System installation and operation where flammable dust is the potential hazard

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Overview of documentation for combustible dusts situations:

In the UK

When the national Code of Practice for electrical apparatus for use in the presence of gases and vapours, BS 5345 was developed it was intended that one document in the series should be devoted to combustible dusts.It was during the development of BS 5345 that it was decided that an apparatus standard for combustible dusts situations and a separate selection guide should be developed.The apparatus standard was published in 1985 as BS 6467 Part 1 and the selection guide in 1988 as BS 6467 Part 2.By that time laboratory test methods were being prepared by the International Electrotechnical Commission (IEC) for use in conjunction with an IEC apparatus standard and an IEC selection guide.It was accepted in the UK that these laboratory methods would become available and would be used with BS 6467 Parts 1 and 2.Included as Appendix B of BS 6467 Part 2 was a Procedure for area classification.

The scope of BS 6467 was limited to areas where combustible dusts might be present outside a process plant containment.There was clearly a need to deal with the possible application of apparatus,particularly instrumentation, within the process plant containment and outside and BS 7535 was prepared and published in 1992.This document provides guidance on how to apply apparatus which complies with apparatus standards for gases and vapours namely BS 5501 and BS 6941 in combustible dusts situations.

Internationally:

The International Electrotechnical Commission has been active in the preparation of international standards for combustible dusts since the 1970's.A standard for electrical apparatus protected by enclosure was prepared together with a selection guide and both were published in 1993.Many of the powders processed by industry are combustible and as the details of their chemical and physical composition may be confidential to the owners they do not appear in the public domain.It is necessary therefore that laboratory methods are available to provide the data on which the eventual selection of the electrical apparatus can be based.To facilitate the application of the selection guide,laboratory test methods were developed for combustible dusts to provide a consistent way of establishing the cloud ignition temperature,the layer ignition temperature and the resistivity of dust in layers. The test methods were published by IEC in 1993 and 1994.Following these publications an area classification guide was prepared and published in 1997.The full titles of these documents are given at the end of the paper.

In Europe:

To achieve the free movement of goods in Europe it was agreed by Ministers in 1985 that a 'New Approach to Technical Harmonisation and Standards' would be adopted.To achieve this 'New Approach' essential requirements, principally for safety, would have to be met before products could be sold in the Community.Harmonised European Standards would be a way of meeting the essential requirements and products complying with the essential requirements would carry the CE mark.

Equipment and protective systems intended for use in Potentially Explosive Atmospheres were embraced by Council Directive 94/9/EC (the Atex Directive) and the 'New Approach' and Regulations were introduced in Great Britain in March 1996.A transitional arrangement is now in force for EEC Certificates of Conformity issued under earlier Directives which will remain in force until 2003.The 1996 Regulations apply to both electrical and mechanical equipment and protective systems.

For the purposes of the Regulations an explosive atmosphere is a mixture with air,under atmospheric conditions,of flammable gases,vapours mists or dusts in which,after ignition has occurred,combustion spreads throughout the entire unburned mixture.A potentially explosive atmosphere is an atmosphere which could become explosive due to local and operational conditions.

The Commission of the European Community General Directorate V has begun the preparation of a directive intended to establish minimum requirements for improving the health and safety of workers potentially at risk from explosive atmospheres.It is intended that this directive (the 118A Directive) will contain the zone definitions for use in classification of areas.CEN and CENELEC are preparing standards which will assist industry to meet the requirements of European legislation.CEN has drawn up and published a harmonised standard BS EN 1127-1 1997 which describes the basic concepts and methodology of explosion prevention and protection.BS EN 1127-1 contains definition of zones and it is intended that these will align with those finally used in the 118A Directive.The zone definitions for dust are based on the three zone concept with the nomenclature Zone 20, Zone 21 and Zone 22 in diminishing order of severity of risk.The risk considered is the risk of explosion in line with the intent of the 118A Directive. The risk from fire is not considered by BS EN 1127-1 and it is understood that CEN have programmed the preparation of a standard which will provide guidance on fire prevention and protection.When the risks are considered following the release of combustibe dust from a process plant containment where a dust layer is formed or where a dust layer arises from an incident such as the the spillage of powder from a container the presence of the dust layer has to be considered as any other source of hazard.It is to be hoped that when an guide to area classification is prepared by CENELEC a procedure to accomodate this requirement is provided to assist the area classification practitioner..
BS EN 1127-1 is what is known as a Type A standard,in accordance with EN 292-10, which describes the basic concepts and methodology of explosion prevention and protection and is a harmonised standard in the context of EU Directives.A CEN technical committee has a mandate to produce Type B and Type C standards which will allow verification of conformity with essential safety requirements.

CENELEC the European body charged with the preparation of electrical standards has prepared an apparatus standard and selection guide which are presently in a late stage of draft preparation.The definitions of the zones for area classification have been agreed between CEN and CENELEC and the definitions from BS EN 1127-1 will be adopted for use in the final harmonised documents.The preparation of an area classification guide is to be considered by the CENELEC technical committee.

Management and operation of apparatus and systems:

Dust comprises small particles of solid material suspended in air some of which settle out under their own weight to form layers.The effect of ventilation on the behaviour of combustible dusts is quite different to the behaviour of ventilation on gases and

vapours.Ventilation can disturb dust layers to form dust clouds which may explode on ignition.With gases and vapours ventilation dilutes and disperses the gas/vapour until it is below its lower flammable limit.

Area Classification is a technique used to establish the zones of risk presented by mixtures of combustible dust in air.The area classification must take account of the behaviour of the dust when it escapes from a process plant containment including the effect of ventilation.When dust settles as a layer the principal hazard is fire rather than explosion.

In a practical sense the kind of situations which have to be considered might be as follows. It is convenient to have many products in the form of powders,they are easy to transport and to use.Powders are prepared by removing solid materials from solution by spray drying, or by filtration to yield a paste then drying in an oven to prepare solids.The required powder consistency can then be achieved by milling.

At the stage in these processes where powders are formed there is always the possibility of escape of the powder into the atmosphere to form a cloud, for instance through joints between two process plant items.The cloud will settle under its own weight to form a layer. Powders can be transported from one location to another in bulk in flexible or rigid intermediate bulk containers or in plastic or paper sacks.The materials then have to be discharged into storages or into process vessels at the receiving location.As the powder is discharged a dust cloud often of limited size will form at the process vessel manhole or entry point of the storage, the dust then settling to form a layer.
The zone classification is determined by considering the behaviour of the dust in the context of the zonal definitions.

The principal method of protection for electrical apparatus for use in the presence of combustible dusts is protection by enclosure.The integrity of the enclosure is its ability to prevent the ingress of solid objects of defined size and liquid of defined physical form.Levels of ingress protection which can be established by test are described by the letters IP followed by two numerals.The first numeral describes the level of ingress protection for solids,the second that for liquids.Where solid ingress only is described the practice is to use the letter X for the liquid,eg IP 6X.

Where the technique is applied to combustible dusts there are two levels of ingress protection which apply .The higher is IP6X where the dust is excluded from the enclosure entirely.The second is IP5X where a small amount of dust is allowed to enter the enclosure.The permissible quantity must be small enough not to interfere with the correct operation of the apparatus and must not be large enough to create an ignition hazard.The selection of the apparatus and its ingress protection level has to be appropriate to the level of risk defined by the zone in the area classification.

The second aspect of selection is the surface temperature of the enclosure.The maximum surface temperature of the enclosure must be below the lower of the cloud ignition temperature and the layer ignition temperature both of which have been defined earlier either from the literature or by laboratory test.A factor of safety is applied to take account of any variations in particle size or moisture content between the sample and the material used in the process.It is always recommended that in sampling for the laboratory test,the sample should be as representative as possible of the material actually in use in the process.

Account has to be taken of the resistivity of the dust to ensure that should combustible dust enter the enclosure tracking between live terminals cannot take place.Where conductive

dusts are present the highest level of ingress protection is required (IP6X) and no dust is permitted within the enclosure.

When apparatus is put into service it is important that the installation is designed and constructed in such a way that the degree of ingress protection of the enclosures is not reduced.Cable selection for combusible dusts situations can be based on normal industrial cables either armoured or unarmoured.The cables should be installed so as to avoid mechanical damage and where practicable in an orientation where the accumulation of dust layers is kept to a minimum.Having addressed the design and construction of apparatus carefully it is important that the integrity of the enclosure is not then reduced when the cable is connected to the enclosure.Cable entry devices (glands) should be selected and installed to ensure that the integrity is maintained.Where the entry is threaded and the enclosure wall thickness is substantial,provided the gland is perpendicular to the surface of the enclosure,the integrity can be maintained without the use of a sealing washer.Where a clearance hole is provided for gland entry to the enclosure it is necessary to use a compressible washer.Care has to be taken to maintain earth continuity of the installation where compressible washers are used.

Periodic inspection and any necessary maintenance should take place on a regular basis to ensure that the standards which were achieved at installation prevail.

Future developments:

As mentioned earlier CENELEC will use the three zone system of definitions which are included within draft European Legislation.IEC has already published definitions which include the cloud explosion risk and the risk from dust layers.The CENELEC approach is to consider the dust layer as a separate source of hazard.In the months ahead attempts are to be made to align the IEC and CENELEC definitions for zones to facilitate a common approach to area classification in all countries in the world.As mentioned earlier the Technical Committee of CENELEC is to decide whether to proceed with a CENELEC guide for area classification.

IEC is presently developing new documents for adopting methods of protection Ex 'p' and Ex 'i' in combustible dusts situations.A comprehensive document on maintenance for apparatus in dusts situations is proposed also.

Standards for combustible dusts situations

British Standards

BS 6467 : Electrical apparatus with protection by enclosure for use in the presence of combustible dusts.

Part1: 1985 Specification for apparatus

Part 2: 1988 Guide to selection,installation and maintenance

BS 7535 : 1992 : Electrical apparatus complying with BS 5501 or BS 6941 in the presence of combustible dusts

IEC Standards

IEC 61241-1-1 : Electrical apparatus for use in the presence of combustible dust -

Part 1 : Electrical apparatus protected by enclosure -

Section 1 : Specification of apparatus

Section 2 ; Selection,installation and maintenance

IEC 61241-2-1 : Electrical apparatus for use in the presence of combustible dust-

Part 2 ; Test methods -

Section 1 : Methods for determining the minimum ignition temperature of dust

IEC/TR 61241-2-2

Part 2 : Test methods -

Section 2 : Method for determining the electrical resistivity of dust in layers (Technical report)

IEC 61241-2-3 : Electrical apparatus for use in the presence of combustible dust -

Part 2 : Test methods -

Section 3 : Method of determining minimum ignition energy of dust/air mixtures

IEC 61241-3 : Classification of areas where combustible dusts are or may be present

DRAFT DOCUMENTS IN PROCESS

DRAFT IEC 61241-4 : Electrical apparatus for use in the presence of combustible dusts -Type of protection 'p'

DRAFT IEC 61241-5 : Intrinsically safe equipment in potentially explosive dust atmospheres

CENELEC Standards

Draft documents based on the IEC documents above :

prEN 50281-1-1 : Construction and testing

prEN 50281-1-2 : Selection,installation and maintenance

prEN 50281-2-1 : Methods of determining the minimum ignition temperatures of dust

The following document has been published :

BS EN 61241-2-2 : Method for determining electrical resistivity of dust in layers

CEN Standard

EN 1127-1: 1997 : Explosive atmospheres- Explosion prevention and protection

Part 1 : Basic concepts and methodology