Combustible Dusts

The Hazards Associated with Combustible Dust

The hazards associated with the storage and handling of combustible dusts are often overlooked in comparison to those associated with flammable liquids and vapours. Indeed the risks associated with flammable liquids and vapours are generally well understood and appropriate control systems are in place to prevent releases and their ignition. In comparison, although many are aware of the possibility of explosions occurring from combustible dust, the controls implemented are rarely adequate.

There have been a number of recent changes to the various Australian Standards in place for the Classification of Hazardous Areas and for the Selection, Installation, Inspection and Testing of equipment in these areas. These changes have been for standards relevant to hazardous areas involving flammable gases, liquids and vapours as well as for combustible dusts. In fact the issues associated with combustible dusts have now been separated out into separate standards from flammable liquids, gases and vapours. The changes made and the new standards introduced, have largely been to bring these standards into line with the international standards for hazardous areas, which will provide benefits particularly for suppliers of equipment, who will only have to comply with a single set of standards to sell equipment all over the world.

Combustible Dust Explosions

Any organic material in dust form will be considered a combustible dust. In a similar fashion to flammable gases and vapours, when combustible dusts are dispersed into the atmosphere and mix in the right proportions with the oxygen in air, they have the potential to explode if an ignition source is provided.

The dust explosion generally begins as a fast burning fire within a vessel causing an increase in temperature and pressure, which if not released can breach the vessel. Similarly, a smaller dust explosion occurring within a plant production area has the potential to cause enough disturbance to generate a larger quantity of dust in the atmosphere leading to a secondary more significant explosion.

Dust explosion events have been recorded in industrial facilities, particularly within the food industry, for over 200 years. Processes such as milling, grinding, drying or even conveyance and storage of combustible grains and powders have the possibility for dust to be released into the atmosphere and as a result have the potential to produce dust explosion events.

Your Responsibilities

Your responsibilities for hazardous areas are defined by the Australian/New Zealand Wiring Rules (AS/NZS 3000:2000), which defines that the occupier is responsible for classification of hazardous areas (Part 7.9.2.1)[1]. AS/NZS 3000:2000 also calls up other hazardous areas standards such as the AS2381 series, which define the selection, installation, inspection and testing of equipment in these areas. These standards state that the owner of the installation is responsible for adequate inspection and testing.

Each State and Territory in Australia has its own Electricity Act and Regulations, all of which invoke AS/NZS 3000:2000 as a mandatory requirement. As a result, the classification of hazardous areas, for both flammable gases, liquids and vapours as well as combustible dusts, along with the selection, installation, inspection and testing of equipment in these areas, is a legislative requirement for which all plant operators handling these hazardous substances are responsible.

Hazardous Area Classification

International standards have recently been updated to expand the zone classification system to account for combustible dusts. Zones 0,1 and 2 are now dedicated solely to the classification of hazardous areas for flammable liquids, gases and vapours and three new zones have been introduced for combustible dusts, being Zones 20, 21 and 22. The definitions for these zones are included in Table 1 below[2]:

Zones	An explosive atmosphere, in the form of a combustible dust in air, is present…..	ICI Definitions[3]	Examples
20	Continuously, for long periods or frequently for short periods	>1,000 hours/year	Within a hopper or a dust transport system
21	Occasionally in normal operation	>10 hours/year and <1,000 hours/year	At filling or emptying points with no dust extraction installed
22	Not likely in normal operation, but if it were to occur, only for a short duration	<10 hours/year	At maintenance access points or bag filter outlet points.

Table 1: Zone Classification

The definitions provided by ICI in Table 1 have been provided as a guide only. They should not be taken as definitive limits for zone classification.

[1] AS/NZS 3000:2000 Australian and New Zealand Wiring Rules

[2] AS/NZS 61241.10:2005 Electrical Apparatus for use in the presence of combustible dust, Part 10: Classification of areas where dusts are or may be present

[3] Baker, Colin; Explosion Protection Technology; Hazardous Area Simplified: Workshop Documentation; 2005.

The correct classification of a combustible dust hazardous area also requires additional information including:

- Zones (20, 21 or 22)
- Minimum Cloud Ignition Energy,
- Ignition temperature of a dust cloud,
- Ignition temperature of a dust layer,
- Explosion severity,
- Ignition sensitivity, and
- Any other specific location requirements (e.g. water, dust, vibration, corrosion, etc.)

The specific characteristics of a combustible dust must be determined by test. These characteristics include the minimum cloud ignition energy, the minimum cloud ignition temperature and the minimum layer ignition. Unfortunately there is not the level of data available for dusts that are available for flammable gases and vapours, but even so, the characteristics of a dust can vary depending on the size and finish of the particle, its temperature, moisture content and conductivity. As a result, two different flours may have different characteristics for example.

The Ignition Sensitivity and Explosion Severity measurements are relative measurements taken in comparison to Pittsburgh Coal Dusts. The explosion severity ranges and some typical figures for common dusts are included in Table 2 below:

Type of Explosion	*Ignition Sensitivity*	*Explosion Severity*
Weak	< 0.2	< 0.5
Moderate	0.2 – 1.0	0.5 – 1.0
Strong	1.0 – 5.0	1.0 – 2.0
Severe	> 5.0	> 2.0
Example Dusts		
Rice	0.5	0.5
Corn	2.3	3.0
Wheat	2.8	3.3

Table 2: Ignition Sensitivity and Explosion Severity[4]

[4] Comparative technical data, figures are indicative only. All samples require individual testing.

Types of Protection

One of the main reasons for adopting the international standards for hazardous area classification and the various equipment standards for use in hazardous areas was to come into line with accepted international standards for the equipment to be used in these areas.

The AS2381 series of standards was previously used for the selection, installation and maintenance of equipment within hazardous areas. These standards will largely be superseded by the adoption of the international standards, namely AS/NZS61241.14:2005 Selection and Installation – Combustible Dusts and AS/NZS61241.17 Inspection and Maintenance – Combustible Dusts. The international standards separate the flammable gases and vapour standards from the combustible dust standards, which provides more focus on combustible dusts compared to the previous standards which had a bias towards flammable gas and vapour hazardous areas.

The selection of equipment for hazardous areas containing combustible dusts is defined in Table 3[5].

Type of Dust	Zone 20	Zone 21	Zone 22
Non-Conductive	tD A20 tD B20 iaD maD	tD A20 or tD A21 tD B20 or tD B21 iaD or ibD maD or mdB pD	tD A20; tD A21 or tD A22 tD B 20; tD B21 or tD B22 iaD or ibD maD or mbD pD
Conductive	tD A20 tD B20 iaD maD	tD A20 or tD A21 tD B20 or tD B21 iaD or ibD maD or mdB pD	tD A20 or tD A21 or tD A22 IP6X tD B 20 or tD B21 iaD or ibD maD or mbD pD

Table 3: Apparatus Selection

There are a range of different types of equipment detailed within Table 3 above. These are normally prefixed by "Ex", as an indication of the suitability of this equipment for explosive areas. Such areas can also be signposted using the triangle "Ex" sign (refer picture included), indicating a potentially explosive atmosphere requiring special precautions and equipment.

Ex iD – Intrinsic Safety

The Ex iD equipment is one of the original designs of protective devices, which was originally developed following a coal mine explosion in Wales in 1913. Intrinsic Safety equipment has power and energy limiting systems installed in order to reduce the energy within the device to a level below that required for ignition, from either spark or thermal effects. Intrinsically safe apparatus are specified in AS/NZS 61241.11.

[5] AS/NZS 61241.14:2005 - Electrical apparatus for use in the presence of combustible dust. Part 14L Selection and installation (IEC 61241-14).

Ex tD – Dust Tight

Apparatus with the Ex tD markings are designed to exclude any dust from entering the device, which may contain potentially arcing or sparking elements. This equipment was formerly known as DIP or Dust Ignition Protection. Dust Tight apparatus are specified in AS/NZS 61241.1.

Dust Tight equipment is normally designed either for no dust layers being present (A) or for dust layers being present (B). Equipment is also designed for the zone classification. As a result, dust tight equipment can be one of six types:

- Ex tD A20;
- Ex tD B20;
- Ex tD A21;
- Ex tD B21;
- Ex tD A22; and
- Ex tD B22.

Equipment designed for a higher level of protection can be used in a less hazardous zone, i.e. Ex tD B20 equipment can be used in Zone 22, but Ex tD A22 cannot be used in Zone 20.

It should also be noted that equipment constructed and stamped as DIP standard has been recognised under the new standard to be equivalent to A21 equipment.

Ex mD – Encapsulation

Ex mD apparatus are less common than intrinsically safe or dust tight equipment. Encapsulated equipment operates by installing the potentially hazardous apparatus in a contained outer shell to prevent the combustible dust atmosphere coming into contact with the spark producing equipment. This equipment is specified in AS/NZS 61241.18.

Ex pD – Pressurisation

Ex pD apparatus is designed to provide a pressurised enclosure for the equipment which will resist the ingress of the potentially hazardous atmosphere. This equipment is specified in AS/NZS 61241.4.

Temperature

The selection of equipment should also take account of the expected ambient temperatures or surface temperatures for the hazardous area. Unless otherwise marked, electrical apparatus is designed for an ambient temperature range of -20˚C to 40˚C. If ambient conditions exceed this range then additional precautions could be taken to either reduce ambient temperatures or to source alternative apparatus designed for the conditions.

Surface temperature considerations are taken into account with the A and B used for dust tight equipment where dust layers may or may not be expected. Temperature limitations defined in AS61241.14 include:

- Dust Clouds: - Maximum surface temperature shall not exceed two thirds the minimum cloud ignition temperature;

- Dust Layers below 5mm in thickness: - Maximum surface temperature shall not exceed a value 75˚C less than the minimum dust layer ignition temperature; and
- Other rules are defined for thicker layers.

Other Equipment – Ex d, Ex e

There are a range of other designations of electrical apparatus for use in areas containing flammable liquids, gases or vapours, but these will not be suitable for areas containing combustible dust. The most common of these include Flameproof (Ex d) or Increased Safety (Ex e) apparatus.

IP Ratings

Ingress Protection (IP) Rating is an international classification system for electrical apparatus. This classification system defines the general level of protection available for the apparatus without defining the type of protection provided or the suitability for a particular application.

The first digit of an IP Rating is the important one when discussing combustible dusts as this digit refers to the level of protection against ingress by solid objects, i.e.:

- IP 5X – Dust protected;
- IP 6X – Dust Tight[6].

IP 5X or ^X rated equipment is quite common, provides a good level of protection and will continue to be used. However it is likely that we will also see the Ex classifications become more common as well.

Documentation

The updated standards have also defined the requirement for documentation to be developed for hazardous areas containing combustible dusts. This documentation includes (but is not limited to):

- Characteristics of the combustible dusts on hand including temperature, moisture content, conductivity, minimum cloud ignition energy, the minimum cloud ignition temperature and the minimum layer ignition, etc.
- Site plans detailing the zone classifications for the plant. AS61241.10:2005 defines the suggested area classification symbols to be used. Zone classifications are three dimensional and therefore both top and side views may be necessary.
- Details of the equipment installed in particular zones, including any equipment certification certificates.
- Details of any additional controls in place such as housekeeping schedules, dust extraction equipment, etc.

What to do now?

First you need to determine whether combustible dust is an issue for your site. Do you regularly handle organic grains, powders or dusts? Is it possible for them to be released into the atmosphere and become suspended in the air? If this is the

[6] Underwriters Laboratories Inc.; http://www.ul.com/hazloc/ref/ingress.htm.

case, further investigation may be warranted. RiskTech suggests the following course of action:

1. Training – maintenance staff should be trained in the hazards associated with combustible dusts and the selection, installation, inspection and testing of electrical equipment in these areas. Explosion Protection Technology provide simplified training courses (www.eptech.com.au) or competency based training courses are provided by institutions such as TAFE in NSW in order to achieve compliance with AS4761.1:2003 – Competencies for working with electrical equipment in hazardous areas.
2. Hazardous Area Zoning – An assessment should be conducted, either by trained staff or by external consultants, to define the hazardous areas of your site. These hazardous areas should be fully documented on detailed site plans and be made available particularly to maintenance staff and/or contractors working in these areas.
3. Dust Characteristics – unless the combustible dusts handled at your site have already been tested, they will need to be tested to ensure you are aware of the necessary information required for effective equipment selection. SIMTARS in Queensland are an example of a testing laboratory with these capabilities.
4. Equipment Assessment – once the hazardous areas for your site have been defined, assess every piece of equipment for its ignition potential, with a focus on electrical equipment. Where electrical equipment has Ex or similar markings note these for assessment against the relevant standards.
5. Corrective Action List – once all equipment is assessed, this will determine what areas require further attention. It should be noted that it may not be strictly necessary to install Ex rated equipment in all areas, it may be possible to change the zoning classifications. For example, the installation of a dust extraction system may reduce a zone from a 21 to a 22 classification.

As defined above, compliance with the provisions of these standards is a legislative requirement. The introduction of the updated standards has also allowed a period to comply, for example AS/NZS 61241.14 allows the use of flameproof apparatus in combustible dust areas under conditions until January 1, 2007. It is however important that you demonstrate a commitment to address this issue where combustible dusts are present in your facility.

Further Information

If you require further information about the risks associated with combustible dusts, or have some more specific questions in relation to the handling of combustible dusts at your site, then contact RiskTech.

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