Loss Prevention Standards – Asset Classes

# Milling and Grinding Operations

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**Milling and grinding activities can create significant fire and explosion hazards. Risks include overheating machinery, and dust generation.**

**This Loss Prevention Standard provides guidance to help businesses identify, and mitigate the risks associated with milling and grinding operations.**

# Milling and Grinding Operations

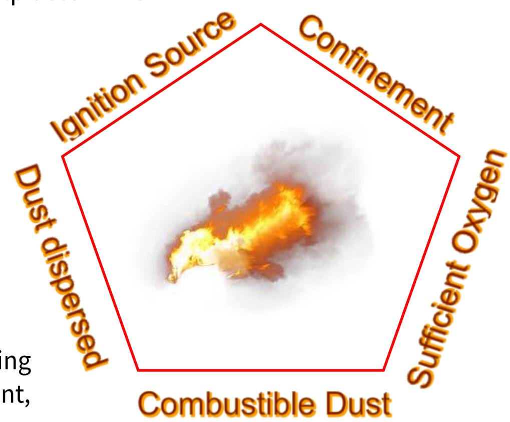
## Introduction

Milling and grinding of materials is a core function of many manufacturing businesses, and generally refers to the process of turning solid materials into smaller particles by some form of mechanical action. The work and energy required to turn such solid materials into fine powders can in certain circumstances create fire and explosion hazards. With careful process and plant design and operation, these risks can be managed and controlled, reducing the risks of damage to buildings, plant and impacts to business trading.

## Understanding the Hazards

### Combustible Dusts & Powders

Milling and grinding or a solid mass of a combustible material into powders can sometimes create a fire and explosion hazard. It is important to stress that not all powdered materials present these risks, and appropriate assessments and/or reference to safety data information can help determine whether the powdered materials can present a fire/explosion hazard.




Combustible powdered materials can catch fire in the presence of an ignition source and sufficient oxygen. Ignition sources can be externally introduced or in some cases result from self-heating.

For a dusty material to explode, certain additional conditions must be met. The dust itself must be combustible and a dust cloud present that is dispersed in such a way that there is sufficient oxygen present to support combustion. The dust cloud must also be confined in a way which supports the propagation of an explosion event. This can be within the mill itself, or within downstream processing equipment such as elevators, bag houses, silos, hoppers, dust filtration equipment, compartments etc.

Ignition sources can be externally introduced, e.g., a foreign object entering the milling equipment; overheating mechanical components within the mill; downstream processing equipment etc. but can also be caused by the self-heating of layers of powder that have built up within the confinement area, or heating caused by the mechanical work on the powdered materials. Self-heating risks are especially associated with natural products where microbial processes are also taking place within the resulting milled powders.

To manage the risks, it is first important to fully understand the properties of the powdered materials to fully understand the actual conditions required to cause a fire or explosion. Tests carried out by an accredited testing laboratory can determine the following properties of the materials:

**Layer Ignition Temperature (LIT**) – The lowest temperature at which a layer of dust of specific thickness, usually 5mm, ignites on a heated surface.

**Minimum Ignition Energy (MIE)** – The lowest amount energy that is just sufficient to ignite the most sensitive fuel-air mixture at atmospheric pressure and room temperature.

**Minimum Ignition temperature (MIT) -** The lowest temperature where a dust has explosible properties in air. It is very important to obtain data at the temperature that the powder will be exposed to in the plant.

**Minimum Explosive Concentration (MEC)** – The minimum concentration of a combustible dust suspended in air that will support a deflagration, such as an explosion or flash fire.

### Explosion Severity - Kst & Pmax

Since it is the pressure wave released during the explosion that causes the main structural damage, the severity of a dust explosion is determined by both the maximum pressure obtained and the speed at which the pressure wave travels. Accredited laboratories can measure this within specialist test equipment and dusts/ powders can be classified based on the severity of the dust explosion. The St or Kst value of the dust is used to describe the severity of the explosion according to the following scale:

| Dust Explosion Class | St or Kst Value (bar.m.s$^{-1}$) | Characteristics |
|---|---|---|
| **0** | 0 | Does not explode |
| **1** | <200 | Weak to moderate explosion |
| **2** | 200-300 | Strong explosion |
| **3** | >300 | Very strong explosion |

Understanding the maximum pressure obtained within the explosion will also help understand the Pmax, defined as the greatest amount of pressure and maximum amount of damage that the dust can cause in a confined space, and whether the plant will be able to withstand the maximum pressure, or fail under the increase in pressure.

### Secondary Dust Explosions

It is important to note the pressure released from a small initial or primary explosion can disturb accumulations of dust in the plant, particularly from upper surfaces such as rafters, roofs, suspended ceilings, ducts, crevices, dust collectors etc. Disturbing these accumulations can raise a second, and potentially much larger dust cloud, and the flames from the original explosion, or another ignition source in the area, can cause a violent "secondary dust explosion" typically resulting in very significant damage to the building and often putting workers lives in danger.

## Mill Types

There are numerous types and designs of milling equipment in use. Some of the more commonly found types of equipment are outlined below:

### Hammer Mills

Commonly used in various industries, these mills feature a number of swing hammers mounted on rotating shafts to impact raw material and pulverize it against an adjustable block. Typically, they require significant electrical power to provide sufficient energy for the impacts to break down solid materials into fine powder. Significant dust clouds are created within the equipment such that the only wholly reliable method of preventing fire/explosion where the dust is combustible is to avoid ignition sources.

### Ball Mills (Tumbling Mills), Pebble & Rod Mills

Ball mills comprise a rotating horizontal cylinder with steel or alloy balls inside. As the cylinder rotates the material is crushed by the impact and grinding action of the balls. The materials being worked can overheat, particularly if the deposits are thick enough, and the residence time in the mill extended. Rod mills are very similar to ball mills, except they use long rods for grinding media. Quartz or silica rock pebbles are used in pebble mills and this approach is selected where product contamination by iron from steel balls must be avoided.

### Roller Mills

Roller mills use cylindrical rollers, either in opposing pairs or against flat plates, to crush or grind various materials, such as grain, ore, gravel, plastic, and others. Low speed roller mills (circumferential speed of around 1 $ms^{-1}$ or less) are usually not an ignition hazard if frictional heating and tramp metal can be avoided. Higher speed mills can create heating on the materials being worked and are more hazardous if foreign objects are introduced.

### Autogenous Mills

Autogenous/autogenic mills feature a rotating drum which throws chunks of material against its walls as it rotates, causing impact breakage and compressive grinding to finer particles. They are sometimes referred to as self-grinding mills. Again, heating of the materials during the process can present a key hazard.

### Jet Mills

A jet mill uses a high-speed jet of compressed air or inert gas to impact particles against each other with the impacts reducing particle size. They can be used to create very fine particle sizes.

### VSI mill (Vertical Shaft Impactor Mill)

VSI mills are typically used to create very fine powders by feeding the raw materials onto a high-speed rotating shaft which throws them outwards towards the mill's outer walls. A stream of air or inert gas is used to separate out suitable particles carrying them into downstream plant whilst larger particles are collected by the mill equipment and generally recirculated.

### Millstones

A traditional mill where the substance is ground between two stones. A turning runner stone grinds against a stationary bed stone creating the "scissoring" or grinding action of the stones.

### Downstream Plant

Powders are often pneumatically or mechanically conveyed or transported into downstream plant including classifiers, driers, hoppers or silos, dust filtration equipment or even packing lines. These plant items provide a potential pathway for explosion propagation. They can also provide the ignition source for the combustible dust cloud.

## Good Process / Plant Design

Good process/plant design is the first consideration when planning ways to reduce dust explosion risks. Factors to consider include:

### Minimising mechanical work on the materials

Here the selection of the type of mill and its power is a key factor. Minimising the mechanical work on the material will help reduce the creation of dust clouds. Lower energy impacts or work on the materials can also reduce the amount and rate of heating of the materials. Over-specified plant with high power ratings can inadvertently compound the fire/explosion hazard but milling plant needs to be sufficiently powered to ensure blockages are minimised, which can lead to frictional heating. Overworking a material can also cause it to degrade and be detrimental to process quality. A good understanding of the variance in the quality of raw material feeds can help in the selection of suitably rated plant.

### Plant sizing

Sizing milling plant to reduce dead space / head space can minimise the size of any combustible dust cloud that forms within it and the size of any explosion that could occur. Oversized mills can also mean that more product is lost during any incident or breakdown event. It is sensible to optimise plant design to reduce both explosion risk and the financial impacts of any breakdowns.

### Excluding Oxygen

'Inerting' the milling equipment using gases such as nitrogen can ensure that explosive atmospheres do not form within the milling equipment and there is insufficient oxygen for powder layers to combust. The costs of such an approach can be a factor especially where classification of particle sizes requires a flow/stream of gas but even in such circumstances the use of this technique can allow safe milling of materials with more hazardous properties such as low minimum ignition energies or layer ignition temperatures. This method is not suitable for the milling of materials classed as "oxidisers" under the Classification, Labelling and Packing Regulations (CLP).

### Residence times

Reducing the amount of time, the powder remains in the milling equipment can reduce the likelihood of self-heating or accumulating heat within layers of ground powder accumulating within the milling plant. Plant design should minimise the areas where powder can accumulate and remain resident for extended periods (e.g., until the plant is cleaned). Building and plant design should eliminate dead spots, ledges, corners, or other areas where dust can accumulate. Always avoid long horizontal runs of ductwork which attract uninterrupted dust build up. To reduce risks of accumulation, vibrating devices or knocking hammers can sometimes be used on chamber walls.

### Containment

Process and plant design should wherever possible minimise the escape of product/dusts, which can settle and accumulate within workrooms. This is especially important in the prevention of secondary explosion events.

### Ventilation

Where there are risks of fugitive dust emissions from the process plant, ventilation should be provided to reduce the risks of dust accumulations. Ventilation ducts and their supports should be of non-combustible construction where combustible dusts are processed, or if combustible lubricants are used within the mill. It can be helpful to install environmental monitoring to detect and alert operators of any escape of dusts from process plant, or at least to conduct frequent visual checks.

### Process Risk Assessment & Upstream/Downstream Hazards

The risks of a fire/ explosion event being caused by or affecting upstream/downstream plant needs careful consideration. It is important the whole plant and not just the mill is subject to a suitable process risk assessment. Helpful techniques for such an exercise include Hazard and Operability (HAZOP) study, fault tree analysis, Hazard Analysis (HAZAN) and Layers of Protection Analysis (LOPA).

## DSEAR Assessment & Electrical Equipment in Hazardous Areas

If there is a risk of explosion, it is a legal requirement to carry out a risk assessment as described within the Dangerous Substances and Explosive Atmospheres Regulations 2002. This should identify any "Hazardous Areas" of the plant where explosive atmospheres may be present, classifying them as either Zone 20, 21 or 22 depending on the frequency upon which an explosive atmosphere maybe present. This assessment should be completed by a competent person and any "hazardous areas" should be clearly identified and signed. Any electrical equipment installed in these areas should be suitably designed and marked as being suitable for use in the appropriate Zoned Area. Consideration should be given to motors, control panels, lighting, and other ancillary plant in the process area. Equipment manufactured prior to 2002 may not be marked as being suitable for use in a hazardous area. In such cases, evaluation of its suitability should be made to ensure such equipment cannot present a source of ignition if exposed to a combustible dust cloud.

The equipment should be designed so that dust cannot accumulate within it and be suitable for the method of cleaning/washdown to be employed. Equipment with an IP rating of IP 66 or better will be "dust tight" and protected against powerful jets of water.

## Lubricants and Combustible Liquids

For some milling processes (e.g., rolling mills), lubricants are added to the milling chamber. These are typically combustible oil-based lubricants, and their use can add to the fire load within the milling equipment, and possibly into ventilation ducting. Whilst the milling chamber is likely to be able to resist any thermal stresses caused by combustion, this may not be the case for ventilation ducting which may also provide a pathway for fire spread. If lubricants are used then maintenance programmes should assess levels of deposition within the mill chamber, ducts and on surrounding walls and surfaces, ensuring cleaning and removal as necessary. Inventories of lubricant should not be stored in the same room as the milling equipment as far as is practicable, with reservoirs supplying the equipment being the only permitted inventory within the process area.

## Mill Control Equipment

It is good practice to locate mill drive motors, electrical equipment, and control equipment in separate, well-ventilated rooms or areas that are cut off from the mill and supplies of lubricants as far as is practicable. These areas should benefit from automatic fire detection and sufficient ventilation to prevent this equipment overheating. Safety critical or production critical control cabinets, cable runs, or other control equipment should be protected by fixed fire protection systems also.

## Plant Redundancy

Milling equipment does require regular and sometimes frequent maintenance. Therefore, if process continuity is required, or to ensure a degree of resilience in process design, it can be helpful to ensure there is redundancy in the design of milling plant. Having standby equipment that can be utilised whilst the milling is being maintained or is requiring repair can be an effective approach. The same logic and rationale also apply to any ancillary equipment. This could be having resilience in the power supply to the milling equipment but also to any equipment that maybe required to assure safety, such as ventilation systems.

## Managing Ignition Sources

Often the creation of a combustible/explosive atmosphere within a mill is unavoidable and the basis of safety for the process relies heavily on the management of ignition sources. Amongst the most important ignition sources for consideration are:

### Foreign Bodies

Typically entering via the raw material feedstock for the mill it is vitally important that foreign bodies which cause blockage, create additional heating, or generate sparks are screened and removed from the raw materials feeds entering the mill. Screening, de-stoning, pneumatic separation and magnets are used to remove foreign bodies.

### Mechanical Friction

Hazards can arise within upstream/downstream plant with bearings, motors, or gearing overheating. Such issues can arise through poor specification of plant causing overloading, contamination and through inadequate maintenance. It is important that vulnerable plant items are identified in plant risk assessment studies, are specified correctly, or protected against contamination and their condition is routinely monitored. Modern sensors (vibration, temperature, or current draw) can be installed to provide early warning of developing issues and interlocked to isolate safely.

### Hot Surfaces

All equipment, such as motor surfaces, pumps, compressors, light fittings etc., that have hot surfaces and are exposed to dust should be appropriately rated. This rating is based on the results of the 5mm layer ignition and the minimum ignition temperature tests as described briefly earlier.


These risks should be assessed and can be easily verified using a thermal imaging camera. If dust can accumulate on these surfaces, it is prudent to select and install equipment whose external surfaces cannot reach the products Layer Ignition Temperature. The “T” Class of equipment which is marked on some equipment can help you determine if the equipment is suitable (see below).

| T Class | Maximum Surface Temperature (°C) |
|---|---|
| T1 | 450 |
| T2 | 300 |
| T3 | 200 |
| T4 | 135 |
| T5 | 100 |
| T6 | 85 |

### Electrical Equipment

Where DSEAR or ATEX risk assessments identify hazardous areas where an explosive atmosphere can foreseeably be present, it is important electrical fittings within those areas are suitably specified and marked as suitable for use in such areas. This also applies to portable appliances such as vacuum cleaners which may be used in housekeeping and cleaning activities. This equipment should be routinely inspected and checked to ensure it remains in good condition and will continue to afford the correct protection.

## Static Electricity & Lightning

Milling processes can generate significant quantities of electrostatic charge on the powders themselves, but also on any plant items that have become isolated from earth. Static can be a concern where the generated powders have a low Minimum Ignition Energy. Providing a means for charge on the powder to 'relax' can help and such approaches can include increasing relative humidity, use of earthing rods where powders settle/accumulate or by doping formed powders with a conductive additive. Ensuring the process plant is well earthed during processing is a critical control measure and the use of "Smart" grounding systems are recommended. These systems should be inspected and checked regularly as part of planned preventative maintenance programmes. Continuity of earth throughout the entire installation should be confirmed during these checks. Such protections should be installed and maintained in accordance with **BS 7430:2011+A1:2015 Code of Practice for Protective Earthing of Electrical Installations.**

The mill building, milling plant, and external silos and walkways should feature lightning protection systems installed and maintained in accordance with **BS EN 62305 - Protection Against Lightning.**

## Self-heating or Heated Powders

The milling process itself can cause heat to accumulate in the powders created. Also accumulating layers of some types of powder, can in specific circumstances self-heat. These risks should be identified and understood during any materials testing. Changes to process conditions or raw material feeds can also alter the characteristics of the powders created. Charring of powders can be a warning sign of an impending problem, and plant operators should be trained to watch and look out for signs of heating in the milled products. Where identified this must be investigated and the need for process/plant change considered to prevent a future fire/explosion incident.

## Hot Works

Fires can occur during plant repairs and maintenance where hot works is undertaken. Typically, it is accumulated powder deposits on or within the plant which ignite particularly during welding, cutting, or grinding operations. Hot works on and around process plant can be especially hazardous and should always be closely managed in accordance with Aviva's Hot Work Operations Loss Prevention Standard.

# Fire & Explosion Protection

Where fire and explosion risks are foreseeable, plant should be designed and or protected to safeguard plant operatives, and to minimise damage and business interruption in any fire/explosion event. It is important the protection strategy encompasses the whole plant, and not just the mill itself. Effective plant protection strategies often include:

## Explosion resistant plant

Many mills are engineered to contain a dust explosion incident without sustaining significant structural damage. However, upstream/downstream equipment including ducts, elevators and dust collection plant may not be. The potential for the propagation of both flame and pressure from the explosion requires careful consideration and these items of plant suitably protected, e.g., via explosion relief. Where silos feature within the plant, it is important they are designed to withstand any overpressure they may receive from an explosion within the mill or be able to relieve the pressure without structural deformation.

## Automatic Fire Detection

In some milling plant temperature probes, or carbon monoxide detection can be installed to provide early warning of combustion or fire within the plant. In addition, mill buildings should be protected by suitable means of automatic fire detection conforming to **BS 5839-1:2017 - Fire detection and fire alarm systems for buildings - Code of practice for design, installation, commissioning, and maintenance of systems in non-domestic premises**. The operation of the plant should be interlocked to all automatic fire detection, ensuring equipment isolates safely, and the supply of combustible materials into the building and equipment is stopped along with any dedicated oxygen/air supplies.

## Explosion Relief

Should an explosion occur, the pressure within the milling plant will increase dramatically and a fireball could develop. It is important to either contain these hazards or safely relieve them to an appropriate location. With knowledge of the **Kst** & **Pmax** values an appropriate approach can be determined.

Strategically positioned explosion relief systems are commonly used to direct both the pressure wave and fireball to a safe location before structural damage to the plant is caused.

A competent engineer should determine the type and number of explosion relief vents required and their appropriate location, however they are typically located on elevators/conveyors; ducting; dust filtration equipment (cyclones & bag filters) and silos.

The explosion relief mechanism should relieve the pressure wave and fireball to a safe location that will not endanger life or cause further property damage. The best options are to relieve the explosion to an external location, e.g., via explosion venting wall panels or a lightweight section of roofing, and by the shortest and most direct route possible. This is not always possible and the use of long, convoluted ducting to direct the explosion outside can create a further hazard and may be more prone to failing in an explosion event. As such, ducting runs should be straight and as short as possible. Circular ducts generally have greater strength and are commonly used for this purpose. Explosion relief hatches should be designed so they do not become projectiles and are retained in some way. The direction in which the explosion relief faces is also important and should not be directed onto:

- Means of escape or areas where pedestrians congregate.
- Glazing.
- Combustible cored composited insulation panels.
- Asbestos containing materials.
- Any other critical item of plant.
- Air intakes for ventilation systems

Where explosion relief vents relieve internally, they should be fitted with flame arrestors. If retrofitted, the impact of these flame arrestors on the ability to relieve the maximum explosion pressure should be re-evaluated.

It is essential that explosion relief systems are included within systems for planned preventative maintenance. This should include regular inspections and checks for obstructions.

## Fire / Explosion Suppression and Avoiding Explosion Propagation

Where there is a credible risk of a spark entering the milling equipment, e.g., via a foreign body, a spark detection and extinguishing system should be installed. Proprietary systems using dry chemical, steam or high-pressure hot water may be suitable depending on the mill type. All such protections should be interlocked to the power supply and be designed, installed, commissioned, and maintained to a recognised standard such as **FM3265: Examination Standard for Spark Detection and Extinguishing Systems, NFPA 69: Standard on Explosion Prevention Systems, VdS Standard for planning and installation of spark extinguishing systems** etc.

Any system installed should be designed, installed, and commissioned by third party approved contractors who have demonstrated their competence and are certificated to work in accordance with LPCB Loss Prevention Standard **LPS 1204: Issue 3.2 Requirements for Firms Engaged in the Design, Installation, Commissioning and Servicing of Gas Extinguishing & Condensed Aerosol Systems**.

If the milling plant is physically connected to other downstream processing or storage areas via pneumatic conveying through pipework, the use of rotary valves within these piped connections can arrest the travel of any flame through the pipe. This reduces the risks of fire spreading to the connected process/storage areas.

## Automatic Fire Protection Systems

It is recommended the building housing the milling plant is protected by an automatic sprinkler system designed and installed to **BS EN 12845:2015+A1:2019 Fixed Firefighting Systems. Automatic Sprinkler Systems. Design, Installation and Maintenance.** If combustible lubricants are used inside the milling equipment, or if there is an assessed risk of a fire starting within combustible materials located in the mill, it may be beneficial to protect the mill chamber with an automatic deluge system designed, installed, commissioned, and maintained in accordance with a recognised standard such as **NFPA15: Standard for Water Spray Fixed Systems for Fire Protection**. Gaseous fire protection systems can also be effective in some applications provided designed, installed, commissioned, and maintained in accordance with a recognised standard such as **NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems.**

The operation of the mill should be interlocked to the automatic fire protection systems, ensuring the process equipment is brought to a safe condition and any supply of combustible materials, and dedicated oxygen/air supplies are isolated.

## Alarms

Alarms associated from the above should raise a site fire alarm to ensure there is an appropriate emergency response and escalation if needed. If not already in place, the alarm should be monitored at a constantly attended location or an approved Alarm Receiving Centre. An accredited fire alarm installer can provide further guidance and assistance.

## Emergency Shutdown and Response

In the event of an incident, an emergency shutdown device for the mill should be provided in a safe location that is accessible to personnel and the Fire and Rescue Service. This shutdown should isolate the mill safely condition and cease the supply of any combustible materials, and dedicated oxygen/air supplies into the mill. This should be clearly labelled. Shutdown devices and interlocks should be tested at least annually. An emergency response plan should also be produced specifically developed to outline key responsibilities and actions in an emergency fire/explosion event. This should be formally documented, and appropriate training provided.

### Fire and Rescue Service

Liaison with the local Fire and Rescue Service and discussions around site activities, processes, storage etc. should be considered. Such disclosure can aid the Fire and Rescue Service with deployment of firefighting resources and allow for any pre-emptive planning in respect of contaminated run off containment to be undertaken.

Local Fire and Rescue Services are often amenable to inspecting premises to evaluate fire risk exposures and offer guidance.

it is also important to maintain suitable access for the Fire and Rescue Services and consider the distances and location to the nearest source of fire water or hydrant that they may need use. The location and number of fire hydrants in the proximity of the premises should be documented in an emergency response plan or shown on appropriate drawings.

It is also good risk management practice to know what water supplies are available for the Fire and Rescue Service to use. Therefore, site management should always establish:

- What fire water is available.
- With static pressure, flows and residual pressure test results.
- Whether additional resources, such as a private hydrant system or water storage tanks are necessary.

## Management Programmes

### Maintenance Programmes

All milling plant and ancillary equipment should be subject to planned preventative maintenance in accordance with OEM recommendations. Regular visual inspection of the condition of equipment and checks for hot surfaces using a thermal imaging camera can also confirm equipment remains safe to use.

A particular hazard associated with milling equipment is the deterioration and thinning of the mill shell wall, caused by mechanical wear. This can degrade the structural strength of the materials of construction and lead to a deterioration of the mill's ability to withstand any high-pressure events such as an explosion. For this reason, maintenance may need to include non-destructive testing methods to assess mill shell wall thickness and integrity.

Similarly high levels of mechanical wear of moving components within the mill is a common problem. An assessment of the extent of wear of the components should be included within maintenance regimes and manufacturers / designers' guidance should be sought on maximum acceptable levels of wear.

High levels of vibration may also weaken mill stands over a period of time and it is important these are not overlooked within maintenance programmes. It may be prudent to also include mill stands in programmes for non-destructive testing.

Where maintenance is to be completed on a mill which may still contain an explosive atmosphere, safety procedures such as 'Lockout Tagout' must be deployed to ensure the safety of the maintenance operative during such tasks. A further consideration is the need to use non-sparking tools for any maintenance tasks within the hazardous areas identified within the DSEAR Risk Assessment and Hazardous Area Classification.

If contractors are engaged to conduct repairs and maintenance, it is essential to check they fully understand the risks presented and have developed and trained their staff on a suitable safe system of work that you are able to ensure is correctly applied using an appropriate "permit to work".

### Cleaning & Housekeeping

Frequent cleaning of the plant and process areas is essential to reduce risks of a secondary dust explosion. The build-up of dusts on horizontal surfaces around the factory should not be tolerated. If dust is accumulating this is likely the result of a leak from the process equipment. This should be investigated, and further leakage prevented. Cleaning schedules should cover the entire plant area and include high level areas on a frequent basis. Regular housekeeping inspections/audits are strongly encouraged.

Fixed vacuum cleaning equipment, appropriately EX rated for the application, should be installed throughout the plant to enable regular and efficient cleaning.

### Dealing with blockages

It is important that process conditions are continually monitored by process staff. Blockages can occur and if powder begins to accumulate within the plant, can increase the risks of fire/explosion. Procedures should be developed to deal with any accumulations that occur, and this may require the plant to be safely shut down to permit clearance. Procedures for clearing the blockage following shut down should take account of the potential risks from the hot powder and should not unnecessarily disturb or blow the powder onto hot surfaces within and outside of the plant.

### Operator Training Programmes

All operators should understand the hazards and why the risk control measures are needed. This “Hazard Education” should be a formal and assessed part of the operator training. As a minimum it is recommended this training programmes includes:

- Hazards of milling and creating combustible dusts.
- Safe start-up/shut down procedures.
- Plant operation procedures.
- Training to detect process or plant conditions that may indicate a problem with milling processes.
- Plant firefighting systems and explosion protection/mitigation.
- Plant alarms and alarm management procedures.
- Plant emergency procedures.
- Plant cleaning procedures.
- Essential inspections, maintenance, and checks.
- Hazard/Near Miss reporting.
- Management of change procedures.

## Business Continuity

Every business should have a formal Business Continuity Plan in place. This should be reviewed to ensure disaster recovery and continuity arrangements remain adequate. Any actions generated should be addressed promptly.

## Checklist

A generic Milling Checklist is available which can be tailored to your own organisation.

## Specialist Partner Solutions

Aviva Risk Management Solutions can offer access to a wide range of risk management products and services at preferential rates via our network of Specialist Partners, including:

- Fire risk assessment: Cardinus Risk Management.
- Explosion/DSEAR Risk Assessments: Bureau Veritas.
- Fire stopping, fire resistant enclosures, fire barriers and passive protection: Checkmate Fire
- Thermographic imaging and PAT testing: PASS
- Automatic fire detection and portable extinguishers: SECOM
- Business continuity: Horizonscan

For more information please visit: Aviva Risk Management Solutions – Specialist Partners

## Sources and Useful Links

- The Dangerous Substances and Explosive Atmospheres Regulations 2002.
- The Regulatory Reform (Fire Safety) Order 2005.
- The Fire Safety (Scotland) Regulations 2006.
- The Fire (Scotland) Act 2005.
- The Fire and Rescue Services (Northern Ireland) Order 2006.
- BS EN 62305 - Protection against lightning.
- BS 7430:2011+A1:2015 Code of Practice for protective Earthing of Electrical Installations.
- BS 5839-1:2017 - Fire detection and fire alarm systems for buildings - Code of practice for design, installation, commissioning, and maintenance of systems in non-domestic premises.
- LPS 1204 : Issue 3.2 Requirements for Firms Engaged in the Design, Installation, Commissioning and Servicing of Gas Extinguishing & Condensed Aerosol Systems.
- BS EN 12845:2015+A1:2019 Fixed Firefighting Systems. Automatic Sprinkler Systems. Design, Installation and Maintenance.
- NFPA 69: Standard on Explosion Prevention Systems.
- FM3265: Spark Detection and Extinguishing Systems.
- VdS 2106en : 2021-04 (05)Spark Detection, Spark Separation and Spark Extinguishing Systems, Planning and Installation.
- NFPA 15: Standard for Water Spray Fixed Systems for Fire Protection.
- NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems.
- British Standard BS5306 – Fire Extinguishing Installations and Equipment on Premises.
- RiscAuthority document RC12: Recommendations for the Prevention and Control of dust Explosions.
- RiscAuthority document RC28: Recommendations for spark detection and suppression systems on pneumatic conveying installations.
- NFPA 652: Standard on the Fundamentals of Combustible Dust.
- NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities.

- IChemE Guide 'Dust explosion prevention and protection: A practical guide' (2002).
- BS EN14491 'Dust Explosion Venting Protective Systems'.

**Note:** Whilst UK standards and legislation are referenced in this document, other international standards and legislation should be referenced where applicable.

## Additional Information

Relevant Aviva Loss Prevention Standards include:

- Control and Management of Combustible Waste Materials.
- Fire Safety Inspections.
- Property and Business Impact Risk Assessment.
- Hot Work Operations.
- Managing Change - Property.
- Thermographic Surveys.
- Managing Contractors.
- Business Continuity.

To find out more, please visit Aviva Risk Management Solutions **or speak to one of our advisors.**

**Email us at riskadvice@aviva.com or call 0345 366 6666.***

*The cost of calls to 03 prefixed numbers are charged at national call rates (charges may vary dependent on your network provider) and are usually included in inclusive minute plans from landlines and mobiles. For our joint protection telephone calls may be recorded and/or monitored.

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