being maintained in a satisfactory condition for continued use within a hazardous area.

9.2.2 If the plant or apparatus is dismantled during the course of an inspection, precautions shall be taken during reassembly, to ensure that the integrity of the type of protection is not impaired.

NOTE Electrical apparatus in a hazardous area can be adversely affected by the environmental conditions in which it is used. Some of the key elements to be considered in the course of an inspection are: corrosion, ambient temperature, ultraviolet radiation, ingress of water, accumulation of dust and sand, mechanical effect and chemical attack.

9.2.3 Alarms and interlocks associated with pressurized equipment and spaces shall be periodically tested to ensure correct operation.

9.2.4 Gas detectors shall be tested periodically for correct operation and calibration.

9.2.5 The result of the inspection shall be documented in a report.