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GENERAL REQUIREMENTS TO SELECT THE ELECTRICAL APPARATUS FOR USE IN EXPLOSIVE GAS ATMOSPHERES

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ABSTRACT: Where electrical apparatus is to be installed in areas where flammable gases, vapors or mists may be present in the atmosphere, protective measures are applied in order to reduce the likelihood of explosion due to ignition by arcs, sparks or hot surfaces, produced either in normal operation or under specified fault conditions. Protective measures aim to reduce, to an acceptable level, the likelihood that the electrical installation could become a source of ignition.

KEYWORDS: electrical apparatus, explosive gas atmospheres

❖ REQUIREMENTS FOR SELECTING ELECTRICAL APPARATUS FOR USE IN EXPLOSIVE GAS ATMOSPHERES

Electrical installations in hazardous areas shall also comply with the appropriate requirements for installations in non-hazardous areas. However the requirements for non-hazardous areas may be insufficient for installations in hazardous areas. Electrical apparatus and materials should be installed and used within their electrical ratings for power, voltage, current, frequency, duty and such other characteristics where non-conformity might jeopardize the safety of the installation. In particular, care should be taken to ensure that the voltage and frequency are appropriate to the supply system in which the apparatus is used and that the temperature classification has been established for the correct voltage, frequency, etc.

Electrical apparatus for use in explosive gas atmospheres is divided into two groups:

- group I: electrical apparatus for mines susceptible to firedamp;
- group II: (which can be divided into subgroups): electrical apparatus for places with an explosive gas atmosphere, other than mines susceptible to firedamp
- group III: (which can be divided into subgroups): electrical apparatus for use in places with an explosive dust atmosphere, other than mines susceptible to firedamp

In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zones 0, 1 and 2 according to EN 60079-10. Electrical apparatus should, as far as is reasonably practicable, be located in non-hazardous areas. Where it is not possible to do this, it should be located in the least hazardous area practicable. All electrical apparatus and wiring in hazardous areas shall be selected and installed in accordance with CEI 60079-14 and the additional requirements for the particular type of protection.

Apparatus shall be installed in accordance with its documentation. Care should be taken to ensure that replaceable items, such as lamps, are of the correct type and rating. On completion of the erection, initial inspection of the apparatus and installation shall be carried out in accordance with EN 60079-17. Assurance of conformity of apparatus is made by using certified apparatus to provide the necessary assurance that apparatus meets the requirements of the appropriate standard.

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

- classification of the hazardous area;
- temperature class or ignition temperature of the gas or vapor involved;
- where applicable, gas/vapor classification in relation to group or subgroup of electrical apparatus;
- external influences and ambient temperature.

Of the types of protection listed in EN 60079-0, the apparatus subgroup is only required for protection types “d” (flameproof enclosures) and “i” (intrinsic safety). The apparatus subgroup is also required for certain apparatus with protection types “n”, “e” or “o” (oil immersion).

❖ SELECTION

APPARATUS FOR USE IN ZONE 0. Electrical apparatus and circuits can be used in zone 0 if they are in accordance with EN 60079-11 (intrinsic safety “ia”), EN 60079-18 (encapsulation “ma”) and with the requirements from EN 60079-26.

APPARATUS FOR USE IN ZONE 1. Electrical apparatus can be used in zone 1 if it is constructed in accordance with the requirements for zone 0 or one or more of the following types of protection.

Flameproof enclosures “d” according to EN 60079-1

Pressurized enclosures “px” or “py” according to EN 60079-2

Powder filling “q” according to EN 60079-5

Oil immersion “o” according to EN 60079-6

Increased safety “e” according to EN 60079-7

Intrinsic safety “ib” according to EN 60079-11

Encapsulation “mb” according to EN 60079-18

APPARATUS FOR USE IN ZONE 2. The following electrical apparatus may be installed in zone 2:

a) electrical apparatus for zone 0 or zone 1; or

b) electrical apparatus designed specifically for zone 2 (for example type of protection “n” according to EN 60079-15, pressurized apparatus “pz”, intrinsic safety “ic”, encapsulation “mc”), 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 EN 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 EN 60079-15.

SELECTION ACCORDING TO THE 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.

If the marking of the electrical apparatus does not include an ambient temperature range, the apparatus shall be used only within the temperature range -20°C to $+40^{\circ}\text{C}$.

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

SELECTION ACCORDING TO APPARATUS GROUPING. Electrical apparatus of types of protection “e”, “m”, “p” and “q” shall be of apparatus group II. There are nevertheless occasions when some of these types of protection, which are normally of apparatus group II, can be allocated within subgroups IIA or IIB (to accommodate discharge of stored energy, static electricity, etc.).

Electrical apparatus of types of protection “d” and “i” shall be of apparatus group IIA, IIB or IIC and selected in accordance with table 2.

Electrical apparatus of type of protection “n” shall normally be of apparatus group II but, if it contains enclosed break devices, non-incentive components or energy limited apparatus or circuits, then the apparatus shall be group IIA, IIB or IIC and selected in accordance with table 2.

Electrical apparatus of type of protection “o” shall be of apparatus group IIA, IIB or IIC for certain apparatus and selected in accordance with table 2.

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

Temperature class of electrical apparatus	Maximum surface temperature of electrical apparatus $^{\circ}\text{C}$	Ignition temperature of gas or vapor $^{\circ}\text{C}$
T1	450	>450
T2	300	>300
T3	200	>200
T4	135	>135
T5	100	>100
T6	85	>85

Table 2. Relationship between gas/vapor subdivision and apparatus subgroup

Gas/vapour subdivision	Apparatus subgroup
IIA	IIA, IIB or IIC
IIB	IIB or IIC
IIC	IIC

❖ 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.

❖ CONCLUSIONS

For selecting the electrical apparatus for use in explosive gas atmospheres, the user should consider:

- the area in which the apparatus will operate;
- type of protection shall be suitable for the considered area;
- correct association of apparatus with processes;
- certification for all electrical and non-electrical apparatus according to ATEX Directive 94/9/EC

❖ TERMS AND DEFINITIONS

- 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
- GROUP (OF AN ELECTRICAL APPARATUS FOR EXPLOSIVE ATMOSPHERES) - classification of electrical apparatus related to the explosive atmosphere for which it is to be used
- MAXIMUM SURFACE TEMPERATURE - highest temperature which is attained in service under the most adverse operating conditions (but within recognized tolerances) by any part or surface of the electrical apparatus, which would be able to produce an ignition of the surrounding explosive atmosphere. The most adverse conditions include recognized overloads and fault conditions recognized in the specific standard for the type of protection concerned. The relevant surface temperature may be internal and/or external depending upon the type of protection concerned.
- TYPE OF PROTECTION - specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere
- FLAMEPROOF ENCLOSURE “d” - type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture and which prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure
- INCREASED SAFETY “e” - type of protection applied to electrical apparatus in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks in normal service or under specified abnormal condition
- INTRINSIC SAFETY “i” - type of protection based upon the restriction of electrical energy within apparatus and of interconnecting wiring exposed to an explosive atmosphere to a level below that which can cause ignition by either sparking or heating effects
- PRESSURIZATION “p” - technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere
- ENCAPSULATION “m” - type of protection in which the parts which could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited
- OIL IMMERSION “o” - type of protection in which the electrical apparatus or parts of the electrical apparatus are immersed in a protective liquid in such a way that an explosive atmosphere which may be above the liquid or outside the enclosure cannot be ignited
- POWDER FILLING “q” - type of protection in which the parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an internal explosive atmosphere
- TYPE OF PROTECTION “n” - type of protection applied to electrical apparatus such that, in normal operation and in certain specified abnormal conditions, it is not capable of igniting a surrounding explosive atmosphere

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