Hazardous Zones

Take the heat out of safe conveying in hazardous zones

FLOVEYOR

'Simplicity in conveying
Integrity in everything'

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Floveyor Pty Ltd and its affiliates do not provide hazardous application or zoning advice. This material has been prepared for information purposes only. It is not intended to provide, and should not be relied on as specialist advice.

We strongly recommend that you seek professional advice from competent persons regarding the delineation of your specific hazardous zones, and the suitability of Floveyor's equipment within these zones.

Floveyor Pty Ltd
ABN 14 114 153 927

6 Alice St, Bayswater
Western Australia 6053

PO Box 116, Bayswater
Western Australia 6933

T +61 (0) 8 9378 3333
F +61 (0) 8 9378 3839

admin@floveyor.com
www.floveyor.com

Introduction

This paper discusses Floveyor's suitability for conveying powders and granules within three IEC classified hazardous zones (20, 21 and 22) relating to combustible dust risks.

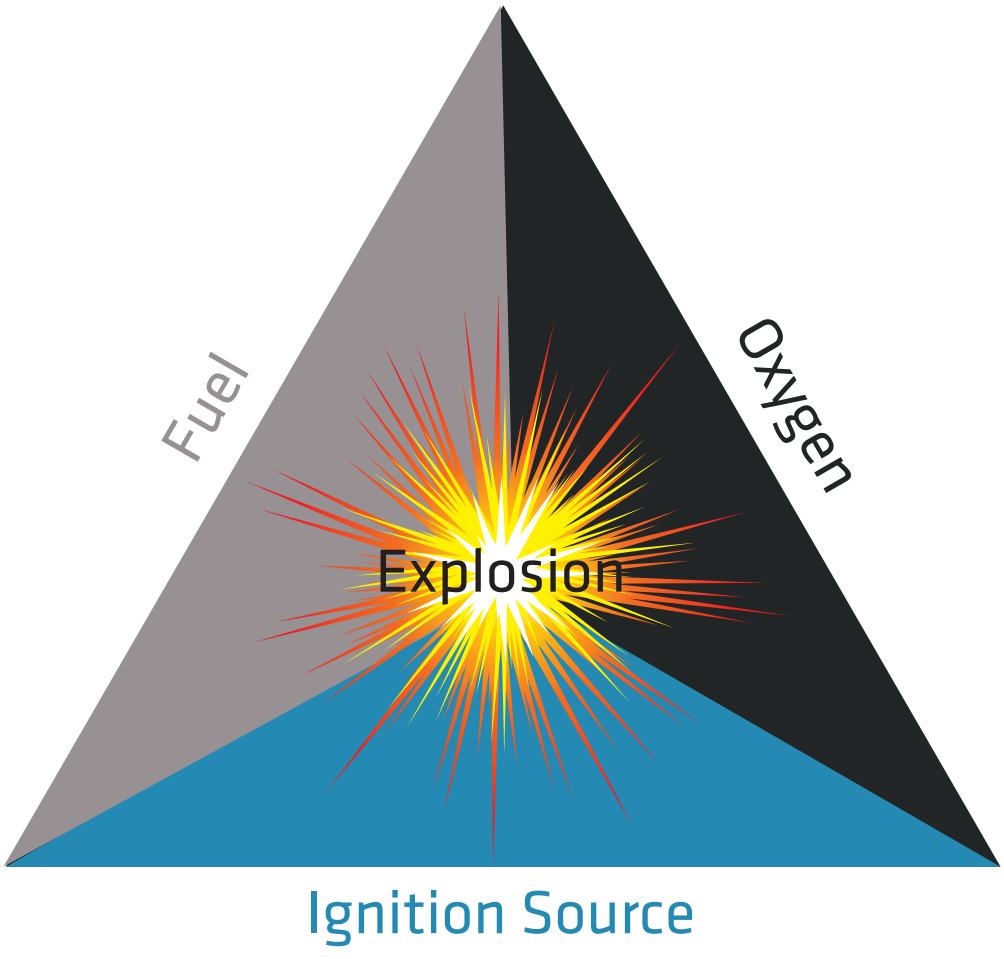
Many industrial powders have the potential to combust if the following environmental and operational conditions known collectively as the 'hazard triangle' are present:

- Appropriate concentration of fuel such as airborne combustible material or accumulated dust layers.
- Sufficient concentration of oxygen.
- Sufficiently energetic ignition source such as an open flame, electrically or mechanically generated spark or high temperature surface.

The Hazard Triangle

The hazard triangle illustrates the three basic conditions that must exist to create a fire or explosion.

Suppressing or separating one or more of these three conditions can avoid a fire or explosion.



This list of materials classified as producing 'combustible dust hazards' includes products as diverse as sugar, aluminium dust, coal, citric acid and wheat, but it is the concentration and density of the dust material when exposed to oxygen that determines the flammable range.

For example, a thick layer of fine dust may not be combustible because there is insufficient oxygen between the particles whereas larger particles that are loosely packed may burn. However, an airborne 'dense enough' cloud of the same fine dust may be combustible unless, it is 'too diluted' with air.

Furthermore, a primary combustion may disturb an accumulation of dust causing it to become airborne in a flammable concentration.

Complex chemistry needs expert analysis

Hazardous areas classification is best done by individuals or organisations who understand the chemistry of the particular hazard and the requisite safely levels of the process. This is an essential step in enabling companies to select and install the appropriate equipment. Hazard assessment can be performed by appropriately skilled company employees, or by experienced external contractors.

Global regulation for safer workplaces

International regulations to protect workers potentially at risk from explosive industrial atmospheres (hazardous zones) have been progressively refined since ATEX Directive 1999/92/E became part of European law. Other countries followed with their own regulations. However in 2007 the IEC introduced a system that is gaining worldwide acceptance.

ATEX is the European Union's regulatory framework governing the manufacture, installation and operation of equipment in explosive atmospheres. The framework contains a number of key directives covering the following areas of hazard management:

1. 2014/34/EU The 'Equipment Directive' covering the manufacture and sale of equipment and protective systems to be used in potentially hazardous atmospheres. (Replaced 94/9/EC on 20th April 2016)

2. 1999/92/EC The 'Use' Directive defining hazardous zones and describing the selection, installation inspection and maintenance of equipment

3. Risk assessment – employers must classify places where explosive atmospheres may arise and select appropriate work equipment for use in these areas

4. Equipment design manufacture and certification to mitigate explosion risk

5. Site inspections to verify process standards and housekeeping practices are aligned to specific hazardous zone requirements

IECEx is an international standards based regulatory framework for electrical equipment in hazardous environments. Many countries outside of EU are adopting it and its test reports are acceptable worldwide as a basis for local certification.

ATEX and IECEx - a comparison

ATEX and IECEx both describe safety requirements for equipment to be used in (potentially) hazardous areas. ATEX and IECEx are derived from the same standards so their technical content is broadly the same.

However the reach and application of each system varies as follows:

ATEX	IECEx
is only valid in the EU	has a global focus and increasingly adopted internationally
is intended to remove trade barriers between member states and improve safety to workers and equipment	facilitates international trade in Ex equipment for explosive atmospheres by eliminating the need for multiple national certifications
is law within EU states	is increasingly becoming adopted (as law) by countries outside EU
is required for all electrical and non-electrical equipment in hazardous environments	is only intended for electrical equipment in hazardous environments
does not specify mandatory compliance with the standards. Instead takes a risk-based approach to achieve the essential health and safety requirements in the EEA country it is assessed in	specifies mandatory compliance with international standards
holds the manufacturer responsible to ensure that the product meets the approved design. Manufacturer issues a certificate of conformity	assesses the design prior to issuing a public certificate and license to display IECEx community mark on products
notified bodies are appointed by government	certification body must pass peer assessment program and approved by the IECEx management committee
provides guiding information on general requirements and standards leaving more room for interpretation of the standards	requires equipment to meet the relevant standards leaving little room for interpretations
community mark 	community mark (cert number in box under 'Ex' 

What is an 'explosive atmosphere' and 'hazardous zone'?

An **'explosive atmosphere'** is a mixture of flammable gases, vapours, mists or dusts whose concentration in air is between the recognised lower and upper explosive limits under normal atmospheric conditions. After ignition has occurred, combustion spreads to the entire unburned mixture.

A **'hazardous zone'** is classified according to the **likelihood** and **frequency** that a potentially explosive atmosphere will exist with the risk of ignition.

NOTE: A Safety Data Sheet (SDS) should list an individual material's explosive potential but it is the responsibility of the plant owner to assess the risk that an explosion will occur.

Hazardous gas zones are defined in EN 60079.10 and designated by single digit zones, being Zone 0, Zone 1 and Zone 2. However this paper is not concerned with gases or vapours.

Hazardous dust zones are defined in EN 61241-10 and designated double digit zones being Zone 20, Zone 21, and Zone 22. This standard treats airborne dust clouds separately from combustible layers of dust and excludes materials that are inherently explosive without an oxygen atmosphere or in underground mining areas.

Flammable gas or vapour atmospheres	Combustible dust atmospheres
Zone 0	Zone 20
Zone 1	Zone 21
Zone 2	Zone 22

Zone 20 is defined as,

' a place in which an explosive atmosphere in the form of a **cloud of combustible dust which is present continuously, or for long periods or frequently.'**

These conditions generally arise in **dust containment areas within equipment**. These areas include:

- Hoppers, silos, cyclones, pipes and filters
- Blenders, mills, dryers, bagging and equipment
- Dust transport systems except some parts of belt and chain conveyor

NOTE: Zone 20 conditions can also arise outside of the active zones. This additional explosive risk often occurs when excessive dust accumulates on surfaces due to poor housekeeping practices.

Zone 21 is defined as

' a place in which an explosive atmosphere in the form of a cloud of combustible dust is ***likely to occur in normal operation occasionally***.'

These conditions generally arise at **points in the immediate processing vicinity** such as powder filling and emptying locations. Common Zone 21 areas include:

- access doors subject to frequent removal or opening for operation purposes when internal explosive dust/air mixtures are present
- filling and emptying points, feed belts, sampling points, truck dump stations, belt dump over points, etc. where no measures are taken to prevent explosive dust/air mixtures from forming
- areas where dust caused by process operations is likely to be disturbed and form explosive dust/air mixtures
- areas where infrequent, short lived dust clouds occur inside dust containers such as intermittently filled or emptied silos and filters subject to long intervals between cleans

Zone 22 is defined as,

'a place in which an explosive atmosphere in the form of a cloud of combustible dust is ***not likely to occur in normal operation, but if it does occur will persist for a short period only***.'

These conditions generally occur **where hazardous quantities of dust leak from equipment accidently** due to equipment malfunction or human error. For example, Zone 22 conditions can apply at:

- outlets from bag filter vents where a malfunction allows explosive dust/air mixtures to escape
- near infrequently opened equipment or equipment vulnerable to leaks caused by atmospheric pressure where dust can be blown out. These issues can arise with pneumatic equipment and equipment with easily damaged, flexible connections
- near storage areas for bags containing dusty product. Bags that fail during handling can cause significant dust leakage.

NOTE: Areas normally classified as Zone 21 can reduce to Zone 22 when companies take measures such as exhaust ventilation to prevent explosive dust/air mixtures from forming. We recommend using these measures near (bag) filling and emptying points, feed belts, sampling points, truck dump stations etc.

Areas can be classified as non-hazardous where good housekeeping systems remove the risk of explosive dusts forming ignitable clouds or layers. These systems must keep dust layers to negligible thickness irrespective of the grade of release.

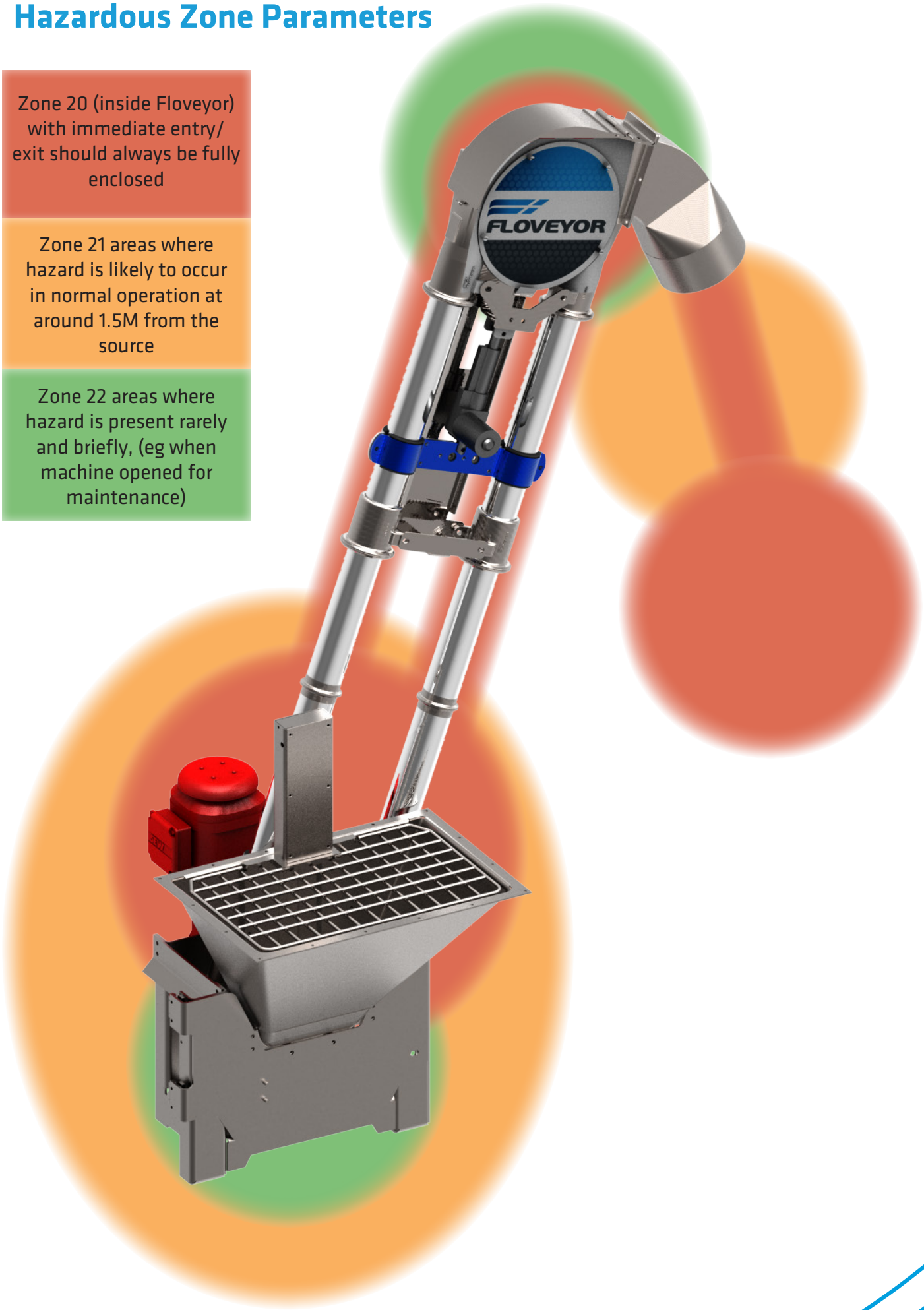
Regular inspections must verify that conditions remain safe. If these housekeeping systems fail, the fire or explosion risk can reach ignition conditions within one shift. Where this situation could occur, hazardous zones classifications apply and equipment must be selected accordingly.

Hazardous Zone Parameters

Zone 20 (inside Floveyor) with immediate entry/ exit should always be fully enclosed

Zone 21 areas where hazard is likely to occur in normal operation at around 1.5M from the source

Zone 22 areas where hazard is present rarely and briefly, (eg when machine opened for maintenance)

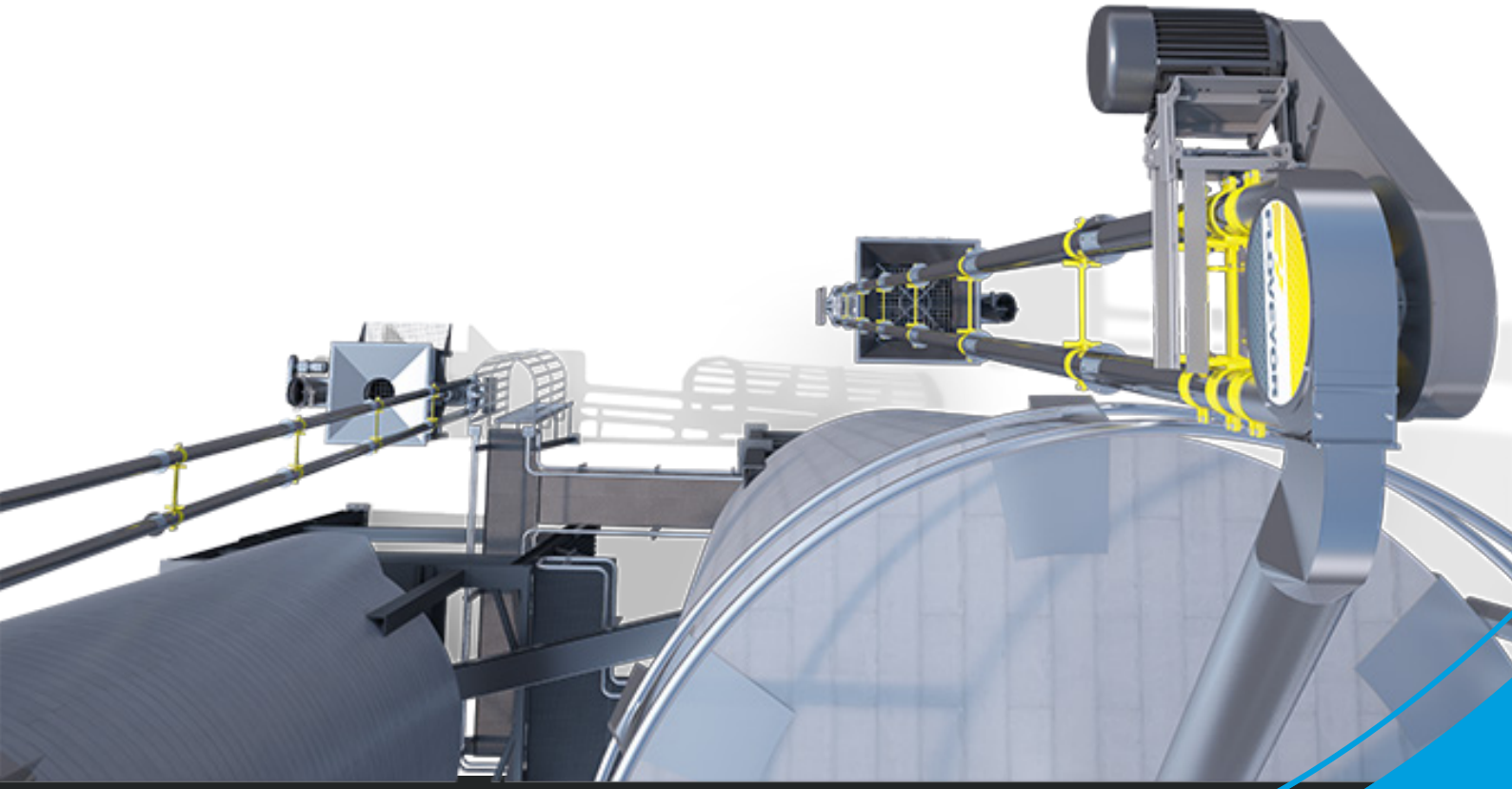


Working safely - employer responsibilities

ATEX Directive 2014/34/EU is the current regulation describing the technical and organisational actions required to protect workers.

It covers:

- assessing explosion risks to:
  - classify workspace into zones: Zones 0, 1 and 2 for gases and vapours and Zones 20, 21 and 22 for dusts
  - compile appropriate explosion protection document
- selecting equipment that complies with ATEX 2014/34/EU
- taking explosion protection measures
- organising for work to be performed safely by:
  - writing instructions and permits to work
  - training the workers
  - having a competent person verify the site before first time use
  - ensuring appropriate worker and process supervision
  - coordinating safety measures in shared workplaces
  - sign posting hazardous sites with an EX where necessary.



Three types of dust hazards

Accumulated dust layers may ignite in contact with a sufficiently high surface temperature. Although this is rare, it is a potential risk where hot surfaces and sparks are created by fault conditions or during hot work maintenance such as welding or grinding.

Disturbing these layers may also generate dust clouds. These clouds generally have much higher contact ignition temperatures than those generated by hot work or faults. However, energetic sparks can still cause these clouds to ignite.

So in essence the three types of dust related hazards are:

- primary and secondary explosions when a dust cloud spontaneously combusts
- fires caused by equipment heat flux igniting an accumulated dust layer or equipment faults linked to poor maintenance such as overheated bearing cases.
- explosions caused by dust clouds contacting any available hot surface or open flame which may result from hot work such as welding or grinding.

Installing appropriately designed and certified equipment combined with conscientious housekeeping mitigates these risks.

Managing dust risks

Risk mitigation is essential at every level of industrial processes that generate combustible dust. Plant design, operation and maintenance must reflect the importance of minimising and managing classified areas.

Reduce the inherent risks explosive dust/air mixtures pose by:

- eliminating the likelihood of explosive dust/air mixtures and combustible dust layers forming
- eliminating the likelihood of any ignition source

Where eliminating these risks is not possible, two options exist to promote a safe efficient operation that protects workers and avoids costly plant downtime. These are:

- organising operations to ensure that the above conditions don't arise simultaneously
- installing protective systems such as dust explosion venting to halt an incipient explosion immediately or to mitigate its effects

NOTE: The underpinning principles defining area classifications 20 – 22 are similar to those used for zones covering flammable gases and vapours. However, unlike flammable gases and vapours, ventilation or dilution after release will not necessarily remove combustible dusts. In time, even very dilute initially non-explosive dust clouds could form thick dust layers.

A simple, safe conveying solution for hazardous zones

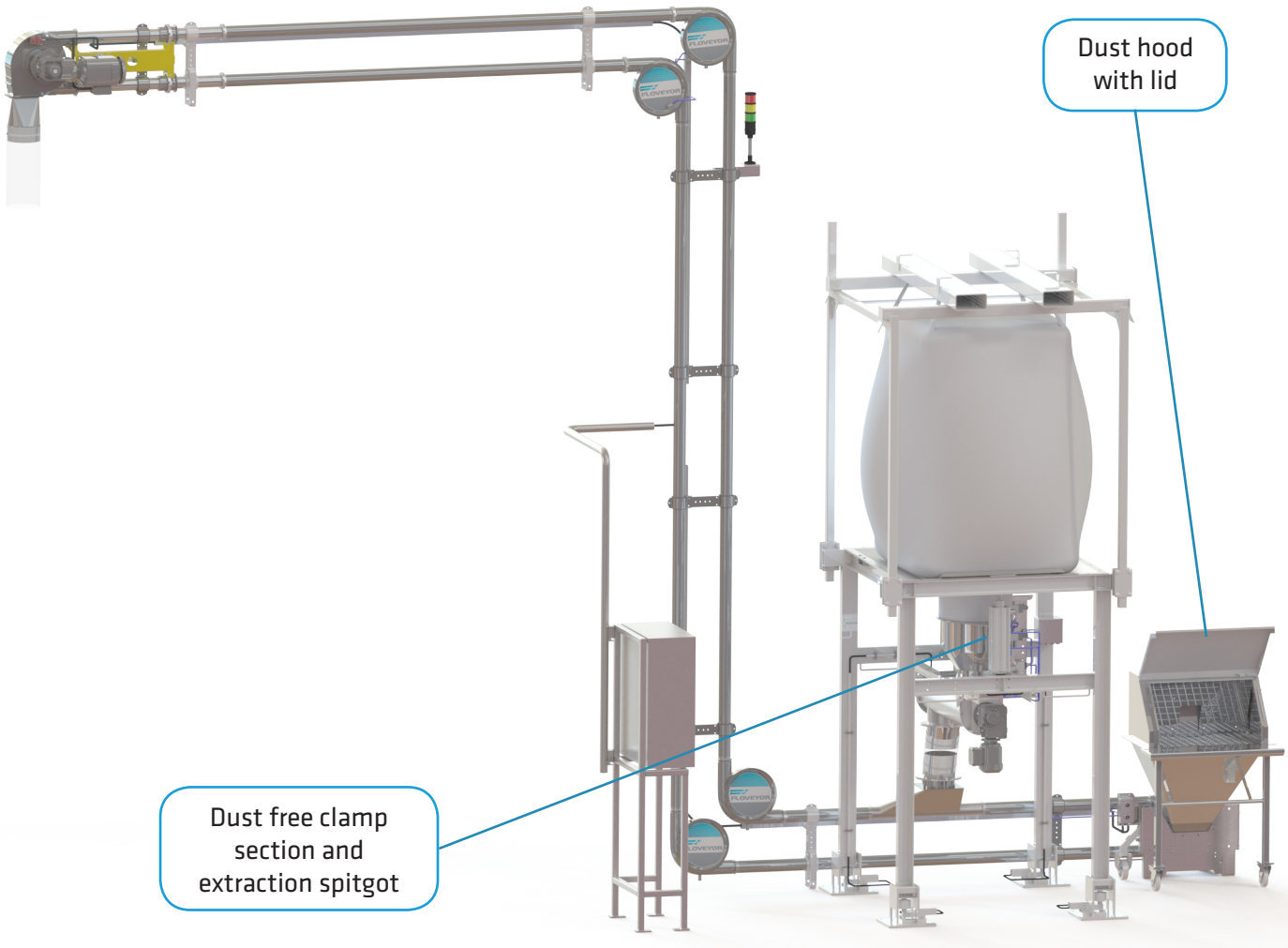
The aero-mechanical Floveyor is an ideal solution for conveying hazardous powdered and granular materials. As a fully enclosed, fluidising system it operates filter free. Floveyor's simple earthed, non-sparking, designed stainless steel product contact parts with ESD protection, eliminates many of the traditional components of alternative systems historically associated with explosion and fire risks.

Filter free conveying driven by rope assemblies using injection moulded polyurethane discs substantially reduces the risk of electrostatic charges from sparking via metal-to-metal contact. Free flowing fluidising technology prevents dangerous overheating caused by clogging and blockages.

All Floveyors' specified electrical components are IECEx / ATEX certified for the hazardous zones identified in your advice to us.

Dust free infeed

Once loaded, fully enclosed Floveyors protect the external environment from dust accumulation. This substantially reduces the workload of plant dust extractors. To further minimise dust risks our manual bag dump stations are fitted with dust hoods and hinged lids that connect directly to extraction systems. Our dust free bulk bag frames are fitted with extraction connection points and seals to contain dust at the discharge spout.



DUST CONTROL

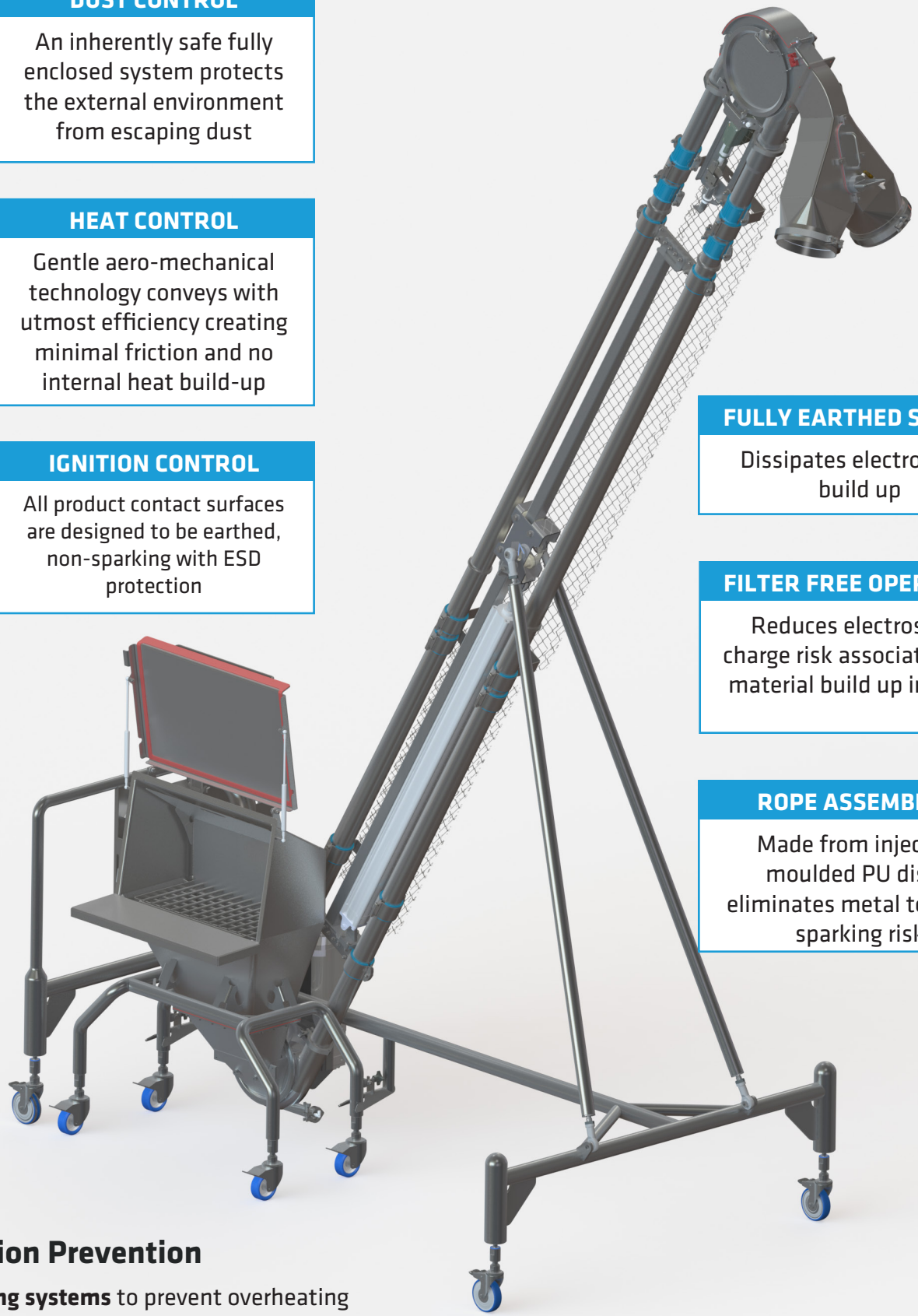
An inherently safe fully enclosed system protects the external environment from escaping dust

HEAT CONTROL

Gentle aero-mechanical technology conveys with utmost efficiency creating minimal friction and no internal heat build-up

IGNITION CONTROL

All product contact surfaces are designed to be earthed, non-sparking with ESD protection



FULLY EARTHED SYSTEM

Dissipates electrostatic build up

FILTER FREE OPERATION

Reduces electrostatic charge risk associated with material build up in filters

ROPE ASSEMBLIES

Made from injection moulded PU discs, eliminates metal to metal sparking risk

Explosion Prevention

Monitoring systems to prevent overheating

LOW SPEED MOTION SENSORS

on the idler shaft, register if the Floveyor changes more than 10% of standard operating speed, which might indicate a rope failure or blockage, instantly shutting off the machine

BEARING TEMPERATURE SENSORS

if there is a bearing failure the temperature sensor will register the increase in temperature and signal the control system to cut off the machine

CURRENT OVERLOAD

if the motor is overloaded the control system will cut power to ensure it doesn't overheat

A clear compliance process

ATEX and IECEx compliant Floveyors operate in countless industrial settings worldwide. Our commitment to 'simplicity in conveying and integrity in everything' extends to supporting you to achieve hazardous zone compliance.

Here is an overview of our process. It's designed to help you acquit your safe operating responsibilities with complete integrity and minimum hassle.

1. Floveyor can provide general recommendations based on our global experience in hazardous materials handling
2. You independently verify risks and calculate zoning with advice from specialist 3rd party advisors as appropriate.
3. Floveyor provides an IECEX / ATEX compliant equipment specification fit for your designated zone(s). This includes all third party electrical and drive parts.
4. Floveyor provides a technical file produced by an independent compliance specialist identifying the risks and detailing actions we have taken to mitigate them.
5. You apply for EX certification. Certificate is issued after installation and final inspection.

NOTE: Floveyor cannot apply for this certification on your behalf.

Good housekeeping practices

Scheduled cleaning and maintenance of dust containment areas are integral aspects of any production process. However housekeeping practices for the wider site environment can be more challenging to schedule and complete.

Dust deposit rates vary. Protective cleaning regimes need to reflect changing dust release patterns and match the most effective methods to the most appropriate schedule.

Failing to maintain optimal housekeeping contributes hugely to creating an explosive atmosphere. It also potentially threatens the integrity and suitability of equipment certified for safety in a hazardous area.

Three levels of housekeeping

QUALITY	DESCRIPTION	RISK
Good	Dust layers are non existent or negligible regardless of levels of release	Insignificant, as all hazardous dust layers and clouds have been removed
Fair	Dust layers are short lived (lasting less than one shift) and can be removed quickly to pre-empt or contain a fire	Significantly decreased depending on: • thermal stability of the dust surface • temperature of the equipment
Poor	Significant dust accumulates for more than one shift	Increased risk of layer and cloud based ignition

Establish an effective cleaning regime

Housekeeping works best as a prescribed and integrated element in overall workflow.

Effective operational instructions for working with flammable substances that include optimal cleaning arrangements will:

- specify cleaning frequency, extent and methods
- allocate responsibility for these tasks
- direct attention to elevated and less accessible surfaces that accumulate dust over time
- create specific work instructions for equipment leakages, breakages and other malfunctions that to remove release potentially hazardous volumes of dust quickly and completely
- consider using wet cleaning or extraction/ignition free vacuum methods with proven safety records
- avoid methods (like blowing or sweeping) that create suspended dust clouds
- describe how to dispose carefully of wet cleaning waste to avoid environmental contamination

Schedule periodic inspections

Link these inspections to managing your equipment's life cycle. This means knowing when any of the following factors need checking:

- susceptibility to corrosion from exposure to chemicals, solvents or water
- likelihood of dust or dirt build up
- mechanical damage indicated by undue undue vibration, excessive noise or elevated temperatures
- potential problems linked to external factors like changes in ambient temperature, unauthorised modifications or adjustments or operation by new or untrained personnel

Supplement scheduled inspections with occasional random checks to ensure your risk mitigation plan is operating effectively. Adjust your regular schedule or your inspection grades to deal with any issues these additional checks uncover.

Implement continual supervision

Train skilled existing personnel to detect and repair faults early as part of their routine work. Making continual supervision part of your company culture starts at installation and underpins every aspect of your operation from normal production/operation, to cleaning and maintenance work.

Successful continual supervision may eliminate the need for regular periodic inspections to ensure equipment integrity and provide a safe workplace.

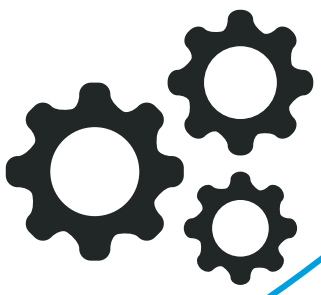
Changes in the minimum ignition energy (MIE) of your specified raw material may change the suitability of our equipment. We recommend seeking specialist advice when any of these changes arise.

Maintain equipment certification

Handle all repairs and replacements carefully. Protect the integrity of your equipment when an inspection report calls for remedial action by:

- consulting the manufacturer for detailed accurate information on solving the problem
- replacing worn or defective parts with genuine ones authorised by the manufacturer
- avoiding modifications that could invalidate the equipment's ATEX or IECEx certification

NOTE: Equipment certified according to the ATEX Directive has specific maintenance requirements that can include the need for special tools. This information is contained in the operating instructions supplied at purchase.



Conclusion

There are clear moral, legal and economic reasons why materials handling equipment for hazardous zones must adhere to the highest safety standards.

As aero-mechanical conveying inventors we have been producing inherently safe systems for over 60 years. Risk mitigation influences every aspect of Floveyor's design, manufacture, installation, operation and maintenance.

This paper illustrates Floveyor's distinctive capacity to operate safely and efficiently in hazardous areas. Its versatility, small size, low energy usage and competitive throughputs attract manufacturers in multiple sectors in over 50 countries.

As niche market specialists we focus entirely on fast, economical aero-mechanical conveying solutions for powders and granules. Our team has decades of global experience and local expertise in compliant handling of challenging materials in complex applications. This means you will receive complete, accurate design and installation advice and technical support and updates on demand.

While ultimate responsibility for workplace safety belongs to you, Floveyor will help you navigate the compliance process. You'll get reliable technical advice based on our thorough understanding of the risks and our track record in finding excellent solutions. We'll supply the most cost effective equipment and you can totally trust us to never over specify.

Install a Floveyor in your hazardous zone and you will be in good company: