# EXPLOSION PROTECTION

# IGNITION ASSESSMENT METHODOLOGY

# NON-ELECTRICAL EQUIPMENT

## Prepared for nabim

## BY

## HSD SAFETY LTD

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Prepared for; nabim, 21 Arlington St, St. James's, London, SW1A 1RN

Author: C.M Lynch mike.lynch@hsd-safety.co.uk

Reviewed by: M. J. Halliday

In case of query or comment, please contact the Author.

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HSD Safety Ltd
Loss Prevention Consultants

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## EXECUTIVE SUMMARY.

HSD Safety Ltd. (HSD) have prepared a methodology, based on appropriate European Standards, for ignition risk assessment of non-electrical (mechanical) equipment typically used in flour milling. The methodology outlines how to undertake and document the assessments and highlights how differing variations of equipment types can interact with the assessment.

The structure and layout of this report is explained below;

- Section 1 provides the background explaining why this report has been produced and lists the example equipment assessed. It also lists and justifies a number of assumptions that have been made, lists the limitations of the report, provides a glossary of terms relating to ignition risk assessment. The overall workflow for carrying out retrospective ignition risk assessment of equipment in an existing facility is also illustrated.
- Section 2 explains the methodology used and references relevant published standards and guidance. Topics covered include; equipment description, material properties, identification of ignition hazards, ignition risk estimation / risk evaluation, equipment verification, published standards / guidance, equipment documentation and competence.
- Section 3 contains summary ignition assessments for example equipment types in Zone 22 area e.g. category 3D equivalent. The detailed example ignition assessments relating to these are recorded in Appendix A.
- Section 4 contains summary ignition assessments for example equipment types in Zone 20 or 21 areas e.g. category 1D or 2D equivalent. The detailed example ignition assessments relating to these are recorded in Appendix B.
- Section 5 illustrates how a modular approach can sometimes be taken where there are similar types of equipment, but which may have variations in how their component parts / elements are configured.

Further guidance is provided in the following Appendices;

Appendix C. Guidance; Preventive Maintenance and Inspection
Appendix D. Guidance; Earthing – Ignition Prevention
Appendix E. Bucket Elevator Explosion Prevention and Protection
Appendix F. Example; Generic Assessment Verification Checklist

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## APPENDICES

## 1.0 BACKGROUND

Much industry employs mechanical equipment pre-dating DSEAR and to continue using it necessitates a demonstration that potential ignition sources associated with the equipment are identified and effectively controlled and maintained by clearly defined methods, including preventive maintenance and inspection.

HSD Safety Ltd. (HSD) has prepared a methodology, based on appropriate European Standards, for ignition risk assessment of non-electrical (mechanical) equipment typically used in flour milling. The methodology outlines how to undertake and document the assessments and highlights how differing variations of equipment types can interact with the assessment.

A range of example assessments have been prepared to illustrate the methodology and how variations of equipment types can influence an assessment. Illustrative examples include;

- Drag link (chain) Conveyors
- Screw Conveyors
- Belt & bucket elevators, belt driven
- Roller Mills
- Bran Finishers
- Supporting assessments for a range of component elements, including; gearboxes, belt drives, chain drives, simple couplings and a mill feeder

An assembly assessment has also been included; this illustrates how a modular approach can be taken using individual assessments, then carrying out an assembly assessment to ensure that the assembly does not cause additional ignition sources or increase the likelihood of ignition sources identified in the individual assessments.

The aim is to allow nabim members to review their own equipment; the document is not a carte blanche to ‘cut and paste’ but a clear starting point with examples for members to understand and follow.

### 1.1 Assumptions

The following assumptions have been made in this report;

| | Assumption | Justification for assumption |
|---|---|---|
| 1.1.1 | The equipment descriptions in the Ignition Assessment Summary Tables in Sections 3,4 and 5 accurately describe the equipment, components elements and their configuration, and materials of construction, particularly for internal components and parts | Detailed manuals and design details were not readily available to cover every item of equipment or variation in configuration. The descriptions have been based on typical equipment observed by HSD in flour milling facilities |
| 1.1.2 | Hazardous area zone requirements in the Ignition Assessment Summary Tables in Sections 3, 4 and 5 are appropriate. | They are based on typical hazardous area zones observed by HSD in flour milling facilities |
| 1.1.3 | Maximum surface temperature, in the Ignition Assessment Summary Tables in Sections 3, 4 and 5 are appropriate. | They are based on material properties taken from “The Explosibility of Flour, Gluten and Wheat Dust”. First edition January 2004, published by nabim |
| 1.1.4 | It is assumed that equipment described has many years of maintenance and inspection based on manufacturer’s instructions, with no significant history of serious failures and no signs of obsolescence. | This is based on the assumption that arrangements are in place for the safe use of work equipment in accordance with the Provision and Use of Work Equipment Regulations (PUWER). |

**Recommendations;**

- Before an illustrative example is used as the starting basis for a nabim member to carry out an ignition risk assessment; confirm equipment descriptions in the Ignition Assessment Summary Tables in Sections 3, 4 and 5 accurately describe the equipment, component parts/elements and materials of construction, speed and other key operating conditions for the equipment that is to be assessed.

## 1.2 Limitations

The report and assessments have limitations as indicated below;

**Limitation**

1.2.1 The standard of planned inspection / maintenance regimes and associated maintenance and commissioning (re-commissioning) procedures and checklists can vary significantly between organisations and sites. These can have a major influence on the likelihood of ignition sources and therefore the suitability of equipment. Assumptions have been made as described above or in the individual assessments.

1.2.2 The standard of documentation of maintenance and inspection records and breakdown history can vary significantly between organisations and sites. A significant history of failures and / or signs of obsolescence are warnings that ignition sources may not be effectively controlled. Assumptions have been made as described above or in the individual assessments.

**Limitation**

1.2.3 Site earthing standards and standards of earth monitoring / testing to control electrostatic ignition sources can vary significantly between organisations and sites. Guidance has been presented in Appendix D to allow nabim members to review earthing and implement appropriate recommendations where earthing or monitoring fails to meet the required standard. Where equipment inspection identifies any earthing inadequacies specific recommendations should be made within the relevant ignition assessments.

1.2.4 Training / competence records relating to explosion hazards and equipment in hazardous areas can vary significantly between organisations and sites. Guidance has been presented in Appendix C relating to information, instructions and training, including competence requirements for key roles, to allow nabim members to carry out a training needs analysis and develop a plan to address any deficiencies.

## 1.3 Glossary of Terms

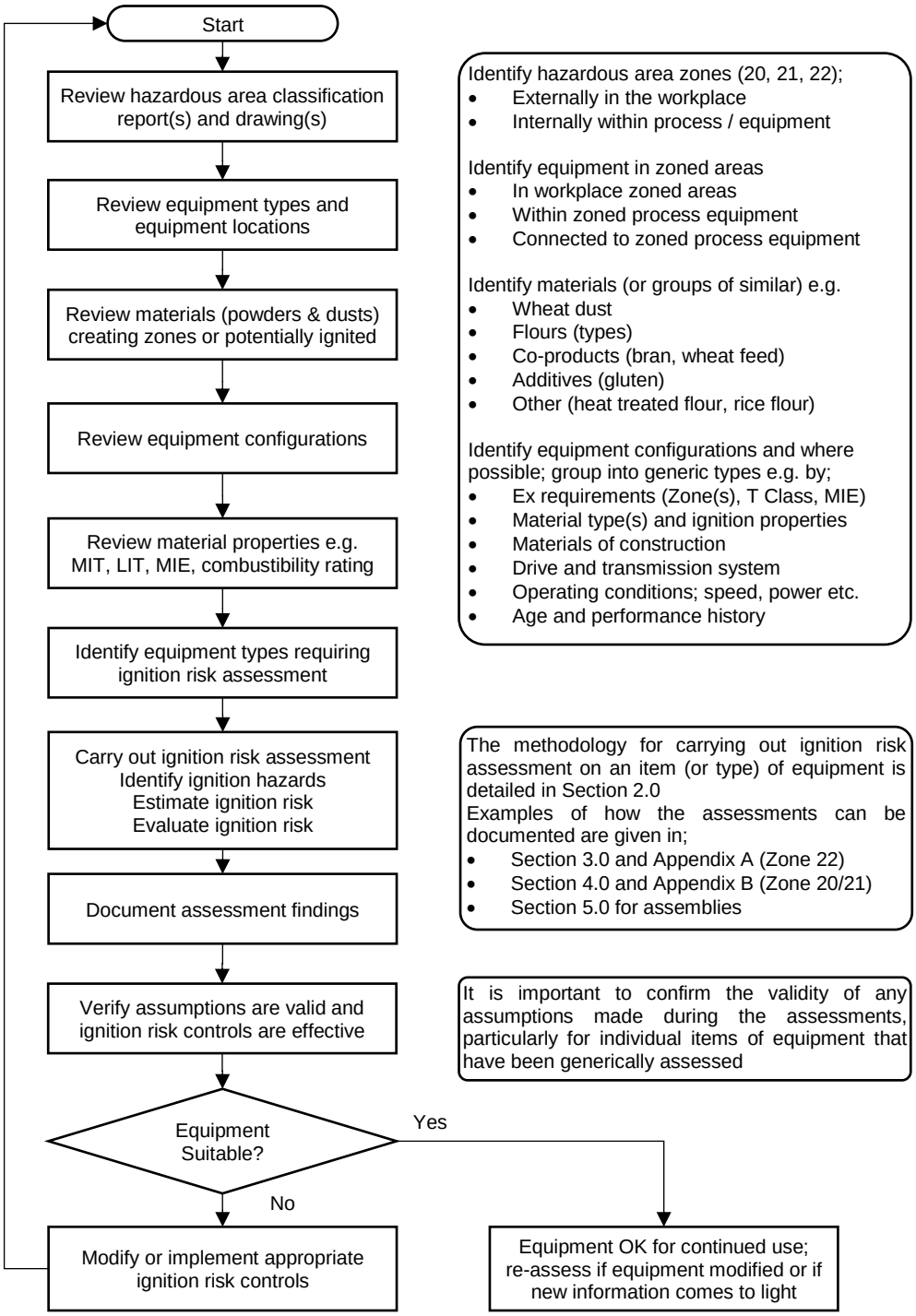
For the purpose of ignition risk assessment, the following terms and definitions apply;

| Term | Definition / Meaning |
|---|---|
| Ignition risk | Probability of occurrence of an ignition source that is capable of igniting an explosive atmosphere |
| Ignition hazard | Occurrence of a potential ignition source that is capable of igniting an explosive atmosphere |
| Potential ignition source | Equipment related ignition source that has the capability to ignite an explosive atmosphere (i.e. to become an effective ignition source) |
| Protective measure | Means used to reduce the probability of an ignition source to become effective |
| Ignition risk estimation | Determination of the probability of the occurrence of an ignition source |
| Ignition risk evaluation | Procedure to determine whether the intended level of protection (related to the equipment category) has been achieved |
| MIT | Minimum (dust cloud) ignition temperature; measure of the minimum temperature of a hot surface required to ignite an explosive dust atmosphere. It is used to assess the risk of ignition of a dust cloud by hot surfaces and to specify maximum surface temperatures. |
| LIT | Layer ignition temperature; a measure of the minimum temperature of a hot surface required to ignite a layer of dust of a known thickness (typically measured at a 5mm layer depth). It is used to assess the risk of ignition of a dust layer by hot surfaces and to specify maximum surface temperatures. |
| MIE | Minimum ignition energy; a measure of the minimum capacitive electrostatic discharge required to ignite an explosive atmosphere. It is used to assess the risk of electrostatic ignition and to specify electrostatic ignition controls |

## 1.4 Workflow; Retrospective Ignition Risk Assessment

The process used to carry out retrospective ignition risk assessment of equipment in an existing facility is complex and the standards used focus on carrying out assessment of individual items (or types) of equipment. The overall workflow required for carrying out ignition risk assessments on a typical flour mill is illustrated below

**Figure 1.1 — Workflow; Retrospective Ignition Risk Assessment**



## 2.0 METHODOLOGY

The overall approach is based on standards intended to be used for the design of new equipment. However, the approach can also be used to retrospectively assess existing equipment. There is a hierarchy of harmonised European standards;

- **Type A**; which describes the general principles and sets out the overall philosophy for explosion prevention and protection
- **Type B1;** which describes general safety aspects and provide solutions for non-electrical equipment for use in potentially explosive atmospheres
- **Type B2**; which relate to specific types of ignition protection or explosion protection methods
- **Type C;** which relate to specific types of equipment and describe significant hazards, specific risks and measures for reducing these risks

In addition, there are a number of guidance documents e.g. Technical Reports which are published to support the standards. The main standards and guidance used or referenced in this report are listed below and discussed further in Section 2.7;

| Reference | Title and Notes / Comments |
|---|---|
| EN 1127-1:2011 | Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology. |
| EN 15198:2007 | Methodology for the risk assessment of non-electrical equipment and components for intended use in potentially explosive atmospheres. |
| EN ISO 80079-36:2016 | Explosive atmospheres. Non-electrical equipment for explosive atmospheres. Basic method and requirements. |
| CEN/TR 16829:2016 | Fire and explosion prevention and protection for bucket elevators.<br>BSI Published Document (PD CEN/TR 16829:2016) |
| CLC/TR 60079-32-1:2015 | Explosive atmospheres Part 32-1: Electrostatic hazards, guidance.<br>BSI Published Document (PD CLC/TR 60079-32-1:2015) |

Ignition risk assessment forms the basis for the decision whether equipment is suitable for use in the required hazardous area zone. The following four steps, based on EN 15198 should be followed:

- Equipment description: performance, lifetime, configuration
- Identification of ignition hazards
- Ignition risk estimation
- Ignition risk evaluation

Before starting the assessment process, it is important to note the following points;

- The boundary or limit of the equipment and/or components must be defined. This should be relatively straightforward for typical items of equipment in a flour mill, as each has a defined purpose and place in the overall mill process.
- The ignition risk assessment should focus on the equipment and/or components and should not be extended to other types of ignition sources for which the equipment user is responsible. This can be difficult when a user is

retrospectively assessing their own equipment. It is important to make sure that the user's explosion risk assessment is valid and up to date and to understand that the ignition risk assessment(s) support the explosion risk assessment by verifying and validating that equipment has suitable ignition protection.

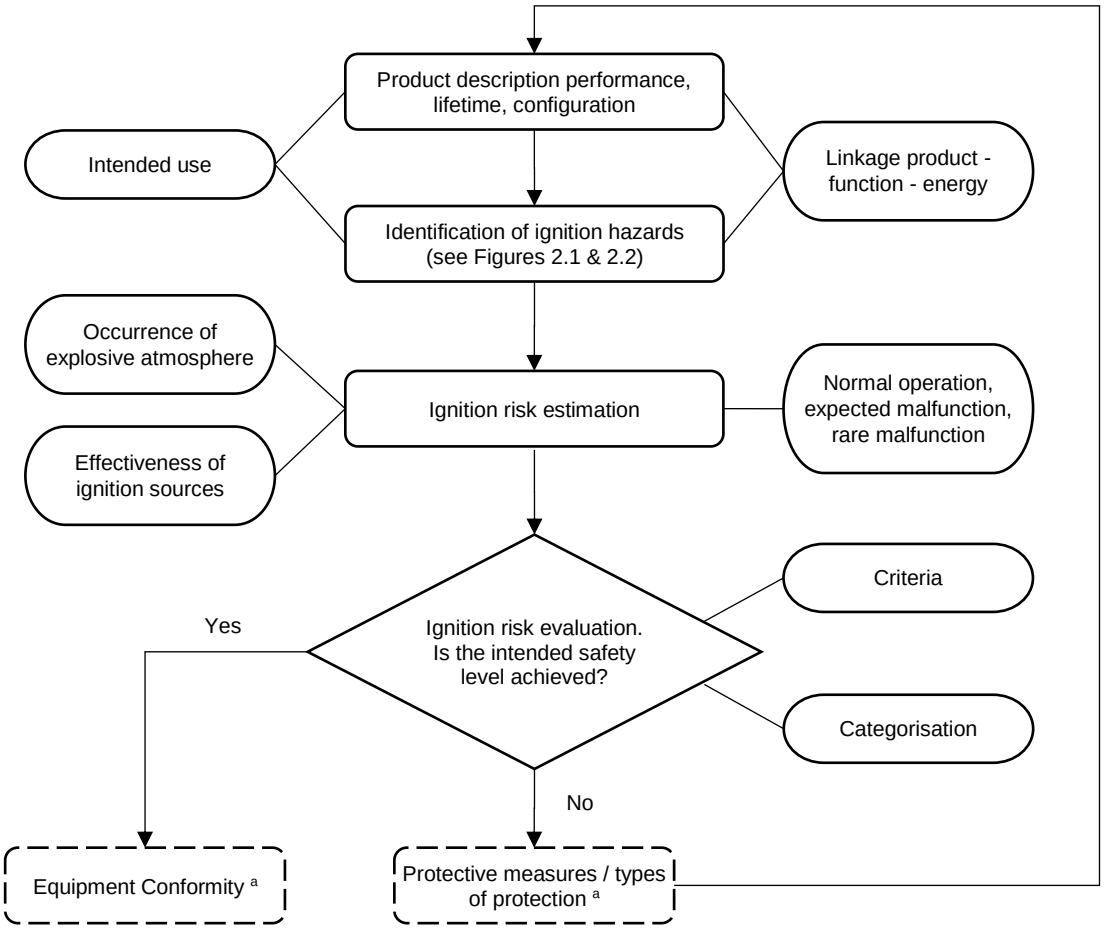
- The ignition risk assessment should take into account intended use, including start-up and shutdown, and reasonably anticipated misuse.
- The following information is needed for ignition risk assessment. However, it should be noted that for retrospective assessment some of the information may not be documented to the standard or level of detail that would be available for the design of new equipment.
    - Intended use; for a flour mill this will be ATEX Group II, with category (or equipment protection level) based on the zone in which the equipment is located and / or which it is connected to (see Section 2.5)
    - Initial appraisal of the equipment or component; for retrospective assessment, the user will normally have established the overall suitability of the equipment as it is likely to have been in use for many years with no significant history of ignition events.
    - Materials to be processed; see detailed discussion in Section 2.2, it is important to understand that some items of equipment may have restrictions placed on their duty that are based on the properties of the materials processed.
    - Requirements for maintenance including cleaning; for CE marked machinery and equipment, the Original Equipment Manufacturer (OEM) Manual for installation, operation and maintenance will form a good starting point as the requirements for maintenance and cleaning will be defined.
    - Design drawings; the use of design drawings enables a clear and logical approach to be followed when identifying potential ignition sources, where these are not available photographs taken during an equipment strip-down and re-assembly are useful.
    - Results of design calculations; these are unlikely to be available to the user and some calculations may need to be carried out e.g. estimation of rotational tip speed to estimate potential impact speed which is used to assess the likelihood of mechanical impact sparks
    - Comparison with OEM Manuals for newer ATEX certified versions of similar equipment makes, models, types can also be a useful source of information. Comparison may help identify additional design features or additional maintenance / inspection requirements.
    - Accident / incident history; knowledge of the history of fires or smouldering material, explosions and significant breakdowns or failures should be gathered. This can be done for groups of similar types of equipment as it is unlikely that equipment or component parts are so

unique that similar types of equipment cannot be found. Shared industry knowledge is particularly useful as it widens the knowledge and understanding of a single user.

- It is also important to be clear about what assumptions have been made when carrying out an assessment. These should be considered carefully and documented as part of the assessment to allow their validity to be checked at a later date.

The principal steps for the ignition risk assessment procedure are shown in Figure 1. It is comprised of four steps taking into consideration the assessment criteria in the oval blocks. To guarantee the intended level of protection, maintenance and installation requirements also need to be considered.

**Figure 2.1 — Ignition risk assessment for design of equipment or component**
*Based on Figure 1 – EN 15198;2007*




[a] Protective measures / types of protection and equipment conformity are not part of ignition risk assessment

For ease and clarity, the example assessments have been documented in two stages

- **Initial Assessment & Summary**; which includes the equipment description and identification of potential ignition sources requiring further assessment. These have been documented in Sections 3 and 4 along with a summary of the key findings and recommendation from the detailed assessments. Section 5 illustrates how assessment of previously assessed components can be documented.
- **Detailed Assessment**; which records the detailed identification of ignition hazards, ignition risk estimation and ignition risk evaluation. These are recorded in Appendices A and B, using the example reporting scheme from EN 15198.

## 2.1 Equipment Description

To ensure clarity about what equipment has been assessed and in what configuration, it is important to clearly describe the equipment in sufficient detail. The following should be summarised as part of the assessments;

- Life cycles of equipment and / or components
- Limits in terms of use, time and space
- Accurate definition of the function
- Materials for construction
- Performance, lifetime and configuration
- Description of the type of substances processed and process conditions

## 2.2 Material Properties

Before identifying ignition hazards, the ignition properties of the relevant materials need to be considered to enable effective ignition sources to be identified. The key dust properties relating to ignition assessment are;

- Minimum (dust cloud) ignition temperature (MIT)
- 5mm layer ignition temperature (LIT)
- Minimum ignition energy (MIE)

Note; explosion indices ($K_{st}$ and $P_{max}$) relate to the violence of an explosion and are relevant to the design of explosion protection (mitigation) systems.

Flour mills can handle a range of materials, however data for the most common materials that lead to classified hazardous areas is summarised below; care must be taken when carrying out ignition risk assessment for other materials such as heat-treated flour and rice flour, where flammability properties may give risk to different ignition hazards.

| Powder | nabim data | | | Generic data | | |
|---|---|---|---|---|---|---|
| | MIE mJ | MIT °C | LIT °C | MIE mJ | MIT °C | LIT °C |
| Wheat dust | > 300 | 470 | --- | > 100 | 420 - 480 | --- |
| Screen room dust | > 300 | 450 | --- | --- | --- | --- |
| White bread making flour | > 1000 | 430 | > 450 | --- | --- | --- |
| Wholemeal flour | > 1000 | 430 | --- | --- | --- | --- |
| Biscuit flour | > 1000 | --- | --- | --- | --- | --- |
| Wheatfeed | > 1000 | 470 | > 450 | --- | --- | --- |
| Gluten | 30 - 100 | 470 | --- | 10 - 50 | 480 | --- |

**Data sources;**
- nabim "The Explosibility of Flour, Gluten and Wheat Dust" First edition January 2004
- Generic data, taken from the following sources;
  - IFA Institute for Occupational Safety and Health of the German Social Accident Insurance GESTIS-DUST-EX database
  - Supplier SDS; data extracted from a range of SDS from Gluten suppliers

For the illustrative ignition assessments in this report, a safety margin has been applied and the following values have been used to determine the maximum surface temperature of equipment;

- Minimum (dust cloud) ignition temperature (MIT) ≥ 400°C;
- 5mm layer ignition temperature (LIT) ≥ 300°C

The maximum surface temperature of equipment should not exceed ⅔ x MIT (260°C) or LIT - 75°C (225°C), whichever is lowest. This equates to a temperature class of T3 (maximum surface temperature 200°C).

For the illustrative ignition assessments, a minimum ignition energy (MIE) of 30 mJ has been used to determine the ignition controls relating to ignition by static electricity discharges. The generic data indicating 10 – 50mJ for gluten is of unknown source and may relate to particularly fine grades of gluten.

The likelihood of ignition of a dust cloud by a hot (smouldering) nest of material is low if the nest burns only by smouldering. Ignition depends crucially on the production of either flame or incandescent particles and if flaming does take place then the risk of an ignition is very high.

Data published by nabim "The Explosibility of Flour, Gluten and Wheat Dust" First edition January 2004, indicates that wheat flour has a combustion rating of 1 e.g. it does not catch fire under the test and fire does not spread. Wheat flour does not produce flames or incandescent particles and it is therefore concluded that the likelihood of ignition of a dust cloud caused by smouldering flour is very low. Similarly, combined with a relatively high MIT and a very high MIE, it is also assumed that wheat dust clouds are not particularly sensitive to ignition caused my mechanical impact sparks.

## 2.3 Identification of ignition hazards

Equipment items and / or components should be assessed in the configuration(s) described according to Section 2.1. This is carried out by considering the material properties and the probability and amount of explosive atmosphere (e.g. zone classification and extent). Four different aspects should be considered when carrying out this process.

- Decide if the intended use is in an explosive atmosphere (i.e. surrounding the equipment or component), either wholly or partially
- Analyse whether an explosive atmosphere will occur inside the equipment or component, either from the process itself or from a connection to the surrounding area. Note; an internal explosion, which can ignite the explosive atmosphere surrounding equipment, needs to be considered as an ignition source of its own.
- Decide if the ignition source present can ignite the atmosphere, i.e. a potential ignition source. Then consider if this potential ignition source becomes effective under normal conditions, foreseeable malfunctions or rare malfunctions
- Determine the ignition hazard for each part of the equipment or component that meets or is connected to an “external” explosive atmosphere.

The block diagram in Figure 2.2 provides the aspects for determination whether ignition hazards are present.

Block 1: It shall be decided if the intended use is the use in an explosive atmosphere (i.e. surrounding the equipment or component). If equipment or a component containing a potentially explosive atmosphere can, due to its construction, operation etc. create a potentially explosive atmosphere, which wholly or partially surrounds it, then such equipment or a component is in effect in a potentially explosive atmosphere.

Block 2: It shall be analysed, whether an explosive atmosphere will occur inside the equipment or component either from the process itself or from a connection to the surrounding area. This is necessary because an internal explosion, which can ignite the explosive atmosphere in the surrounding of the equipment, shall be considered as an ignition source of its own. Therefore, the likelihood and duration of occurrence of an internal explosive atmosphere shall be determined.

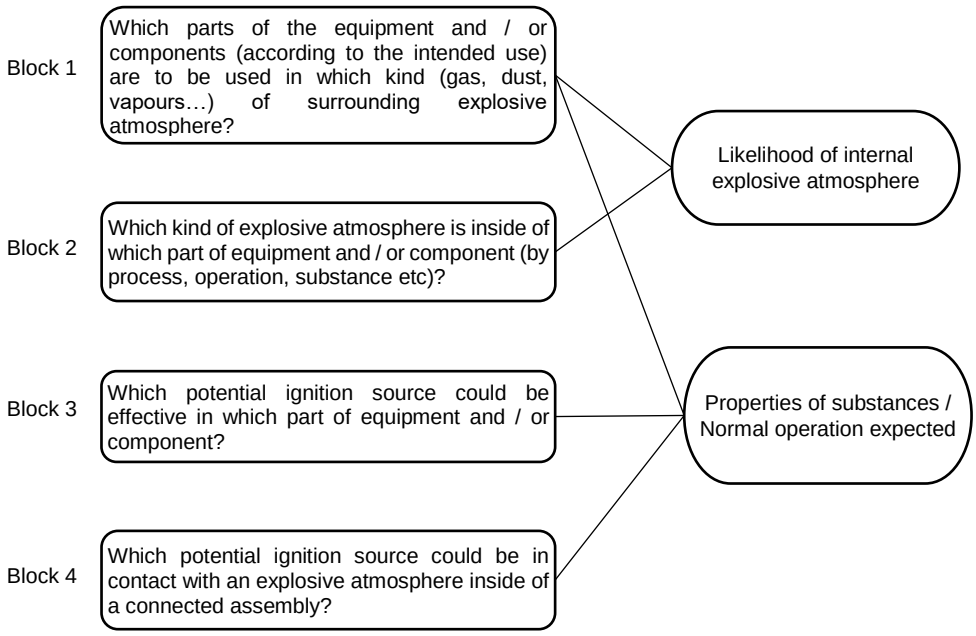
Block 3: It shall be decided if the present ignition source is able to ignite the atmosphere, i.e. the ignition source is a potential ignition source. It is to consider if this ignition source becomes effective under normal conditions, foreseeable malfunctions or rare malfunctions.

NOTE The energy required to ignite an explosive atmospheres depends on its nature. Thus, non-electrical equipment or a component that moves very slowly or has low power may not ignite the particular explosive atmosphere present during intended use.

Block 4: Ignition hazard of equipment or component shall be determined for each part of the equipment or component that comes into contact with or is connected to an “external” explosive atmosphere.

*Text copied from EN 15198; 2007(relating to Figure 2.3 below)*

**Figure 2.2 — Identification of ignition hazards**
*Based on Figure 2 – EN 15198;2007*




When identifying ignition hazards the following points need consideration;

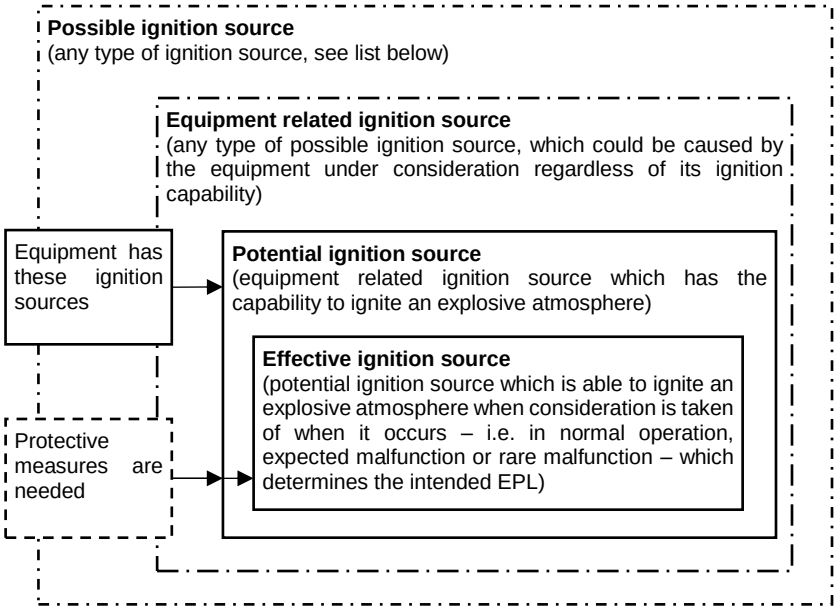
- Safety Characteristics;
  - The substance(s) handled themselves do not represent the potential explosion hazard
  - The contact or mixing of the substance(s) with air is what presents the potential explosion hazard
  - The key properties of the mixture of the flammable substance with air need to be determined
  - Information about a substance's burning behaviour and whether it could give rise to fire or explosions is required and for dusts the properties of dust layers also needs considering
- Likelihood and duration of an internal explosive atmosphere
  - An internal explosive atmosphere will only occur if the concentration of mixtures of air and gases, vapours, mists or dusts mixtures is above the lower explosion limit.
  - Concentration variations by start-up and shut down and other process conditions require consideration
  - Likelihood and duration of internal explosive atmospheres forms an inherent part of the user's explosion risk assessment and should be defined into zones using the principles of hazardous area classification

- Occurrence of a hazardous explosive atmosphere depends on the following:
    - Presence of a flammable substance
    - Degree of dispersion of the flammable substance (e.g. gases, vapours, mists, dusts)
    - Concentration of the flammable substance in air within the explosion range
    - Amount of explosive atmosphere sufficient to cause injury or damage by ignition

There are a number of ignition source scenarios, illustrated in Figure 2.3;

- **Possible ignition sources**; type of ignition source to be considered for the identification of ignition hazards (listed in EN1127-1, see below)
- **Equipment related ignition source**; possible ignition source which could be caused by the equipment
- **Potential ignition source;** equipment related ignition source which has the capability to ignite an explosive atmosphere
- **Effective ignition source;** potential ignition source which is able to ignite an explosive atmosphere when consideration is taken of when it occurs (i.e. normal operation, expected malfunction or rare malfunction)

**Figure 2.3 — Relationship between ignition source definitions**
*Based on Figure 1 – EN ISO 80079-36*




The following possible ignition source types (from EN 1127-1) form the starting point for identifying potential ignition sources;

- Hot surfaces

- Flames and hot gases (including hot particles)
- Mechanically generated sparks
- Electrical ignition sources
- Stray electric currents, cathodic corrosion protection
- Static electricity
- Lightning
- Radio frequency (RF) electromagnetic waves ($10^4$ Hz to 3 x $10^{12}$ Hz)
- Ionizing radiation
- Ultrasonic
- Adiabatic compression and shock waves
- Exothermic reactions, including self-ignition of dusts

When carrying out ignition hazard assessment of equipment handling powders and dusts, it is particularly important to consider dust deposits and other material that can become trapped between two moving parts or a moving part and a fixed part. If dust or other material remains in contact with the same moving part for a long period, it can heat up and can cause a burning deposit (of dust or other material) which can later ignite an explosive atmosphere. Even slow-moving parts can cause a large rise in temperature in this type of situation.

Flour trapped and heated by this means has been known to occur in powder handling equipment such as roller mills and cause “smouldering nests”. These nests of smouldering / burning material could become potential ignition sources for an explosive atmosphere. However, as discussed in Section 2.2, the wheat flours under consideration do not burn to produce flames or incandescent particles and they are unlikely to become effective ignition sources for a flour dust cloud.

It is important to note that the above judgement applies only to the types of wheat flours listed in Section 2.2 and other materials or types of flours may be more readily ignited by smouldering materials generated by mechanical heating. This has led to a restriction on the material duty being placed on some items of equipment assessed in this report. Where this is the case these restrictions are highlighted in the relevant ignition assessments.

In addition, flames from an explosion within an item of equipment can become an ignition source for an explosive atmosphere that surrounds the equipment. In most cases, explosion risk assessment determines that an internal explosion within an item of equipment should be a rare malfunction. For the purposes of documentation an internal explosion as a potential ignition source can be recorded as an exothermic reaction.

The following parameters also require consideration;

| Parameter | Notes – in relation to the assessments in this report |
|---|---|
| Energy levels | • Temperature; the operating temperature ranges of the equipment considered is close to ambient and the flammability properties and ignition sensitivity of the materials will not vary significantly<br>• Pressure; the operating pressure of the equipment assessed is close to atmospheric and pressure variations have minimal influence on the ignition sensitivity of the materials.<br>• Friction; the equipment assessed contains parts that are moving / rotation at various speeds and there are a range of drive systems with varying power levels, this has been reflected in assessments<br>• Electromagnetic fields; not significant for the equipment assessed<br>• Electrostatic discharge; the materials handled in a typical flour mill are not particularly sensitive to ignition by electrostatic discharge. Equipment handling or exposed to other materials with lower minimum ignition energies should be assessed separately. |
| Constructional variants | Items of similar overall design may have components or parts which are significantly different in design, materials of construction or in how component elements are configured; care must be taken when carrying out assessment by comparison between similar types of equipment to ensure any variants are identified and assessed. The range of variants covered by an assessment should be described in the equipment description section of the assessment. |
| Operating conditions | General operating conditions, working cycles, including stops, starts and load or speed variations should be described in the equipment description section of the assessments. |
| Ambient conditions | • Temperature; the ambient temperature fluctuations are not significant in most flour milling operations. Ambient temperatures above 40$^{o}$C should be highlighted in the assessment.<br>• Pressure; the equipment assessed operates in an open plant area at atmospheric pressure, internal process pressures vary only slightly from atmospheric pressure unless specifically stated in the equipment description section of the assessment.<br>• Humidity; the equipment assessed operates in an open plant area under typical ambient humidity levels. Internal process humidity is low unless specifically stated in the equipment description section of the assessment.<br>• Energy supply; the drive systems for the equipment assessed are generally electrically driven, and are described in the equipment description section of the assessments |
| Material parameters | • Materials of construction are primarily metallic, carbon steel or stainless steel. Details are included in the equipment description section of the assessments.<br>• Material properties of the process materials have been discussed in detail in Section 2.2 above, particularly for wheat flour |
| Material interdependencies | Pneumatic conveying is known to generate high levels of electrostatic charge on powders. |

| Parameter | Notes – in relation to the assessments in this report |
|---|---|
| Components or equipment interdependence | • Contact and separation of non-metallic components or parts can generate electrostatic charge,<br>• Mechanical impact spark energies vary significantly depending on the metals which come into contact. Care needs to be taken to ensure materials of construction of components and parts are known and documented<br>• For some types of equipment, some failures can cause coincidental formation of an explosive atmosphere and presence of an effective ignition source e.g. bucket elevator belt misalignment can cause buckets to catch on the casing. This in turn causes rousing of internal dust accumulations and generating frictional heat |
| People interdependencies | Human / machine interactions need to be considered, and the frequency of misuse or maloperation needs to be determined, varying from reasonably anticipated through to rare or very rare. The equipment assessed is assumed to be used as part of an automated process operating at fixed throughput rates. Human failures considered include incorrect assembly, failure of manual checks such as lubrication or cleaning and maintenance error |
| Combinations of malfunctions | Where necessary, combinations of malfunctions need to be considered e.g. failure to add conditioning / tempering water combined with equipment failure within equipment immediately downstream |

General discussion is presented below, including justification for those type of ignition sources that have been deemed to be not credible for the equipment types assessed in a typical flour mill;

| Ignition Source Type | Discussion / Justification if not included in assessments |
|---|---|
| Hot surfaces | Present in most of the equipment types assessed, mainly due to friction caused by rotating or moving parts |
| Flames / hot gases | Not considered credible for the equipment types assessed. There are no sources of flame or hot gas present. Hot particles could be present, but these are only caused by ignition of process materials by other ignition sources such as hot surfaces. |
| Mechanical sparks | Present in some parts of many of the equipment types assessed, mainly due to contact with moving parts |
| Electrical apparatus | Excluded; electrical equipment is assessed separately against the requirements of BS EN 60079-14 & 60079-17 |
| Stray electric currents, and cathodic corrosion protection | Not considered credible;<br>• Return currents are not applicable as there are no power generating systems associated with the equipment.<br>• Short-circuit or of a short-circuit to earth owing to faults in electrical installations associated with the equipment excluded; electrical equipment is assessed separately against the requirements of appropriate electrical safety standards including primary earthing.<br>• Magnetic induction is not applicable as there are no electrical installations with high currents or radio frequencies associated with the equipment.<br>• Stray currents caused by lightning (see below)<br>• Cathodic protection is not used on the equipment. |

| Ignition Source Type | Discussion / Justification if not included in assessments |
|---|---|
| Static electricity | Present in most of the equipment types assessed. However, it should be noted that the minimum ignition energy of the materials handled is relatively high. Low energy electrostatic discharges from non-conductive elements are not an effective ignition source in almost all of the equipment assessed |
| Lightning | Not considered credible; it is assumed that lightning risk assessment has been carried out to EN 62304 and that any required lightning protection has been installed and is inspected to meet the requirements of EN 62304.<br>Non-electrical equipment items covered by this report are located within or very close to the main building structures. It is assumed that large items of equipment outside the building structure have been included in the lightning risk assessment. |
| Electromagnetic waves | There are no sources of sufficient power to cause ignition located near to hazardous areas |
| Ionizing radiation | |
| Ultrasonic | |
| Adiabatic compression or shock waves | Considered credible for a very limited number of equipment types e.g. blowers where compression occurs. Not credible for the majority of the equipment as pressures vary only slightly from atmospheric pressure. |
| Chemical reactions | The materials handled in a typical flour mill are all relatively stable. Oxidation of the process materials at elevated temperature is credible, but this is generally protected against by specification of the appropriate maximum surface temperature (T Class) for the equipment and where appropriate, by controls to prevent layer accumulation within equipment. However, particular care is required when heat treatment of flours is involved.<br>As noted in Section 2.2 the wheat flours under consideration do not burn to produce flames or incandescent particles and they are unlikely to become effective ignition sources for a flour dust cloud. |

## 2.4 Ignition risk estimation

The probability of the ignition hazard occurring should be determined, based on the following three different types of situations:

- Normal operation, including reasonably be anticipated misuse
- Expected malfunction; frequently occurring disturbances or equipment faults
- Rare malfunctions; rare incidents, disturbances or equipment faults

As a guide the following can be used;

| Likelihood | Meaning |
|---|---|
| Normal operation | Ignition hazard expected on a regular basis in normal operation or reasonably anticipated misuse e.g. more frequent than once in 2 years |
| Expected malfunction | Ignition hazard expected within the lifetime of the plant e.g. more frequent than once in 20-25 years |
| Rare malfunction | Ignition hazard rare but credible e.g. it may have occurred in the industry, but not expected within the lifetime of the plant e.g. less than once in 25 years |

Ignition hazards caused by a combination of the following have not been considered

- More than two independent malfunctions
- Two independent rare malfunctions
- Independent rare and expected malfunctions at the same time

## 2.5 Ignition risk evaluation

The estimated ignition risk should be evaluated by comparing the level of protection achieved against the level of ignition protection required, based on the relevant hazardous area classification zone(s), using the criteria below;

| Group II Category | Criteria to achieve category | Zone suitability |
|---|---|---|
| Uncategorised | Effective ignition sources in normal operation or anticipated misuse | **NOT** suitable for use in classified areas (Zone 22, 21 or 20) |
| Category 3D (EPL Dc) | No effective ignition sources in normal operation or anticipated misuse | Suitable for use in Zone 22 areas only. |
| Category 2D (EPL Db) | No effective ignition sources in the event of expected malfunction | Suitable for use in Zone 22 and Zone 21 areas |
| Category 1D (EPL Da) | No effective ignition sources in the event of rare malfunctions. | Suitable for use in Zone 22, Zone 21 and Zone 20 areas. |
| EPL = equipment protection level | | |
| **Note;** the above is the minimum level of protection required, there are some cases where explosion risk assessment may determine that an additional equipment protection level is required e.g. where an item of equipment is located in, or connected to, a large hopper or bin that would ideally have explosion protection, but it does not. | | |

Formal retrospective ATEX categorisation and retrospective CE marking are not required for existing equipment; however, if the required level of ignition protection is not achieved, it will be necessary to modify the design of the equipment (or relevant parts / components) and to reassess after redesign.

Preventive and protective measures should be considered in the following order:

- Prevention of explosive atmospheres
- Ensure that ignition sources cannot arise
- Ensure that ignition sources cannot become effective
- Prevent explosive atmosphere reaching the ignition source
- Either contain the explosion within the equipment and / or component or reduce the effect of the explosion to an acceptable level and prevent flame propagation

Preventive measures and protective measures and types of ignition protection according relevant standards are specified in EN standards including those outlined below:

| Measure | Method or Type | Standard |
|---|---|---|
| Prevention of explosive atmospheres | Various methods | EN 1127-1 |
| Ensure ignition source cannot arise | Constructional Safety “c” | EN 13463-5, recently replaced by EN ISO 80079-37 |
| Ensure ignition source cannot become active | Control of Ignition Sources “b” | EN 13463-6, recently replaced by EN ISO 80079-37 |
| Prevent explosive atmosphere from reaching ignition source | Liquid Immersion “k | EN 13463-8, recently replaced by EN ISO 80079-37 |

## 2.6 Equipment Verification

It is important to confirm the validity of any assumptions made during the assessments, particularly for individual items of equipment that have been generically assessed. In order to ensure equipment is safe for continued use, it is also important to verify that all of the ignition risk controls identified in the ignition risk assessment are actually in place and effective. An example of a checklist that can be used for verification is given in Appendix F (based on the example ignition risk assessment for drag-link (chain) conveyors).

## 2.7 Published Standards and Guidance

The following Type A standards have been used as the basis for methodology described in this report and for production of the illustrative example assessments;

- EN 1127-1 describes the basic concepts and methodology of explosion prevention and protection and should be used when considering the types of ignition sources that could be present
- EN 15198 describes principles for a consistent systematic procedure for ignition risk assessment. Its methodology has been followed throughout.

Appropriate parts of the following Type B standards have been used in support of the methodology described in this report and for production of the illustrative example assessments;

- EN ISO 80079-36 is a Type B1 standard, which describes general safety aspects and provide solutions for non-electrical equipment for use in potentially explosive atmospheres.

- EN ISO 80079-36 refers to other Type B2 standards relating to types of protection such as constructional safety “c”, control of ignition sources “b” and liquid Immersion “k”.

Where a Type C standard exists for a machine it takes priority over other (Type B or Type A) standards and the requirements. Type C Standards should be followed where appropriate e.g. EN 14986 for fans working in potentially explosive atmospheres.

In addition to the above standards, published European harmonised guidance should be used to support ignition assessment e.g. CEN/TR 16829:2016 which provides detailed guidance on the requirements for bucket elevators and CLC/TR 60079-32-1:2015 which provides detailed guidance on electrostatic hazards.

## 2.8 Equipment Documentation

It is important to compile and retain technical documentation for the equipment assessed, which should include the ignition risk assessment and copies of supporting documentation;

- Description of the equipment or component for which the assessment has been made (e.g. specifications, limits, intended use)
- Relevant assumptions which have been made (e.g. loads, strengths, safety factors)
- Information on which the ignition risk assessment was based
- Data used and the sources e.g. incident histories, experiences gained from ignition risk reduction applied to similar machinery (the uncertainty associated with the data used and its impact on the ignition risk assessment should be considered)
- Ignition hazards identified
- Combustion properties
- Likelihood of explosive atmosphere
- Ignition sources
- Residual ignition risks associated with the equipment or component
- Safety measures implemented to eliminate or reduce identified ignition risks
- Result of the final ignition risk evaluation
- Resulting categorisation (including T Class and any restrictions on use).

## 2.9 Competence Requirements

It is important to ensure that the person, or team of people, carrying out ignition risk assessment is competent. As discussed in Section 1.2.4, competence can vary significantly between organisations and sites and detailed guidance is given in Appendix C relating to the key roles, responsibilities and competence requirements relating to management of non-electrical (mechanical) equipment in hazardous areas.

For ignition risk assessment three key competencies are generally required;

- Asset integrity management, particularly equipment criticality and risk-based maintenance and inspection.
- Mechanical and / or process engineering, with competence in the management of non-electrical equipment in hazardous areas
- Extensive operational experience in flour milling processes, with a good understanding of the handling and flammability properties of the materials being processed.

## 3. EXAMPLE ASSESSMENTS – ZONE 22

As described in the methodology in Section 2 above, the assessments have been carried out in two stages. The details from each stage are presented in appendices and the key points, findings and recommendations are summarised below. For ease of use, supporting assessments for some of the common elements found in main equipment are also provided. For ease of cross referencing; the corresponding sections of the main report and relevant appendices are given

| Summary Section | Equipment Type / Item | Assessment Appendix A |
|---|---|---|
| 3.1 | Drag link (chain) Conveyors | A.1 |
| 3.2 | Screw Conveyors | A.2 |
| 3.3 | Gearboxes; supporting assessment | A.3 |
| 3.4 | Belt drive; supporting assessment | A.4 |
| 3.5 | Chain drive; supporting assessment | A.5 |
| 3.6 | Simple couplings; supporting assessment | A.6 |
| 3.7 | Mill Feeder; supporting assessment | A.7 |

En-masse conveying (e.g. drag link and screw conveying) does not cause rousing of dust clouds even on material with a high dust content. These types of conveyors are often located in areas of a flour mill where low rate dust releases from equipment can lead to dust layers forming, giving rise to localised Zone 22 areas in the workplace.

The assessments are all based on Zone 22 hazardous zone locations requiring Group II, Category 3D (EPL Dc), T3, for dust with MIE > 30 mJ, e.g. no effective ignition sources in normal operation. The materials considered are; grain, flour, gluten and co-products e.g. bran, wheat feed, screenings and recovered dusts.

On flour or other fine material duty, en-masse conveyors such as drag link and screw conveyors may be connected to upstream silos, hoppers, bins or equipment that are internally classified as Zone 21 or even Zone 20 inside. In many cases the inlet to the conveyors will run flooded meaning the conveyor itself is not exposed to the Zone 21 or 20 inside the upstream equipment. However, it should be noted that some conveyors may be integral within silos, bins, hoppers or equipment e.g. as part of an internal discharge system. In these cases, parts of the conveyor will be exposed to the zone within the zone within the upstream equipment and the conveyor may require different internal and external Category / EPL requirements.

## Table 3.1 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Drag link (chain) conveyors<br>**DUTY:** En-masse conveying of grain, flour and co-products |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Generic Assessment covering the following type of equipment

**DESCRIPTION;**

Draglink (chain) conveyors, at ≤15º incline, of several configurations installed in hazardous Zone 22 areas;

- Drive system; fixed speed electric motor drive (typically 660 – 1440 rpm)
- Transmission system; v-belt or chain drive through a speed reduction shaft mounted gearbox
- Materials of construction; carbon steel casing (painted or galvanised externally), carbon steel chain, some conveyers may have non-metallic clearing flights. Wear rails may be high manganese steel
- Driven and non-driven shaft bearings & seals; pad mounted rolling element bearings with simple lip seal
- Bearing lubrication; a mixture of sealed for life, automatic lubrication and manual lubrication
- Note; some older conveyors have rotation sensors driven by small gear drive from the trailing wheel shaft

**Excludes; Conveyors integral within Zone 21 or 20 vessels**

**OPERATING CONDITIONS**

| | | | |
|---|---|---|---|
| Rotation / speed range; | Drive motor ≤ 1450 rpm. | Drive belt speed ≤ 30m/sec | Drive chain speed ≤ 1m/sec |
| | Conveying chain speed ≤ 0.5 m/sec | | |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal; upstream | 22 | Inlet normally runs choked even when upstream equipment is Zone 20 or 21<br>Negligible extent Zone 21 may exist within conveyor inlet |
| Internal; downstream | 22 | Conveyor components are not within any downstream Zone 20 or 21 areas |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**EQUIPMENT ITEMS COVERED BY THIS ASSESSMENT**

| ID | Duty | ID | Duty |
|---|---|---|---|
| | *Use this section to list equipment covered* | | *This section can be moved to the end of this table* |
| | | | |
| | | | |
| | | | |
| | | | |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The conveyors assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available.

*Assessment continued - see following page*

## Table 3.1 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Drag link (chain) conveyors<br>**DUTY:** En-masse conveying of grain, flour and co-products |

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Tip speeds at motor drive may be high enough for impact sparks |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | Yes | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion is a rare event |

**Notes/ Comments;**
- None

**CONTROL MEASURES**

| Potential Ignition Sources | Required Control Measures |
|---|---|
| Hot surfaces caused by friction;<br>• Between conveying chain and casing or runners / rails and sprockets / trailing wheels<br>• Between sprocket cleaner and sprocket or groove cleaner and trailing wheel<br>• Within bearings<br>• Between shaft(s) and lip seals<br>• Between guards and moving parts e.g. drive shafts, pulleys, belts, sprockets, chains<br>• Between drive belts and pulleys<br>• Between drive chain and sprockets<br>  ○ Includes rotation sensor drive chain where used<br>• Within gearbox (gears and bearings) | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Conveying chain tension checks<br>• Casing / rail wear checks<br>• Conveying chain / sprocket alignment & wear checks<br>• Adjustment & checking of sprocket & groove cleaners<br>• Bearing lubrication & checks<br>• Seal & shaft inspection and checks<br>• Guard clearance checks<br>• Drive belt alignment & tension checks<br>• Drive chain alignment & tension checks<br>• Drive chain lubrication checks<br>• Gearbox lubrication & checks |
| Hot surfaces; excessive friction caused by foreign material entering conveyor | Design features<br>• Shear pin on drive system<br>• Grid on intake & further cleaning processes upstream<br>• Magnetic traps at key points in the process upstream |
| Mechanical sparks caused by contact; drive chain failure, between guards and moving parts or gearbox failure | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic internal components and casing or by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive lubricant and / or elements | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; internal explosion | Ignition controls defined above |

**Recommendations;**
- Consider using periodic thermal imaging to monitor bearing temperature and seal temperature
- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems

**Notes / Comments;**
- See Appendices A.1 for further details and justification.

## Table 3.2 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Screw Conveyors<br>**DUTY:** En-masse conveying of grain, flour, gluten and co-products |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Generic Assessment covering the following type of equipment

**DESCRIPTION;**

U trough screw conveyors, nominal diameter 50 – 300mm, installed in hazardous Zone 22 areas;

- Drive system; fixed speed electric motor drive, with close coupled gearbox and tyre coupling
- Materials of construction; carbon steel casing (painted externally) with carbon steel screw auger
- Driven and non-driven shaft bearings & seals; flange mounted rolling element bearings with simple lip seal
- Intermediate hanger bearing; phosphor bronze bush (fitted on some conveyors)
- Bearing lubrication; a mixture of sealed for life, automatic lubrication and manual lubrication

**Excludes; Screw conveyors that are integral within vessels**

**OPERATING CONDITIONS**

| | | |
|---|---|---|
| Rotation / speed range; | Drive motor ≤ 1450 rpm. | Screw auger ≤ 62 rpm (tip speed < 1.0 m/sec @300m dia.) |
| External ambient temperature; ≤ 40ºC | | |

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal; upstream | 22 | Inlet normally runs choked even when upstream equipment is Zone 20 or 21<br>Negligible extent Zone 21 may exist within conveyor inlet |
| Internal; downstream | 22 | Conveyor components are not within any downstream Zone 20 or 21 areas |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**EQUIPMENT ITEMS COVERED BY THIS ASSESSMENT**

| ID | Duty | ID | Duty |
|---|---|---|---|
| | *Use this section to list equipment covered* | | *This section can be moved to the end of this table* |
| | | | |
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**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The conveyors assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available.

*Assessment continued - see following page*

## Table 3.2 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Screw Conveyors<br>**DUTY:** En-masse conveying of grain, flour, gluten and co-products |

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | No | Auger tip speeds < 1m/sec |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | Yes | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion is a rare event |

**Notes/ Comments;**
- None

**CONTROL MEASURES**

| Potential Ignition Sources | Required Control Measures |
|---|---|
| Hot surfaces caused by friction;<br>• Between screw auger and casing<br>• Within intermediate hanger bearing (where fitted)<br>• Within flange (end) bearings<br>• Between shaft(s) and lip seals<br>• Within coupling<br>• Between guards and moving parts e.g. coupling or shaft<br>• Within gearbox (gears and bearings) | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Clearance checks on screw auger<br>• Routine lubrication of hanger bearing<br>• Bearing lubrication & checks<br>• Seal & shaft inspection and checks<br>• Drive system / coupling alignment checks<br>• Guard clearance checks<br>• Gearbox lubrication & checks |
| Hot surfaces; excessive friction caused by foreign material entering conveyor | Design features<br>• Grid on intake & further cleaning processes upstream<br>• Magnetic traps at key points in the process upstream |
| Mechanical sparks caused by contact; gearbox failure | As for hot surfaces, above |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic internal components and casing or by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive lubricant and / or elements | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; internal explosion | Ignition controls defined above |

**Recommendations;**
- Consider using periodic thermal imaging to monitor bearing temperature and seal temperature
- Ensure plastic inserts used to hold intermediate phosphor bronze bush bearings are made of anti-static (dissipative) material

**Notes / Comments;**
- See Appendices A.2 for further details and justification.

## Table 3.3 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Gearboxes<br>**DUTY:** Speed reduction on drive systems |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Supporting assessment covering the following type of equipment

**DESCRIPTION;** Gearboxes of several configurations installed in hazardous Zone 22 areas, including;

- Shaft mounted gearboxes
- Gearboxes close coupled to drive motors
- Stand-alone gearboxes, coupled to motors via couplings

Oil filled, or filled with semi-solid grease, without oil / lubricant pump.

**OPERATING CONDITIONS**

| | |
|---|---|
| Rotation / speed range; | driven (input) shaft speed typically ≤ 1450 rpm, but some operate at 2880 rpm |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | N/C | Non-classified |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The gearboxes assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available**.**

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts or due to temperature increase in lubricant |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Gear & coupling tip speeds could exceed 1m/sec |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion not considered credible |

*Assessment continued - see following page*

| Table 3.3 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Gearboxes<br>**DUTY:** Speed reduction on drive systems |
| **CONTROL MEASURES** | |
| **Potential Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between gears and within bearings<br>• Between shaft(s) and lip seals<br>• Within couplings<br>Between moving parts (shaft / coupling) and guards | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Lubrication level checks<br>• Use of correct grade of lubricant<br>• Seal inspection and checks<br>• Alignment checks<br>Guard clearance checks |
| Mechanical sparks caused by;<br>• Gear or bearing failure<br>• Contact; guards and moving parts | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic internal components and casing. Casing is earthed. |
| Electrostatic; charge accumulation on non-conductive lubricant and / or elements | Restriction on use of equipment; MIE must be > 30mJ |
| **Recommendations;**<br>• Consider using periodic thermal imaging to monitor temperature<br>• Consider using vibration analysis to monitor for progressive and / or sudden changes in vibration level<br>• Consider using oil analysis to monitor for progressive and / or sudden oil degradation | |
| **Notes / Comments;**<br>• See Appendices A.3 for further details and justification. | |

## Table 3.4 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt Drives<br>**DUTY:** Speed reduction on drive systems |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Supporting assessment covering the following type of equipment

**DESCRIPTION;** Belt drives of several configurations installed in hazardous Zone 22 areas, including;

- Friction belt drive systems e.g. flat belts, V-belts, wedge belts, V-ribbed belts
- Synchronous belt drives e.g. timing belts with positive interaction between belt teeth and pulley grooves

**OPERATING CONDITIONS**

| | |
|---|---|
| Rotation / speed range; | Belt speed ≤ 30 m/sec |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | N/C | Non-classified |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The belt drives assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available.

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Rotational tip speeds are high enough |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion not applicable |

*Assessment continued - see following page*

| Table 3.4 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt Drives<br>**DUTY:** Speed reduction on drive systems |
| **CONTROL MEASURES** | |
| **Potential Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Belts loose or misaligned<br>• Between guards and moving part e.g. belts, pulleys or shafts | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Belt tension and alignment checks<br>• Guard clearance checks |
| Mechanical sparks caused contact between guards and moving parts e.g. pulleys or shafts | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components e.g. pulleys | Pulleys earthed by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive belts and / or elements | Restriction on use of equipment; MIE must be > 30mJ |
| **Recommendations;**<br>• Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems | |
| **Notes / Comments;**<br>• See Appendices A.4 for further details and justification. | |

## Table 3.5 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Chain Drives<br>**DUTY:** Transmission on drive systems or rotation sensor drives |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Supporting assessment covering the following type of equipment

**DESCRIPTION;** Chain and sprocket drives installed in hazardous Zone 22 areas, including;

- Speed reduction and / or transmission on drive systems
- Transmission; indirectly driven rotation sensors

**OPERATING CONDITIONS**

| | |
|---|---|
| Rotation / speed range; | Chain speed ≤ 1m/sec |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | N/C | Non-classified |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The chain drives assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available**.**

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Rotational tip speeds may be high enough depending on duty |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion not applicable |

*Assessment continued - see following page*

| Table 3.5 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Chain Drives<br>**DUTY:** Transmission on drive systems or rotation sensor drives |
| **CONTROL MEASURES** | |
| **Potential Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between guards and moving parts e.g. shafts, sprockets, chains<br>• Between drive chain and sprockets | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Guard clearance checks<br>• Drive chain alignment & tension checks<br>• Drive chain lubrication checks |
| Mechanical sparks caused by;<br>• Contact; drive chain failure<br>• Contact; guards and moving parts | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive elements | Restriction on use of equipment; MIE must be > 30mJ |
| **Recommendations;**<br>• None | |
| **Notes / Comments;**<br>• See Appendices A.5 for further details and justification. | |

## Table 3.6 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Simple Couplings<br>**DUTY:** Connections between rotating shafts |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Supporting assessment covering the following type of equipment

**DESCRIPTION;** Couplings of several types e.g. between motor drive shafts and gearboxes, between gearbox driven shafts and rotating equipment installed in hazardous Zone 22 areas, including;

- Rigid; e.g. flanged/bolted or sleeve (keyway / set screws)
- Flexible; e.g. flanged with elastomeric buffer, pin & bush, tyre

**Excludes; geared couplings, fluid drive couplings, magnetic couplings**

**OPERATING CONDITIONS**

| | |
|---|---|
| Rotation / speed range; | driven (input) shaft speed typically ≤ 1450 rpm, but some operate at 2880 rpm |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | N/C | Non-classified |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The couplings assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available**.**

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Rotational tip speeds may be high enough |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion not applicable |

*Assessment continued - see following page*

| Table 3.6 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Simple Couplings<br>**DUTY:** Connections between rotating shafts |
| **CONTROL MEASURES** | |
| **Potential Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Coupling loose or misaligned<br>• Between guards and moving part | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Coupling assembly and alignment checks<br>• Guard clearance checks |
| Mechanical sparks caused by;<br>• Contact; guards and moving parts | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic bolting, metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive elements (where used) e.g. in flexible couplings) | Restriction on use of equipment; MIE must be > 30mJ |
| **Recommendations;**<br>• Where elastomeric elements are used; use fire retardant, anti-static (dissipative) materials | |
| **Notes / Comments;**<br>• See Appendices A.6 for further details and justification. | |

## Table 3.7 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Mill Feeder<br>**DUTY:** Feeding wheat grain into Roller Mill |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Supporting assessment covering the following type of equipment

**DESCRIPTION;** Feed system with rotating roll, distribution screw and adjustable feed gate, driven by drive belt from roller mill drive system; installed in hazardous Zone 22 areas, including;

- Materials of construction; carbon steel casing (painted externally) with carbon steel rolls and screw auger
- Shaft bearings & seals; rolling element bearings with simple lip seal, mounted on casing
- Bearing lubrication; a mixture of sealed for life, automatic lubrication and manual lubrication

**Excludes; feeders which are driven independently from the roller mill drive system**

**OPERATING CONDITIONS**

| | |
|---|---|
| Rotation / speed range; | Drive belt speed << 30 m/sec |
| | Feed roll ≤ 100 rpm (roller and auger tip speed < 0.7 m/sec @120m dia.) |

**Notes/ Comments;**

- Other operating conditions as for the roller mill the feeder is connected to

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | N/C | Non-classified |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**Notes/ Comments;** None

**OTHER INFORMATION**

**Notes/ Comments;**

- The feeders assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available**.**

**POTENTIAL IGNITION SOURCES IDENTIFIED**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | No | Feed roller tip speeds < 1m/sec |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | Yes | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion not applicable |

*Assessment continued - see following page*

| Table 3.7 – IGNITION ASSESSMENT SUMMARY – CATEGORY 3D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Mill Feeder<br>**DUTY:** Feeding wheat grain into Roller Mill |
| **CONTROL MEASURES** | |
| **Potential Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between feed roll, screw auger and fixed parts e.g. scraper, feed gate, casing<br>• Within bearings on shafts<br>• Between drive shafts and lip seals<br>• Belts loose or misaligned<br>• Between guards and moving part e.g. belts, pulleys or shafts | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Correct adjustment of feed gate stops<br>• Clearance checks on feed roll and auger<br>• Bearing lubrication and checks<br>• Seal inspection and checks<br>• Belt tension and alignment checks<br>• Guard clearance checks |
| Hot surfaces; excessive friction caused by foreign material entering feeder | Design features<br>• Upstream sieve and destoner |
| Excessive friction caused by incorrectly assembled input drive systems | Correctly assembled components should not introduce additional ignition sources See separate assembly assessment |
| Mechanical sparks caused by;<br>• Contact; inside feeder<br>• Contact; guards and moving parts | Tip speeds of rotating internal and drive system components is < 1m/sec. - for carbon or stainless steel; sparks will not be incendive. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic bolting, metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive belts and / or elements | Restriction on use of equipment; MIE must be > 30mJ |
| **Recommendations;**<br>• Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems | |
| **Notes / Comments;**<br>• See Appendices A.7 for further details and justification. | |

## 4. EXAMPLE ASSESSMENTS – ZONE 20/21

As described in the methodology in Section 2 above, the assessments have been carried out in two stages. The details from each stage are presented in appendices and the key points, findings and recommendations are summarised below. For ease of cross referencing; the corresponding sections of the main report and relevant appendices are given

| Summary Section | Equipment Type / Item | Assessment Appendix B |
|---|---|---|
| 4.1 | Belt & bucket elevators, belt driven | B.1 |
| 4.2 | Roller Mills Also see separate assembly assessment (Section 5.1) | B.2 |
| 4.3 | Bran Finisher | B.3 |

Bucket elevators are often located in areas of a flour mill where low rate dust releases from equipment can lead to dust layers forming, giving rise to localised Zone 22 areas in the workplace. Similarly, roller mills and bran finishers may also be located in Zone 22 areas e.g. due to low rate dust releases from flexible connections and bellows causing dust layers.

The assessments are all based on external (workplace) Zone 22 hazardous zone locations requiring Group II, Category 3D (EPL Dc), T3, for dust with MIE > 30 mJ, e.g. no effective ignition sources in normal operation. The materials considers are; grain, flour, gluten and co-products e.g. bran, wheat feed, screenings and recovered dusts.

The internal requirements as specified in each assessment and discussed below;

- Zone 20 internal; requiring internal Group II, Category 1D (EPL Da), T3
- Zone 21 internal; requiring internal Group II, Category 2D (EPL Dc), T3

Two example elevators are described in the CEN/TR 16829:2016, along with guidance relating to materials such as grain. Example B has been considered e.g. the bucket elevator is conveying a coarse product (typically > 1,000 µm) e.g. grain, with a very limited amount of fines. For this situation, it is assumed that a potential explosive atmosphere is likely to occur occasionally during normal operation.

Both external and internal assessments are for dust with MIE > 30 mJ.

## Table 4.1 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven<br>**DUTY:** Conveying of cleaned grain |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Generic Assessment covering the following type of equipment

**DESCRIPTION;**

Belt and bucket elevators (Example B; CEN/TR 16829:2016) with belt drives installed in hazardous Zone 22 areas, with internal Zone 21;

- Drive system; fixed speed electric motor drive
- Transmission system; v-belt drive through a speed reduction shaft mounted gearbox, with backstop
- Materials of construction;
  - Carbon steel head, boot and leg casing (painted externally)
  - Steel pulley wheels and steel drive shafts with rubber lining / lagging
  - Multi-ply rubber conveying belt with fabric or steel woven carcase, fitted with carbon steel buckets
- Driven (head) shaft bearings & seals; rolling element bearings with simple lip seal, housed on head casing or external pedestal bearings
- Non-driven (boot) shaft bearings & seals; rolling element bearings with simple lip seal, housed on boot casing
- Bearing lubrication; a mixture of sealed for life, automatic lubrication and manual lubrication

**Excludes; High speed direct drive bucket elevators** – these can have increased risk of internal impact sparks

**OPERATING CONDITIONS**

| | | |
|---|---|---|
| Rotation / speed range; | Drive motor ≤ 1450 rpm. | Drive belt speed ≤ 30m/sec |
| | Conveying belt speed ≤ 2.5 m/sec | |
| External ambient temperature; ≤ 40ºC | | |
| **Notes/ Comments;** None | | |

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | 21 | Localised Zone 21 in head and discharge chute |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**EQUIPMENT ITEMS COVERED BY THIS ASSESSMENT**

| ID | Duty | ID | Duty |
|---|---|---|---|
| | *Use this section to list equipment covered* | | *This section can be moved to the end of this table* |
| | | | |
| | | | |
| | | | |
| | | | |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8
- Ensure compliance with the defined lubrication schedule is formally audited to monitor compliance

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The bucket elevators assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available.

*Assessment continued - see following page*

| Table 4.1 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven<br>**DUTY:** Conveying of cleaned grain |

| POTENTIAL EXTNERAL IGNITION SOURCES IDENTIFIED | | |
|---|---|---|
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Tip speeds at motor drive may be high enough for impact sparks |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | Yes | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion is a rare event |

**Notes/ Comments;**

- Bearings and seals mounted directly on the casing and are treated as potential internal ignition sources
- External pedestal bearings and bearings within the gearbox are included within the external assessment

| POTENTIAL INTERNAL IGNITION SOURCES IDENTIFIED | | |
|---|---|---|
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Conveying belt speed > 1m/sec. |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class |

**Notes/ Comments;**

- None

*Assessment continued - see following page*

| Table 4.1 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven<br>**DUTY:** Conveying of cleaned grain |
| **CONTROL MEASURES EXTERNAL IGNITION SOURCES** | |
| **Potential External Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between guards and moving parts e.g. shafts, pulleys, belts<br>• Between drive belts and pulleys<br>• Within gearbox (gears and bearings)<br>• Within pedestal bearings | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Guard clearance checks<br>• Drive belt alignment & tension checks<br>• Gearbox lubrication & checks<br>• Bearing lubrication & checks |
| Mechanical sparks caused by;<br>• Contact; guards and moving parts<br>• Contact; gearbox bearing failure | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic components and casing or by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive lubricant and / or elements e.g. belts | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; internal explosion | See internal ignition source control measures below.<br>Use of flameless explosion relief or explosion relief discharging to an unoccupied / non-classified area will provide an additional level of protection where required. |
| **CONTROL MEASURES INTERNAL IGNITION SOURCES** | |
| **Potential Internal Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between conveying belt or buckets & casing<br>• Between conveying belt and pulley wheels<br>• Within shaft bearings<br>• Between shaft(s) and lip seals | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Conveying belt / pulley alignment & wear checks<br>• Conveying belt tension checks<br>• Bearing lubrication & checks<br>• Seal & shaft inspection and checks<br>Design features;<br>• Fire resistant conveying belt<br>• Belt alignment sensors at boot<br>• Low speed sensor on non-driven (boot) shaft<br>• Elevator shutdown on misalignment or slow speed |
| Hot surfaces; excessive friction caused by foreign material entering elevator | Design features<br>• Upstream cleaning sieve and destoner |
| Mechanical sparks caused by contact between buckets & casing | As for hot surfaces above, plus commissioning and planned maintenance based on manufacturer's instructions, which includes conveying belt wear checks & splice checks |
| Electrostatic; charge accumulation on metallic / conductive components e.g. metal buckets on belts | Design features;<br>• Metal pulleys earthed by metallic internal components and casing or by metallic drive shafts and bearings.<br>• Metal buckets earthed by anti-static (dissipative) conveying belts & anti-static (dissipative) lagging on pulley wheels |
| Electrostatic; charge accumulation on non-conductive elements e.g. conveying belt | Restriction on use of equipment; MIE must be > 30mJ |

*Assessment continued - see following page*

| Table 4.1 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven<br>**DUTY:** Conveying of cleaned grain |
| **Recommendations;**<br>• Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems<br>• Ensure pulley wheel lagging is made of anti-static (dissipative) materials<br>• Ensure conveying belts are fire resistant / anti-static (dissipative)<br>• Ensure elevator is shutdown on misalignment or slow speed<br>• Use periodic thermal imaging to monitor bearing temperature and seal temperature and consider installing bearing temperature monitoring on bearings housed on the elevator casing<br>• Consider using periodic thermal imaging to monitor operating temperatures of the belt drive, gearbox and external pedestal bearings<br>• Assign the appropriate level of safety criticality to the key maintenance and inspection control measures for internal ignition source control identified above. | |
| **Notes / Comments;**<br>• See Appendices B.1 for further details and justification. | |

## Table 4.2 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Roller Mill<br>**DUTY:** Production of wheat flour by size-reduction |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Generic Assessment covering the following type of equipment

**DESCRIPTION;**

Four and Eight Roll Mill, with 250mm diameter rolls installed in hazardous Zone 22 areas, with internal Zone 20 within parts of the mill discharge;

- Drive system; fixed speed electric motor drive
- Transmission (rolls); belt drives to each roll pair and helical spur gearboxes between each roll pair
- Materials of construction; carbon steel casing (painted externally) with hardened steel rolls, steel internal components and guide plates / scrapers and some internal plastic components
- Bearings & seals; rolling element bearings with simple lip seal mounted on casing on roll drive shafts
- Bearing lubrication; a mixture of sealed for life, automatic lubrication and manual lubrication

**Excludes; Mill Feeder**, which is in Zone 22 area (see separate supporting and assembly assessments)

**OPERATING CONDITIONS**

| | | |
|---|---|---|
| Rotation / speed range; | Drive motor ≤ 1450 rpm. | Drive belt speed << 30 m/sec |
| | Roll ≤ 150 rpm (tip speed 2 m/sec @250m dia.) | |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | 21 | Very localised Zone 20 in mill, below lowest roll pair |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**EQUIPMENT ITEMS COVERED BY THIS ASSESSMENT**

| ID | Duty | ID | Duty |
|---|---|---|---|
| | *Use this section to list equipment covered* | | *This section can be moved to the end of this table* |
| | | | |
| | | | |
| | | | |
| | | | |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8
- Ensure compliance with the defined lubrication schedule is formally audited to monitor compliance

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The roller mills assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available.

*Assessment continued - see following page*

| Table 4.2 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Roller Mill<br>**DUTY:** Production of wheat flour by size-reduction |

| POTENTIAL EXTNERAL IGNITION SOURCES IDENTIFIED | | |
|---|---|---|
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Tip speeds of rotating parts of the drive system may be high enough for impact sparks |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | Yes | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion is a rare event |

**Notes/ Comments;**
- Bearings and seals mounted directly on the casing and are treated as potential internal ignition sources
- External pedestal bearings and bearings within the gearbox are included within the external assessment

| POTENTIAL INTERNAL IGNITION SOURCES IDENTIFIED | | |
|---|---|---|
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Tip speeds of rolls may be high enough to create impact sparks |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class |

**Notes/ Comments;**
- None

*Assessment continued - see following page*

| Table 4.2 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Roller Mill<br>**DUTY:** Production of wheat flour by size-reduction |
| **CONTROL MEASURES EXTERNAL IGNITION SOURCES** | |
| **Potential External Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between guards and moving parts e.g. shafts, pulleys, belts<br>• Between drive belts and pulleys<br>• Within helical spur gearbox (gears and bearings)<br>• Within pedestal bearings | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Guard clearance checks<br>• Drive belt alignment & tension checks<br>• Gearbox lubrication & checks<br>• Bearing lubrication & checks |
| Mechanical sparks caused by;<br>• Contact; guards and moving parts<br>• Contact; gearbox bearing failure | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic components and casing or by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive lubricant and / or elements e.g. belts | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; internal explosion | See internal ignition source control measures below. |
| **CONTROL MEASURES INTERNAL IGNITION SOURCES** | |
| **Potential Internal Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between rolls and fixed parts e.g. scraper, guide plates or other fixed parts<br>• Excessive contact between moveable and fixed rolls<br>• Within roll shaft bearings<br>• Between shaft(s) and lip seals | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Roll alignment and parallelism checks with clearance / minimum gap checks at key points<br>• Roll drive system bearing lubrication & checks<br>• Seal & shaft inspection and checks<br>Design features<br>• Bearings are not mounted directly onto the inner mill casing |
| Hot surfaces; excessive friction caused by foreign material caught between rolls | Design features<br>• Upstream cleaning sieve and destoner<br>• Magnetic trap in the upstream feed system<br>• Pre-tensioned springs or pneumatic dampers (foreign matter safety devices)<br>Commissioning and planned maintenance based on manufacturer's instructions, which includes checking spring tension or pressure setting for safety devices |
| Mechanical sparks caused by contact between rolls and fixed parts e.g. scraper, guide plates or fixed parts | As for hot surfaces above |
| Mechanical sparks caused by contact between moveable and fixed rolls | Counter rotating rolls minimises differential tip speed. Speed difference between fast roll and slow roll gives differential tip speed << 1 m/sec |
| Mechanical sparks caused by contact between foreign material and rolls | As for hot surfaces above |
| Electrostatic; charge accumulation on metallic / conductive components | Design features;<br>• Earthed by metallic internal components and casing or by metallic rolls, shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive elements | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; smouldering / burning material generated by dust trapped between parts | Restriction on use of equipment; Wheat flour duty only (white bread making flour and wholemeal flour) |

*Assessment continued - see following page*

| Table 4.2 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Roller Mill<br>**DUTY:** Production of wheat flour by size-reduction |
| **Recommendations;**<br>• Ensure quality build plan and check sheets with independent sign off for key checks are in place<br>• Ensure there is a magnetic trap in the upstream feed system e.g. between First Break Hopper and Mill<br>• Ensure periodic thermal imaging is used to monitor roll shaft bearing temperature.<br>• Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems<br>• Consider using periodic thermal imaging to monitor helical gearbox temperature<br>• Consider using oil analysis to monitor for progressive and / or sudden oil degradation<br>• Consider using periodic thermal imaging to monitor pedestal bearing temperature<br>• Consider installing roll shaft bearing temperature monitoring / trips<br>• Assign the appropriate level of safety criticality to the key maintenance and inspection control measures for internal ignition source control identified above. | |
| **Notes / Comments;**<br>• See Appendix B.1 for further details and justification. | |

## Table 4.3 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT

| | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Bran Finisher<br>**DUTY:** Separation of flour adhering to bran |

**EQUIPMENT DESCRIPTION**

**MAKE & MODEL;** Generic Assessment covering the following type of equipment

**DESCRIPTION;**

Rotary (centrifugal) Bran Finisher, with 400mm diameter screen, installed in hazardous Zone 22 areas, with internal Zone 21 in the flour discharge under the screen;

- Drive system; fixed speed electric motor drive
- Transmission; v-belt drive between motor and rotor
- Materials of construction; stainless steel rotor and drive shaft, stainless steel screen mesh or fabric mesh on stainless steel support frame. Stainless steel beater bars bolted to rotor using locknuts, Stainless steel casing and endplates. Some internal plastic components such as screen seals.
- Bearings & seals; rolling element bearings with simple lip seal mounted on casing on roll drive shafts
- Bearing lubrication; a mixture of sealed for life, automatic lubrication and manual lubrication

**Excludes; Other types of rotary sifters used for flour finishing / re-dressing**

**OPERATING CONDITIONS**

| | | |
|---|---|---|
| Rotation / speed range; | Drive motor ≤ 1450 rpm. | Drive belt speed ≤ 30 m/sec |
| | Beaters ≤ 1200 rpm (tip speed 25 m/sec @400m dia.) | |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**HAZARDOUS AREA ZONE REQUIREMENTS**

| Requirement | Zone | Comments / Notes |
|---|---|---|
| External | 22 | Localised workplace zone |
| Internal | 21 | Localised Zone 21 in flour discharge under the screen mesh |
| Maximum Surface Temperature | | T3 Class ≤ 200ºC |

**EQUIPMENT ITEMS COVERED BY THIS ASSESSMENT**

| ID | Duty | ID | Duty |
|---|---|---|---|
| | *Use this section to list equipment covered* | | *This section can be moved to the end of this table* |
| | | | |
| | | | |
| | | | |
| | | | |

**MAINTENANCE & INSPECTION HISTORY**

Greater than 10 years of maintenance based on manufacturer's instructions, with no reported serious failures

**Recommendations;**

- Confirm that overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- Confirm that the commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- Ensure an appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8
- Ensure compliance with the defined lubrication schedule is formally audited to monitor compliance

**Notes/ Comments;**

- None

**OTHER INFORMATION**

**Notes/ Comments;**

- The bran finishers assessed currently show no signs of obsolesce or excessive ageing. OEM spare parts and servicing are readily available.

*Assessment continued - see following page*

| Table 4.3 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Bran Finisher<br>**DUTY:** Separation of flour adhering to bran |

| POTENTIAL EXTNERAL IGNITION SOURCES IDENTIFIED | | |
|---|---|---|
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Tip speeds of rotating parts of the drive system may be high enough for impact sparks |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | Yes | Self-heating / decomposition covered by LIT / MIT & T Class<br>Internal explosion is a rare event |
| **Notes/ Comments;**<br>• Bearings and seals mounted directly on the casing and are treated as potential internal ignition sources | | |

| POTENTIAL INTERNAL IGNITION SOURCES IDENTIFIED | | |
|---|---|---|
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | Yes | Frictional heating due to rotating / moving parts |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | Tip speeds of beaters are high enough to create impact sparks |
| Electrical apparatus | Yes | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | Yes | Note; powder has high MIE ≥ 30 mJ |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Self-heating / decomposition covered by LIT / MIT & T Class |
| **Notes/ Comments;**<br>• None | | |

*Assessment continued - see following page*

| Table 4.3 – IGNITION ASSESSMENT SUMMARY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Bran Finisher<br>**DUTY:** Separation of flour adhering to bran |
| **CONTROL MEASURES EXTERNAL IGNITION SOURCES** | |
| **Potential External Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between guards and moving parts e.g. shafts, pulleys, belts<br>• Between drive belts and pulleys | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Guard clearance checks<br>• Drive belt alignment & tension checks |
| Mechanical sparks caused by;<br>• Contact; guards and moving parts | As for hot surfaces, above. |
| Electrostatic; charge accumulation on metallic / conductive components | Earthed by metallic components and casing or by metallic drive shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive elements e.g. belts | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; internal explosion | See internal ignition source control measures below. |
| **CONTROL MEASURES INTERNAL IGNITION SOURCES** | |
| **Potential Internal Ignition Sources** | **Required Control Measures** |
| Hot surfaces caused by friction;<br>• Between rotor / beaters and fixed parts e.g. screen mesh, supports or end plates<br>• Within rotor shaft bearings<br>• Between shaft(s) and lip seals | Commissioning and planned maintenance based on manufacturer's instructions, which includes;<br>• Beater alignment checks with clearance / minimum gap checks at key points<br>• Bearing lubrication & checks<br>• Seal & shaft inspection and checks<br>Design features<br>• Use of lock nuts to hold beaters in place on rotor |
| Hot surfaces; excessive friction caused by foreign material caught between beaters and screen | Design features<br>• Upstream cleaning sieve and destoner<br>• Magnetic trap in the upstream feed system<br>• Clearance of ***mm between beaters and screen minimises likelihood of foreign material becoming trapped between beater and screen |
| Mechanical sparks caused by contact between rotor / beaters and fixed parts e.g. screen mesh, supports or end plates | As for hot surfaces above |
| Mechanical sparks caused by contact between foreign material and beaters | As for hot surfaces above |
| Electrostatic; charge accumulation on metallic / conductive components | Design features;<br>• Earthed by metallic internal components and casing or by metallic beaters, rotor, shafts and bearings. |
| Electrostatic; charge accumulation on non-conductive elements | Restriction on use of equipment; MIE must be > 30mJ |
| Chemical reaction; smouldering / burning material generated by dust trapped between parts | Restriction on use of equipment; Wheat bran duty only (white bread making flour and wholemeal flour) |
| **Recommendations;**<br>• Ensure quality build plan and check sheets with independent sign off for key checks are in place<br>• Ensure there is a magnetic trap in the upstream feed system at an appropriate point<br>• Ensure periodic thermal imaging is used to monitor rotor shaft bearing temperature.<br>• Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems<br>• Consider installing rotor shaft bearing temperature monitoring / trips<br>• Assign the appropriate level of safety criticality to the key maintenance and inspection control measures for internal ignition source control identified above | |
| **Notes / Comments;**<br>• See Appendix B.3 for further details and justification. | |

## 5. EXAMPLE ASSESSMENTS – ASSEMBLY

The assessments in this section illustrate how a modular approach can sometimes be taken where there are similar types of equipment, but which may have variations in how their component parts / elements are configured.

| Summary Section | Assembly; Equipment Types / Items |
|---|---|
| 5.1 | Roller Mill and Feeder |

This type of assessment considers individual equipment types / items which have their own separate detailed ignition assessments and considers how they are configured and assembled together. The purpose is to determine if their configuration and assembly introduces any new potential ignition sources or affects the likelihood of any ignition sources identified in the separate assessments.

| Table 5.1 – IGNITION ASSESSMENT ASSEMBLY – CATEGORY 2D EQUIVALENT | |
|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **ASSEMBLY;** Roller Mill and Feeder<br>**DUTY:** Production of wheat flour by size-reduction |

**ASSEMBLY DESCRIPTION**

| Component Item Description | ATEX Requirement | Assessment Ref. |
|---|---|---|
| 1. Mill Feeder | II, 3D (EPL Dc), T3 | 3.7 |
| 2. Roller Mill | External; II, 3D (EPL Dc), T3<br>Internal; II, 2D (EPL Db), T3 | 4.2 |

**Description;** Four and Eight Roll Mill with integral Mill Feeder. Mill feeder drive is connected to the main mill drive system by a drive belt.

**OPERATING CONDITIONS**

| | |
|---|---|
| Rotation / speed range; | As described in the individual component assessments |

External ambient temperature; ≤ 40ºC

**Notes/ Comments;**

- None

**EQUIPMENT ASSEMBLIES ITEMS COVERED BY THIS ASSESSMENT**

| ID | Duty | ID | Duty |
|---|---|---|---|
| | *Use this section to list equipment covered* | | *This section can be moved to the end of this table* |
| | | | |
| | | | |
| | | | |
| | | | |

**OTHER INFORMATION**

**Notes/ Comments;**

- The mill assemblies have been operating in this, their original un-modified, configuration for many years since installation, with no reported serious failures

**POTENTIAL ADDITIONAL EXTERNAL IGNITION SOURCES**

| Type (BS EN 1127-1) | Equipment | Comments |
|---|---|---|
| Hot surfaces | Yes | More likely if component items are misaligned |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | Yes | More likely if component items are misaligned |
| Electrical apparatus | No | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | No | Component parts earthed as described in individual assessments |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Ignition likelihood not affected by assembly of components 1 & 2 |

**Notes/ Comments;**

- None

*Assessment continued - see following page*

| Table 5.1 – IGNITION ASSESSMENT ASSEMBLY – CATEGORY 2D EQUIVALENT | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **ASSEMBLY;** Roller Mill and Feeder<br>**DUTY:** Production of wheat flour by size-reduction | |
| **POTENTIAL ADDITIONAL INTERNAL IGNITION SOURCES** | | |
| **Type (BS EN 1127-1)** | **Equipment** | **Comments** |
| Hot surfaces | No | Ignition likelihood not affected by assembly of components 1 & 2 |
| Flames / hot gases | No | Not considered credible |
| Mechanical sparks | No | Ignition likelihood not affected by assembly of components 1 & 2 |
| Electrical apparatus | No | Covered by EN 60079-14 & 60079-17 |
| Stray electric currents, cathodic corrosion protection | No | Not considered credible |
| Static Electricity | No | Ignition likelihood not affected by assembly of components 1 & 2 |
| Lightning | No | Assume building as lightning protection to EN 62304 |
| Electromagnetic Waves | No | Not considered credible |
| Ionising Radiation | No | Not considered credible |
| Ultrasonic | No | Not considered credible |
| Adiabatic compression or shock waves | No | Not considered credible |
| Chemical reactions | No | Ignition likelihood not affected by assembly of components 1 & 2 |
| **Notes/ Comments;**<br>• None | | |
| **Recommendations;**<br>• Ensure engineering procedures for assembling and checking the component items includes appropriate alignment checks | | |
| **Notes / Comments;**<br>• None | | |

## APPENDIX A; EXAMPLE IGNITION ASSESSMENT TABLES - ZONE 22

Detailed example ignition risk assessments are tabulated below for the following equipment types and items in Zone 22 areas;

| Appendix A Section | Equipment Type / Item | Main Report Section |
|---|---|---|
| A.1 | Drag link (chain) Conveyors | 3.1 |
| A.2 | Screw Conveyors | 3.2 |
| A.3 | Gearboxes; supporting assessment | 3.3 |
| A.4 | Belt Drives; supporting assessment | 3.4 |
| A.5 | Chain Drives; supporting assessment | 3.5 |
| A.6 | Simple Couplings; supporting assessment | 3.6 |
| A.7 | Mill Feeder; supporting assessment | 3.7 |

For ease of cross referencing; the corresponding sections of the main report are given.

**A.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Drag link (chain) conveyors
**DUTY:** En-masse conveying of grain, flour and co-products

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ref. No | Potential Ignition Cause | Description / Basic Cause | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Reason for assessment | Description of measures applied | Basis | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Conveying chain rubbing on casing, runners / rails | | X | | | Friction between chain and casing or runners causing localised heating, | Natural heat losses from casing and dissipated from chain into conveyed material minimises operating temperature<br>Routine tensioning of conveying chain and checks for chain / runner / casing wear as part of commissioning and planned maintenance procedures | Convening chain low speed (≤ 0.5m/sec).<br>Manufacturer's estimate of power at chain sprocket shaft < 2kW<br>There is no significant history of wear greater than manufacturers expected wear and tear, over many years.<br>Localised temperatures < 100°C. | | | X | | 2D Db | N |
| 2 | Hot surfaces | Conveying chain rubbing on sprockets and trailing wheel | | X | | | Friction between chain and sprocket or wheel causing localised heating, particularly if over tensioned or not aligned with sprocket or wheel | Heat dissipated from sprocket / wheel by conduction through drive shaft and bearings and from chain into conveyed material minimises operating temperature<br>Routine tensioning of conveying chain and checks for chain / sprocket alignment and wear as part of commissioning and planned maintenance procedures | Convening chain low speed (≤ 0.5m/sec).<br>Manufacturer's estimate of power at chain sprocket shaft < 2kW<br>There is no significant history of wear greater than manufacturers expected wear and tear, over many years<br>Localised temperatures < 100°C. | | | X | | 2D Db | N |
| 3 | Hot surfaces | Sprocket cleaner rubbing on sprocket or groove cleaner rubbing on trailing wheel | | X | | | Friction between cleaner and sprocket or trailing wheel causing localised heating, particularly if not correctly adjusted | Heat dissipated from sprocket / wheel by conduction through drive shaft and bearings and from cleaner by conduction through mountings and casing.<br>Routine adjustment and checking of cleaners as part of commissioning and planned maintenance procedures | Convening chain low speed (≤ 0.5m/sec).<br>Manufacturer's estimate of power at chain sprocket shaft < 2kW<br>There is no significant history of wear greater than manufacturers expected wear and tear, over many years<br>Localised temperatures < 100°C | | | X | | 2D Db | N |
| 4 | Hot surfaces | Excessive friction caused by foreign material in the conveyor e.g. tramp metal or stones | | X | | | Large items of foreign material in the conveyed material could damage internal components and cause increased frictional heating | Shear pin fitted on drive system<br>Intake grid prevents large pieces of foreign material entering the system and further cleaning processes remove smaller items of tramp and stones.<br>Magnetic separators at key points in the process remove tramp metal. | Low speed en-masse conveying means most foreign material will be transferred through the with the conveyed material<br>There is no significant history of damage caused by foreign material, over many years.<br>Localised temperatures < 100°C. | | | X | | 2D Db | N |

**A.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Drag link (chain) conveyors
**DUTY:** En-masse conveying of grain, flour and co-products

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 5 | Hot surfaces | Bearing friction | | X | | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Sealed for life bearings or lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions. **Recommendation; Consider using periodic thermal imaging to monitor bearing temperature** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. Expected to be much lower due to slow shaft rotation speed (typically ≤ 25 rpm) | | X | | | 3D Dc | N |
| 6 | Hot surfaces | Driven and non-driven sprocket shafts rubbing on lip seals | | X | | | Friction between shaft and seal material particularly in the event of, incorrect assembly or use of incorrect sealing material | Heat dissipated from shaft through bearings and housing and from seal through seal housing and casing<br>Use of manufacturer's approved sealing materials made from synthetic fibres or elastomers<br>Routine inspection for seal & shaft wear as part of commissioning and planned maintenance procedures<br>**Note;** seal temperature can be monitored by thermal imaging (see above). | In normal operation, the temperature of a simple lip made from synthetic fibres or elastomers is not expected to exceed 100°C. Expected to be much lower due to slow shaft rotation speed (typically ≤ 25 rpm) | | | X | | 2D Db | N |
| 7 | Hot surfaces | Friction between guards and moving parts e.g. shafts, pulleys or belts, sprockets or chains | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| 8 | Hot surfaces | Friction between drive belts and pulleys | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Continuous belt and belt speed < 30m/sec.<br>*Note; belt connectors should not be used above 5m/sec.*<br>Tension and alignment checked as part of commissioning and planned maintenance procedures<br>**Recommendation; Use fire resistant belts on drive systems** | A correctly designed and installed friction belt drive, operating near the limit of its capability is not expected to exceed 50°C above ambient temperature (e.g. 90°C maximum) | | X | | | 3D Dc | N |

**A.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Drag link (chain) conveyors
**DUTY:** En-masse conveying of grain, flour and co-products

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 9 | Hot surfaces | Friction between drive chains and sprockets | | X | | | Foreseeable, particularly on start-up if chain tension or alignment is incorrect | Chain speed < 1m/sec<br>*Note; for chains operating > 1m/sec, a means of ensuring continuous positive engagement of the chain with the associated sprocket(s) is required* Tension and alignment checked as part of commissioning and planned maintenance procedures | In normal operation and start-up, the temperature is not expected to exceed 100°C for correctly adjusted chains | | X | | | 3D Dc | N |
| 10 | Hot surfaces | Friction within gearbox | | X | | | Friction occurs within internal components and bearings. Heat is lost from the casing. | Natural heat losses from gearbox casing minimises operating temperature<br>Routine lubrication as part of commissioning and planned maintenance procedures | Under normal operation casing temperature is typically ≤ 80°C. | | X | | | 3D Dc | N |
| 11 | Mechanical sparks | Contact between fixed parts and moving parts within the conveyor, including conveyor bearing failure | | | X | | Contact between moving and non-moving metal parts could create impact sparks. For carbon or stainless steel; impact speeds < 1m/sec sparks will not be incendive. | All metallic components are carbon or stainless steel | Convening chain operates at very low speed (≤ 0.5m/sec). | | | | X | 1D Da | N |
| 12 | Mechanical sparks | Contact between guards and moving parts of the drive system e.g. shafts, pulleys or belts, sprockets or chains | | X | | | Contact between moving and non-moving metal parts could create impact sparks. Motor rotational speed means impact speeds of drive pulley could exceed 1m/sec for belt drives | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| 13 | Mechanical sparks | Drive system bearing failure | | | | X | Electric motor bearings | Electric motor bearings are covered by EN 60079-14 & 60079-17 inspections | No bearing between the drive motor and the belt pulley or chain sprocket. | | | | X | -- | -- |
| 14 | Mechanical sparks | Gearbox bearing failure | | | X | | Catastrophic bearing failure is credible, but rare. | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | N |

**A.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Drag link (chain) conveyors
**DUTY:** En-masse conveying of grain, flour and co-products

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 15 | Static electricity | Charge accumulation on metal or conductive elements caused by conveyed material movement or drive chain movement | | X | | | Charge on metallic / conductive components is possible | Slow speed en-masse movement minimises charge generation<br>Earth continuity inspection and testing | Earthed by metallic internal components and casing or by metallic sprockets shafts and bearings. | | | X | | 2D Db | N |
| 16 | Static electricity | Charge accumulation on metal or conductive elements caused by drive belt movement. | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Recommendation; Use anti-static (dissipative) belts e.g. ISO 1813 on friction belt drive systems.** These provide an element of earthing, but should not be relied on to earth metallic or conductive pulleys or shafts | Pulleys are the only conductive element affected and these are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| 17 | Static electricity | Charge accumulation on non-conductive elements | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |
| 18 | Chemical reaction | Internal explosion | | | X | | Potential for internal explosion | Ignition controls defined above | Explosion risk assessment has determined internal explosion as a rare event | | | X | | 2D Db | 2 |

**Recommendations;**

- Consider using periodic thermal imaging to monitor bearing temperature and seal temperature
- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems

**Restrictions;**

1. Powder MIE must be > 30mJ
2. Applicable to equipment where explosion risk assessment has determined an internal explosion is a rare event

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**A.2 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Screw Conveyors
**DUTY:** En-masse conveying of grain, flour, gluten and co-products

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Screw auger rubbing against casing | | X | | | Friction between screw auger and casing is possible in the event of bearing failure or incorrect assembly | Minimal heat input into conveyed material during operation, natural heat losses from casing and into conveyed material minimises operating temperature<br>Clearances between screw auger and casing checked as part of commissioning and planned maintenance procedures. See bearing precautions below | Typical clearances between screw auger and casing are ≥ 1mm which means rubbing will not occur in normal operation<br>There is no significant history of wear greater than manufacturers expected wear and tear, over many years. | | | X | | 2D Db | N |
| 2 | Hot surfaces | Excessive friction caused by foreign material in the conveyor e.g. tramp metal or stones | | X | | | Large items of foreign material in the conveyed material could damage internal components and cause increased frictional heating | Intake grid prevents large pieces of foreign material entering the system and further cleaning processes remove smaller items of tramp and stones.<br>Magnetic separators at key points in the process remove tramp metal. | Low speed en-masse conveying means most foreign material will be transferred through the with the conveyed material<br>There is no significant history of damage caused by foreign material, over many years.<br>Localised temperatures < 100°C. | | | X | | 2D Db | N |
| 3 | Hot surfaces | Shaft rubbing within intermediate hanger bearing bush | X | | | | Friction will occur within the bush bearing | Heat dissipated from bearing by conduction through bearing housing and hanger.<br>Routine greasing of hanger bearing as part of commissioning and planned maintenance procedures<br>Routine checks for hanger bearing wear as part of planned maintenance procedures | There is no significant history of hanger bearing failure greater than manufacturers expected wear and tear, over many years<br>Localised temperatures < 100°C for a correctly lubricated bush bearing | | X | | | 3D Dc | N |
| 4 | Hot surfaces | Flange (end) bearing friction | | X | | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Sealed for life bearings or lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions **Recommendation; Consider using periodic thermal imaging to monitor flange bearing temperature** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. | | X | | | 3D Dc | N |

**A.2 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Screw Conveyors
**DUTY:** En-masse conveying of grain, flour, gluten and co-products

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 5 | Hot surfaces | Shafts rubbing on flange lip seals | | X | | | Friction between shaft and seal material particularly in the event of, incorrect assembly or use of incorrect sealing material | Heat dissipated from shaft through bearings and housing and from seal through seal housing and casing<br>Use of manufacturer's approved sealing materials made from synthetic fibres or elastomers<br>Routine inspection for seal & shaft wear as part of commissioning and planned maintenance procedures<br>**Note;** seal temperature can be monitored by thermal imaging (see above). | In normal operation, the temperature of a simple lip made from synthetic fibres or elastomers is not expected to exceed 100°C. | | | X | | 2D Db | N |
| 6 | Hot surfaces | Coupling friction | | X | | | Friction is possible, particularly if couplings are misaligned or loose. | Coupling and alignment checks as part of commissioning and planned maintenance procedures. | In normal operation, a correctly aligned coupling will not result in significant heat generation | | X | | | 3D Dc | |
| 7 | Hot surfaces | Friction between guards and moving parts e.g. coupling or shaft | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| 8 | Hot surfaces | Friction within gearbox, including gearbox bearing failure | | X | | | Friction occurs within internal components and bearings. Heat is lost from the casing. | Natural heat losses from gearbox casing minimises operating temperature<br>Routine lubrication as part of commissioning and planned maintenance procedures | Under normal operation casing temperature is typically ≤ 80°C. | | X | | | 3D Dc | N |
| 9 | Mechanical sparks | Contact between fixed parts and moving parts within the conveyor, including conveyor bearing failure and entry of foreign material | | | X | | Contact between moving and non-moving metal parts could create impact sparks. For carbon or stainless steel; impact speeds < 1m/sec sparks will not be incendive. | All metallic components are carbon or stainless steel, hanger bearing is phosphor bronze<br>See Hot Surfaces above | At typical screw auger rotation speeds (~60rpm and 150-300mm dia.) the tip speed of the auger is < 1 m/sec | | | | X | 1D Da | N |
| 10 | Mechanical sparks | Contact between guards and moving parts of the drive system e.g. coupling or shaft | | | X | | Contact between moving and non-moving metal parts could create impact sparks. Motor rotational speed means impact speeds of drive pulley or drive chain could exceed 1m/sec | See Hot Surfaces above | At gearbox output speed, the tip speed of rotating drive system components is < 1m/sec. | | | | X | 1D Da | N |

**A.2 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Screw Conveyors<br>**DUTY:** En-masse conveying of grain, flour, gluten and co-products | **ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 11 | Mechanical sparks | Bearing failure, flange (end) bearings, intermediate (hanger) bearings | | | X | | Catastrophic bearing failure is credible, but rare. | See Hot Surfaces above | At gearbox output speed, the tip speed of rotating drive system components is < 1m/sec. | | | | X | 1D Da | N |
| 12 | Mechanical sparks | Drive system bearing failure | | | | X | Electric motor bearings | Electric motor bearings are covered by EN 60079-14 & 60079-17 inspections | | | | | X | -- | -- |
| 13 | Mechanical sparks | Gearbox bearing failure | | | X | | Catastrophic bearing failure is credible, but rare. | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | N |
| 14 | Static electricity | Charge accumulation on metal or conductive elements caused by conveyed material movement or screw auger movement | | X | | | Charge on metallic / conductive components is possible | Relatively slow speed en-masse movement minimises charge generation<br>Earth continuity inspection and testing<br>**Ensure plastic inserts used to hold intermediate phosphor bronze bush bearings are made of anti-static (dissipative) material** | Earthed by metallic internal components and casing or by metallic screw auger shafts and bearings. | | X | | | 3D Dc | N |
| 15 | Static electricity | Charge accumulation on non-conductive elements | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |
| 16 | Chemical reaction | Internal explosion | | | X | | Potential for internal explosion | Ignition controls defined above | Explosion risk assessment has determined internal explosion as a rare event | | | X | | 2D Db | 2 |

**Recommendations;**

- Consider using periodic thermal imaging to monitor bearing temperature and seal temperature

**Restrictions;**

1. Powder MIE must be > 30mJ
2. Applicable to equipment where explosion risk assessment has determined an internal explosion is a rare event

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Plastic inserts used to hold intermediate phosphor bronze bush bearings are made of anti-static (dissipative) material
- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**A.3 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Gearboxes; supporting assessment
**DUTY:** Speed reduction on drive systems

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Gears, frictional heating | | X | | | Friction between gears, causing localised heating.<br>Heat transferred to lubricant. | Heat transfer to lubricant | Localised gear temperature is typically ≤ 100°C.<br>Lubrication minimises casing temperature to ≤ 80°C (see below) | | X | | | 3D Dc | |
| 2 | Hot surfaces | Lubricant temperature | | X | | | Shaft and gear rotation and friction will cause the lubricant temperature to increase, but heat is dissipated by conduction through casing | Routine lubrication as part of commissioning and planned maintenance procedures. | Under normal operation temperature is typically ≤ 80°C. Will only exceed this in the event of lubrication failure | | X | | | 3D Dc | |
| 3 | Hot surfaces | Gearbox casing, including internal bearings | | X | | | Friction occurs within internal components and bearings. Heat is lost from the casing. | Natural heat losses from gearbox casing minimises operating temperature | Under normal operation casing temperature is typically ≤ 80°C. | | X | | | 3D Dc | |
| 4 | Hot surfaces | Shaft bearing(s), frictional heating | | X | | | Friction within bearing but heat is dissipated by conduction through bearing housing | Sealed for life bearings or lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. | | X | | | 3D Dc | |
| 5 | Hot surfaces | Lip seal(s) | | X | | | Excessive frictional heating could occur in the event of, incorrect assembly or use of incorrect sealing material | Routine seal inspection as part of planned maintenance procedures.<br>Elastomeric seal material is suitable for un-lubricated seal | Lip seal localised temperature typically ≤ 10°C above the gearbox casing temperature in normal operation | | X | | | 3D Dc | |
| 6 | Hot surfaces | Coupling friction | | X | | | Friction is possible, particularly if couplings are misaligned or loose. | Coupling and alignment checks as part of commissioning and planned maintenance procedures. | In normal operation, a correctly aligned coupling will not result in significant heat generation | | X | | | 3D Dc | |
| 7 | Hot surfaces | Friction between guards and moving parts e.g. couplings and shafts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | |

**A.3 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Gearboxes; supporting assessment<br>**DUTY:** Speed reduction on drive systems | **ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 8 | Mechanical sparks | Bearing or Coupling failure | | | X | | Catastrophic failure is credible, but rare | See hot surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | N |
| 9 | Mechanical sparks | Contact between guards and moving parts e.g. couplings and shafts | | X | | | Mechanically generated sparks are credible. | See hot surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| 10 | Electrostatic | Charge accumulation on non-conductive lubricant caused by movement and splashing | | | X | | Non-conductive or low conductivity lubricant fluid has potential to accumulate charge | Lubricant remains within gearbox casing which is earthed (see below) | Powdered materials handled have high MIE | | | | X | 1D Da | 1 |
| 11 | Electrostatic | Charge accumulation on metal or conductive elements caused by movement | | X | | | Charge on metallic / conductive components is possible | Earth continuity inspection and testing | Gearbox casing, gears, shafts and main components are metallic and are earthed by earthing of the gearbox casing | | X | | | 3D Dc | N |
| 12 | Static electricity | Electrostatic; charge accumulation on non-conductive lubricant and / or elements | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |

**Recommendations;**

- Consider using periodic thermal imaging to monitor temperature
- Consider using vibration analysis to monitor for progressive and / or sudden changes in vibration level
- Consider using oil analysis to monitor for progressive and / or sudden oil degradation

**Restrictions;**

1. Powder MIE must be > 30mJ

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**A.4 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Belt Drives; supporting assessment
**DUTY:** Speed reduction on drive systems

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Friction between belts and pulleys | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Continuous belt and belt speed < 30m/sec. *Note; belt connectors should not be used above 5m/sec.* Tension and alignment checked as part of commissioning and planned maintenance procedures **Recommendation; Use fire resistant belts on drive systems** | A correctly designed and installed friction belt drive, operating near the limit of its capability is not expected to exceed 50°C above ambient temperature (e.g. 90°C maximum) | | X | | | 3D Dc | N |
| 2 | Hot surfaces | Friction between guards and moving parts e.g. shafts, pulleys or belts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| 3 | Mechanical sparks | Contact between guards and moving parts e.g. pulleys and shafts | | X | | | Mechanically generated sparks are credible. | See hot surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| 4 | Static electricity | Charge accumulation on metal or conductive elements caused by belt movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Recommendation; Use anti-static (dissipative) belts e.g. ISO 1813 on friction belt drive systems.** These provide an element of earthing, but should not be relied on to earth metallic or conductive pulleys or shafts | Pulleys are the only conductive element affected and these are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| 5 | Static electricity | Charge accumulation on non-conductive elements (belts) | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |

**Recommendations;**

- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems

**Restrictions;**

1. Powder MIE must be > 30mJ

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**A.5 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Chain Drives; supporting assessment
**DUTY:** Speed reduction on drive systems

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Friction between guards and moving parts e.g. shafts, sprockets or chains | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| 2 | Hot surfaces | Friction between chains and sprockets | | X | | | Foreseeable, particularly on start-up if chain tension or alignment is incorrect | Chain speed < 1m/sec<br>*Note; for chains operating > 1m/sec, a means of ensuring continuous positive engagement of the chain with the associated sprocket(s) is required*<br>Tension and alignment checked as part of commissioning and planned maintenance procedures | In normal operation and start-up, the temperature is not expected to exceed 100°C for correctly adjusted chains | | X | | | 3D Dc | N |
| 3 | Mechanical sparks | Contact between guards and moving parts of the drive system e.g. shafts, sprockets or chains or due to chain failure | | X | | | Contact between moving and non-moving metal parts could create impact sparks. Motor rotational speed means impact speeds of drive pulley or drive chain could exceed 1m/sec, but are no expected to be > 10 m/sec | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| 4 | Static electricity | Charge accumulation on metal or conductive elements caused by movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | Earth continuity inspection and testing | Earthed by metallic sprockets shafts and bearings. | | X | | | 3D Dc | N |
| 5 | Static electricity | Charge accumulation on non-conductive elements | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |

**Recommendations;**
- None

**Restrictions;**
1. Powder MIE must be > 30mJ

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided
- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**A.6 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Simple Couplings; supporting assessment
**DUTY:** Connections between rotating shafts

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Coupling friction | | X | | | Friction is possible, particularly if couplings are misaligned or loose. | Coupling and alignment checks as part of commissioning and planned maintenance procedures. Where elastomeric elements are used; fire resistant elastomeric materials will provide an extra safeguard | In normal operation, a correctly aligned coupling will not result in significant heat generation. | | X | | | 3D Dc | N |
| 2 | Hot surfaces | Friction between guards and moving parts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| 3 | Mechanical sparks | Coupling failure | | | X | | Catastrophic failure is credible, but rare | See hot surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | N |
| 4 | Mechanical sparks | Contact between guards and moving parts | | X | | | Mechanically generated sparks are credible. | See hot surfaces above | | | X | | | 3D Dc | N |
| 5 | Static electricity | Charge accumulation on metal or conductive elements caused by movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | Where elastomeric elements are used; anti-static (dissipative) materials will provide an extra safeguard by providing additional earth path | Metal coupling elements are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| 6 | Static electricity | Charge accumulation on non-conductive elements (elastomeric elements) | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |

**Recommendations;**

- Where elastomeric elements are used; use fire retardant, anti-static (dissipative) materials

**Restrictions;**

1. Powder MIE must be > 30mJ

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**A.7 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Mill Feeder; supporting assessment
**DUTY:** Feeding wheat grain into Roller Mill

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 1 | Hot surfaces | Feed roll or screw auger rubbing against fixed parts e.g. scraper, feed gate, casing | | X | | | Friction between roll or screw auger and fixed parts is possible in the event of bearing failure or incorrect assembly | Minimal heat input into conveyed material during operation, natural heat losses from casing and by conduction from metal roll or auger via drive shaft minimises operating temperature<br>Adjustment of feed gap stops and minimum gap between roll, auger and fixed parts checked as part of commissioning and planned maintenance procedures | Minimum gap between roll, auger and fixed parts is **** mm (specified by manufacturer) which means metal on metal rubbing will not occur in normal operation<br>There is no significant history of wear greater than manufacturers expected wear and tear, over many years. | | | X | | 2D Db | N |
| 2 | Hot surfaces | Excessive friction caused by foreign material in the feeder e.g. tramp metal or stones | | X | | | Large items of foreign material in the feed material could cause increased frictional heating | Upstream sieve and destoner prevents large pieces of foreign material entering mill system<br>**Ensure there is a magnetic trap in the upstream feed system e.g. between the First Break Hopper and First Break Mill** | There is no significant history of damage caused by foreign material, over many years. Localised temperatures < 100°C. | | | X | | 2D Db | N |
| 3 | Hot surfaces | Drive shaft bearing friction (roll and screw auger) | | X | | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Sealed for life bearings or lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions**. Recommendation; Consider using periodic thermal imaging to monitor bearing temperature** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. | | X | | | 3D Dc | N |
| 5 | Hot surfaces | Shafts rubbing on drive shaft lip seals (roll and screw auger) | | X | | | Friction between shaft and seal material particularly in the event of, incorrect assembly or use of incorrect sealing material | Heat dissipated from shaft through bearings and housing and from seal through seal housing and casing<br>Use of manufacturer's approved sealing materials made from synthetic fibres or elastomers<br>Routine inspection for seal & shaft wear as part of commissioning and planned maintenance procedures<br>**Note;** seal temperature can be monitored by thermal imaging (see above). | In normal operation, the temperature of a simple lip made from synthetic fibres or elastomers is not expected to exceed 100°C. Will be much lower for slewing axle bearing due to limited rotation and slow speed | | | X | | 2D Db | N |
| 6 | Hot surfaces | Friction between guards and moving parts e.g. shafts, pulleys or belts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guarding is provided by the outer casing surrounding the drive elements. Fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if the outer casing is fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |

**A.7 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Mill Feeder; supporting assessment
**DUTY:** Feeding wheat grain into Roller Mill

**ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 7 | Hot surfaces | Friction between drive belts and pulleys | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Continuous belt and belt speed < 30m/sec. *Note; belt connectors should not be used above 5m/sec.* Tension and alignment checked as part of commissioning and planned maintenance procedures **Recommendation; Use fire resistant belts on drive systems** | A correctly designed and installed friction belt drive, operating near the limit of its capability is not expected to exceed 50°C above ambient temperature (e.g. 90°C maximum) | | X | | | 3D Dc | N |
| 8 | Hot surfaces | Excessive friction caused by incorrectly assembled input drive systems | | X | | | Foreseeable depending on the type of connection / couplings on input connections | Correct assembly / alignment of input transmission systems or couplings | See separate assessment for assemblies; Correctly assembled components should not introduce additional ignition sources | | | X | | 2D Db | N |
| 9 | Mechanical sparks | Contact between fixed parts and moving parts within the feeder, including bearing failure and entry of foreign material | | | X | | Contact between moving and non-moving metal parts could create impact sparks. For carbon or stainless steel; impact speeds < 1m/sec sparks will not be incendive. | All metallic components are carbon or stainless steel, hanger bearings are phosphor bronze See Hot Surfaces above | At the maximum roll rotation speeds (100rpm and 120mm dia.) the tip speed of the roll and auger is < 0.7 m/sec | | | | X | 1D Da | N |
| 10 | Mechanical sparks | Contact between guards and moving parts of the drive system e.g. coupling or shaft | | | X | | Contact between moving and non-moving metal parts could create impact sparks. | See Hot Surfaces above | The tip speed of rotating drive system components is < 1m/sec. | | | | X | 1D Da | N |
| 11 | Mechanical sparks | Drive shaft bearing failure (roll and screw auger) | | | X | | Catastrophic bearing failure is credible, but rare. | See Hot Surfaces above | At gearbox output speed, the tip speed of rotating drive system components is < 1m/sec. | | | | X | 1D Da | N |
| 12 | Static electricity | Charge accumulation on metal or conductive elements caused by movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | Where elastomeric elements are used; anti-static (dissipative) materials will provide an extra safeguard by providing additional earth path | Metal coupling elements are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| 13 | Static electricity | Charge accumulation on metal or conductive elements caused by drive belt movement. | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Recommendation; Use anti-static (dissipative) belts e.g. ISO 1813 on friction belt drive systems.** These provide an element of earthing, but should not be relied on to earth metallic or conductive pulleys or shafts | Pulleys are the only conductive element affected and these are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |

**A.7 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Mill Feeder; supporting assessment<br>**DUTY:** Feeding wheat grain into Roller Mill | **ATEX Requirement;** External & Internal; Group II, Category 3D (EPL Dc), T3<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| 14 | Static electricity | Charge accumulation on other non-conductive elements (other elastomeric elements) | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |

**Recommendations;**

- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems
- Where other elastomeric elements are used; use fire retardant, anti-static (dissipative) materials if practicable

**Restrictions;**

1. Powder MIE must be > 30mJ

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Correct assembly / alignment of input transmission systems or couplings (see separate supporting and assembly assessments)
- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

## APPENDIX B; IGNITION ASSESSMENT TABLES - ZONE 20/21

Detailed ignition risk assessments are tabulated below for the following equipment types and items in Zone 20/21 areas;

| Appendix B Section | Equipment Type / Item | Main Report Section |
|---|---|---|
| B.1 | Belt & bucket elevators, belt driven | 4.1 |
| B.2 | Roller Mills | 4.2 |
| B.3 | Bran Finisher | 4.3 |

For ease of cross referencing; the corresponding sections of the main report are given.

**B.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven
**DUTY:** Conveying of cleaned grain - Example B; CEN/TR 16829:2016

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| E.1 | Hot surfaces (external) | Friction between guards and moving parts e.g. shafts, pulleys or belts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guard fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if guards are fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| E.2 | Hot surfaces (external) | Friction between drive belts and pulleys | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Continuous belt and belt speed < 30m/sec.<br>*Note; belt connectors should not be used above 5m/sec.*<br>Tension and alignment checked as part of commissioning and planned maintenance procedures<br>**Recommendation; Use fire resistant belts on drive systems** | A correctly designed and installed friction belt drive, operating near the limit of its capability is not expected to exceed 50°C above ambient temperature (e.g. 90°C maximum) | | X | | | 3D Dc | N |
| E.3 | Hot surfaces (external) | Friction within gearbox | | X | | | Friction occurs within internal components and bearings. Heat is lost from the casing. | Natural heat losses from gearbox casing minimises operating temperature<br>Routine lubrication as part of commissioning and planned maintenance procedures<br>**Recommendation; Consider using periodic thermal imaging to monitor gearbox temperature** | Under normal operation casing temperature is typically ≤ 80°C. | | X | | | 3D Dc | N |
| E.4 | Hot surfaces (external) | Pedestal bearing friction | | X | | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions<br>**Recommendation; Consider using periodic thermal imaging to monitor pedestal bearing temperature** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. Expected to be much lower due to slow shaft rotation speed (typically ≤ 25 rpm) | | X | | | 3D Dc | N |
| E.5 | Mechanical sparks (external) | Contact between guards and moving parts of the drive system e.g. shafts, pulleys | | X | | | Contact between moving and non-moving metal parts could create impact sparks. Motor rotational speed means impact speeds of drive pulley or drive chain could exceed 1m/sec | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| E.6 | Mechanical sparks (external) | Drive system bearing failure | | | | X | Electric motor bearings | Electric motor bearings are covered by EN 60079-14 & 60079-17 inspections | No bearing between the drive motor and the belt pulley. | | | | X | -- | -- |

**B.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven
**DUTY:** Conveying of cleaned grain - Example B; CEN/TR 16829:2016

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| E.7 | Mechanical sparks (external) | Gearbox bearing failure | | | X | | Catastrophic bearing failure is credible, but rare. | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | N |
| E.8 | Static electricity (external) | Charge accumulation on metal or conductive elements caused by drive belt movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Recommendation; Use anti-static (dissipative) belts e.g. ISO 1813 on friction belt drive systems.** These provide an element of earthing, but should not be relied on to earth metallic or conductive pulleys or shafts | Pulleys are the only conductive element affected and these are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| E.9 | Static electricity (external) | Charge accumulation on non-conductive elements (belts) | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |
| E.10 | Various | Ignition sources from within the equipment | | | X | | See below | See below, internal ignition sources only in the event of rare malfunction | See below | | | X | | 2D Db | N |
| I.1 | Hot surfaces (internal) | Conveying belt or buckets rubbing on casing | | X | | | Friction between belt or buckets and the casing causing localised heating, particularly if the belt becomes misaligned | Routine belt alignment checks and checks for wear as part of commissioning and planned maintenance procedures. **Ensure belt alignment sensors are installed and elevator is shutdown on misalignment** | In normal operation, there is no contact between the belt or buckets and the casing. There is no significant history of wear greater than manufacturers expected wear and tear, over many years. | | | X | | 2D Db | N |
| I.2 | Hot surfaces (internal) | Conveying belt rubbing on pulley wheels | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Tension and checked as part of commissioning and planned maintenance procedures.<br>See above for alignment<br>**Ensure fire resistant conveying belts are used on bucket elevators**<br>**Ensure low speed sensors are installed on the non-driven (boot) pulley shaft to detect significant belt slippage and shut down elevator on low speed** | In normal operation and start-up, the temperature is not expected to exceed 100°C for correctly adjusted belts. | | | X | | 2D Db | N |

**B.1 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven
**DUTY:** Conveying of cleaned grain - Example B; CEN/TR 16829:2016

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.3 | Hot surfaces (internal) | Bearing friction (bearings housed on elevator casing) | | X | | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions<br>**Ensure periodic thermal imaging is used to monitor pulley bearing temperatures.**<br>**Recommendation; Consider installing bearing temperature monitoring on bearings housed on the elevator casing** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. Expected to be much lower due to slow shaft rotation speed | | | X | | 2D Db | N |
| I.4 | Hot surfaces (internal) | Driven and non-driven pulley wheel shafts rubbing on lip seals | | X | | | Friction between shaft and seal material particularly in the event of, incorrect assembly or use of incorrect sealing material | Heat dissipated from shaft through bearings and housing and from seal through seal housing and casing<br>Use of manufacturer's approved sealing materials made from synthetic fibres or elastomers<br>Routine inspection for seal & shaft wear as part of commissioning and planned maintenance procedures<br>**Note;** seal temperature can be monitored by bearing temperature monitoring above | In normal operation, the temperature of a simple lip made from synthetic fibres or elastomers is not expected to exceed 100°C. Expected to be much lower due to slow shaft rotation speed | | | X | | 2D Db | N |
| I.5 | Hot surfaces (internal) | Excessive friction caused by foreign material in the conveyor e.g. tramp metal or stones | | X | | | Large items of foreign material in the conveyed material could damage internal components and cause increased frictional heating | Upstream cleaning using a sieve and destoner will prevent large items of foreign material entering the elevator | Relatively low speed en-masse conveying means most foreign material will be transferred through the with the conveyed material<br>There is no significant history of damage caused by foreign material, over many years. Localised temperatures < 100°C. | | | X | | 2D Db | N |
| I.6 | Mechanical sparks (internal) | Contact between metal buckets and elevator casing due to belt misalignment | | X | | | Contact between moving and non-moving metal parts could create impact sparks as the belt speed is > 1m/sec | See Hot surfaces above. | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | N |

**B.1 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Belt & bucket elevators, belt driven<br>**DUTY:** Conveying of cleaned grain - Example B; CEN/TR 16829:2016 | **ATEX External Requirement;** Group II, Category 3D (EPL Dc),<br>**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.7 | Static electricity (internal) | Charge accumulation on metal or conductive elements (e.g. metal buckets) caused by belt movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Ensure pulley wheel lagging and conveying belt are anti-static (dissipative)** | Pulleys wheels are earthed via the drive shafts and bearings.<br>Metal buckets and attachments to the belt can only be earthed by use of anti-static (dissipative belt and pulley wheel lagging). | | | X | | 2D Db | N |
| I.8 | Static electricity (internal) | Charge accumulation on non-conductive elements (belts) | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Powdered materials handled have high MIE > 30 mJ | | | | X | 1D Da | 1 |
| I.9 | Chemical reaction (internal) | Internal explosion | | | X | | Potential for internal explosion | Ignition controls defined above | Explosion risk assessment has determined internal explosion as a rare event. Use of flameless explosion relief provides additional control on most elevators | | | X | | 2D Db | 2 |

**Recommendations;**

- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems
- Consider installing bearing temperature monitoring on bearings housed on the elevator casing
- Consider using periodic thermal imaging to monitor operating temperatures of external parts of the drive system e.g. belt drive, gearbox and external pedestal bearings
- Assign the appropriate level of safety criticality to the key maintenance and inspection control measures for internal ignition source control identified above

**Restrictions;**

1. Powder MIE must be > 30mJ
2. Applicable to equipment where explosion risk assessment has determined an internal explosion is a rare event

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Conveying belts are fire resistant / anti-static (dissipative)
- Belt alignment sensors are installed and elevator is shutdown on misalignment
- Low speed sensors are installed on the non-driven (boot) pulley shaft to detect significant belt slippage and shut down elevator on low speed
- Periodic thermal imaging is used to monitor pulley shaft bearing and seal temperatures
- Pulley wheel lagging is made of anti-static (dissipative) materials
- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**B.2 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Roller Mill
**DUTY:** Production of wheat flour by size-reduction

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| E.1 | Hot surfaces (external) | Friction between guards and moving parts e.g. shafts, pulleys or belts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guarding is provided by the mill outer casing surrounding the drive elements. Fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if the outer casing is fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| E.2 | Hot surfaces (external) | Friction between drive belts and pulleys | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Continuous belt and belt speed < 30m/sec.<br>*Note; belt connectors should not be used above 5m/sec.*<br>Tension and alignment checked as part of commissioning and planned maintenance procedures<br>**Recommendation; Use fire resistant belts on drive systems** | A correctly designed and installed friction belt drive, operating near the limit of its capability is not expected to exceed 50°C above ambient temperature (e.g. 90°C maximum) | | X | | | 3D Dc | N |
| E.3 | Hot surfaces (external) | Friction within gearbox | | X | | | Friction occurs within internal components and bearings. Heat is lost from the casing. | Natural heat losses from gearbox casing minimises operating temperature<br>Routine lubrication as part of commissioning and planned maintenance procedures<br>**Recommendation; Consider using periodic thermal imaging to monitor gearbox temperature**<br>**Recommendation; Consider using oil analysis to monitor for progressive and / or sudden oil degradation** | Under normal operation casing temperature is typically ≤ 80°C. | | X | | | 3D Dc | N |
| E.4 | Hot surfaces (external) | Pedestal bearing friction | | X | | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions<br>**Recommendation; Consider using periodic thermal imaging to monitor pedestal bearing temperature** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. Expected to be much lower due to slow shaft rotation speed (typically ≤ 25 rpm) | | X | | | 3D Dc | N |

**B.2 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Roller Mill
**DUTY:** Production of wheat flour by size-reduction

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| E.5 | Mechanical sparks (external) | Contact between guards and moving parts e.g. shafts, pulleys | | X | | | Contact between moving and non-moving metal parts could create impact sparks. | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| E.6 | Mechanical sparks (external) | Drive system bearing failure | | | | X | Electric motor bearings | Electric motor bearings are covered by EN 60079-14 & 60079-17 inspections | | | | | X | -- | -- |
| E.7 | Static electricity (external) | Charge accumulation on metal or conductive elements caused by belt movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Recommendation; Use anti-static (dissipative) belts e.g. ISO 1813 on friction belt drive systems.** These provide an element of earthing, but should not be relied on to earth metallic or conductive pulleys or shafts | Pulleys are the only conductive element affected and these are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| E.8 | Static electricity (external) | Charge accumulation on non-conductive elements e.g. belts or gearbox lubricant | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Wheat flour has high MIE > 30 mJ | | | | X | 1D Da | 2 |
| E.9 | Various | Ignition sources from within the equipment | | | X | | See below | See below, internal ignition sources only in the event of rare malfunction | See below | | | X | | 2D Db | N |
| I.1 | Hot surfaces (internal) | Rolls rubbing against fixed parts e.g. scraper, guide plates or fixed parts | | | X | | Friction between roll and fixed parts is possible in the event of bearing failure or incorrect assembly | Minimal heat input into material during operation, natural heat losses from casing and by conduction from metal rolls via drives shaft minimises operating temperature. Roll alignment and clearances between rolls and key fixed parts checked as part of commissioning and planned maintenance procedures **Ensure quality build plan and check sheets with independent sign off for key checks are in place** | Minimum clearances between rolls and fixed part is **** mm (specified by manufacturer) which means metal on metal rubbing will not occur in normal operation There is no significant history of wear greater than manufacturers expected wear and tear, over many years. | | | | X | 1D Da | N |

**B.2 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Roller Mill
**DUTY:** Production of wheat flour by size-reduction

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.2 | Hot surfaces (internal) | Excessive friction caused by contact between moveable and fixed rolls | | | X | | Excessive friction between rolls is possible in the event of bearing failure or incorrect assembly | Roll alignment, parallelism and minimum gap between moveable and fixed rolls checked as part of commissioning and planned maintenance procedures.<br>**Ensure quality build plan and check sheets with independent sign off for key checks are in place** | Counter rotating rolls minimise speed difference between contact surfaces<br>There is no significant history of wear greater than manufacturers expected wear and tear, over many years. | | | | X | 1D Da | N |
| I.3 | Hot surfaces (internal) | Excessive friction caused by foreign material in caught between rolls e.g. tramp metal or stones | | | X | | Large items of foreign material in the feed material could cause increased frictional heating | Upstream sieve and destoner prevents large pieces of foreign material entering mill system<br>**Ensure there is a magnetic trap in the upstream feed system e.g. between the First Break Hopper and First Break Mill**<br>Pre-tensioned springs or pneumatic dampers (foreign matter safety devices) opens grinding gap if foreign material enters roll gap. Spring tension or pressure setting checked as part of commissioning and planned maintenance procedures.<br>**Ensure quality build plan and check sheets with independent sign off for key checks are in place** | Several upstream controls have to fail before significantly sized tramp enters the mill system.<br>There is no significant history of damage caused by foreign material, over many years.<br>Localised temperatures < 100°C. | | | | X | 1D Da | N |

**B.2 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Roller Mill<br>**DUTY:** Production of wheat flour by size-reduction | **ATEX External Requirement;** Group II, Category 3D (EPL Dc),<br>**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.4 | Hot surfaces (internal) | Roll shaft bearing friction | | | X | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Bearings are not mounted directly onto the inner mill casing and excessive heat from bearing failure will be conducted and dissipated via the drive system<br>Lubrication checks as part of commissioning. Periodic manual lubrication of bearings in line with manufacturer's instructions<br>**Ensure periodic thermal imaging is used to monitor roll shaft bearing temperature.**<br>**Ensure compliance with the defined lubrication schedule is formally audited to monitor compliance**<br>**Ensure quality build plan and check sheets with independent sign off for key checks are in place**<br>**Recommendation; Consider installing roll shaft bearing temperature monitoring / trips** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings.<br><br>Note; bearing failure could lead to other caused of ignition (see above) | | | | X | 1D Da | N |
| I.5 | Hot surfaces | Shafts rubbing on roll shaft lip seals | | X | | | Friction between shaft and seal material particularly in the event of, incorrect assembly or use of incorrect sealing material | Heat dissipated from shaft through bearings and housing and from seal through seal housing and casing<br>Use of manufacturer's approved sealing materials made from synthetic fibres or elastomers<br>Routine inspection for seal & shaft wear as part of commissioning and planned maintenance procedures<br>**Note;** seal temperature can be monitored by thermal imaging (see above). | In normal operation, the temperature of a simple lip made from synthetic fibres or elastomers is not expected to exceed 100°C. | | | X | | 2D Db | N |

**B.2 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Roller Mill
**DUTY:** Production of wheat flour by size-reduction

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.6 | Mechanical Sparks (internal) | Contact between rolls and fixed parts e.g. scraper, guide plates or fixed parts | | | X | | Contact between moving and non-moving metal parts could create impact sparks. Roll tips speeds >> 1m/sec are high enough to cause impact sparks for steel / steel impacts | See Hot surfaces above.<br>Flour dust clouds are not particularly sensitive to ignition caused by mechanical impact sparks (see Section 2.2) | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, impact sparks are also controlled. However, mechanical spark ignition sources are still possible as the foreign matter safety device may not operate quickly enough to prevent a single impact spark. | | | X | | 2D Db | 2 |
| I.7 | Mechanical Sparks (internal) | Contact between moveable and fixed rolls | | | X | | Contact between moving and non-moving metal parts could create impact sparks. For carbon or stainless steel; impact speeds < 1m/sec sparks will not be incendive. | All metallic components are carbon or stainless steel | Difference in speed between fast roll and slow roll is expected to give a differential tip speed is << 1 m/sec.<br>Counter rotating rolls prevents higher tips speeds if rolls were to contact each other. | | | | X | 1D Da | 2 |
| I.8 | Mechanical Sparks (internal) | Contact between foreign material and rolls e.g. tramp metal or stones | | | X | | Large items of foreign material in the feed material could become trapped between rolls | See Hot surfaces above. | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | | X | 1D Da | 2 |
| I.9 | Static electricity (internal) | Charge accumulation on metal or conductive elements caused by material movement or roll movement | | | X | | Charge on metallic / conductive components is possible | Commissioning and planned maintenance based on manufacturer's instructions, which includes checking of internal earthing connections and mill body / casing. Earth continuity inspection and testing | Earthed by metallic internal components and internal earthing connection to casing or by metallic rolls, shafts and bearings. | | | | X | 1D Da | N |
| I.10 | Static electricity (internal) | Charge accumulation on non-conductive elements | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Wheat flour has high MIE > 30 mJ | | | | X | 1D Da | 1 |
| I.11 | Chemical reaction (internal) | Smouldering / burning material generated by dust trapped between parts (see I.1 to I.5 hot surfaces above) | | X | | | Flour dust within parts of roller mills has been known to be heated to smouldering. | The wheat flours under consideration do not burn to produce flames or incandescent particles and they are unlikely to become effective ignition sources for a flour dust cloud. Restriction placed on material duty | See discussion in Sections 2.2 and 2.3 of the main body of this report | | | X | | 2D Db | 2 |

**B.2 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Roller Mill<br>**DUTY:** Production of wheat flour by size-reduction | **ATEX External Requirement;** Group II, Category 3D (EPL Dc),<br>**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.12 | Chemical reaction (internal) | Internal explosion | | | X | | Potential for internal explosion | Ignition controls defined above | Explosion risk assessment has determined internal explosion as a rare event. | | | X | | 2D Db | 3 |

**Recommendations;**

- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems
- Consider using periodic thermal imaging to monitor gearbox temperature
- Consider using oil analysis to monitor for progressive and / or sudden oil degradation
- Consider using periodic thermal imaging to monitor pedestal bearing temperature
- Consider installing roll shaft bearing temperature monitoring / trips
- Assign the appropriate level of safety criticality to the key maintenance and inspection control measures for internal ignition source control identified above

**Restrictions;**

1. Powder MIE must be > 30mJ
2. Wheat flour duty only; White bread making flour and Wholemeal flour
3. Applicable to equipment where explosion risk assessment has determined an internal explosion is a rare event

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Quality build plan and check sheets with independent sign off for key checks are in place
- There is a magnetic trap in the upstream feed system e.g. between the First Break Hopper and First Break Mill
- Periodic thermal imaging is used to monitor roll shaft bearing temperature.
- Compliance with the defined lubrication schedule is formally audited to monitor compliance
- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

**B.3 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Bran Finisher
**DUTY:** Separation of grades of flour products

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| E.1 | Hot surfaces (external) | Friction between guards and moving parts e.g. shafts, pulleys or belts | | X | | | Foreseeable if guards are loose or incorrectly fitted | Guarding is provided surrounding the drive elements. Fixing and clearances checked as part of commissioning and planned maintenance procedures | No rubbing can occur in normal operation if the outer casing is fixed in place with suitable clearances from moving parts | | X | | | 3D Dc | N |
| E.2 | Hot surfaces (external) | Friction between drive belts and pulleys | | X | | | Foreseeable, particularly on start-up if belt tension or alignment is incorrect | Continuous belt and belt speed < 30m/sec. *Note; belt connectors should not be used above 5m/sec.* Tension and alignment checked as part of commissioning and planned maintenance procedures **Recommendation; Use fire resistant belts on drive systems** | A correctly designed and installed friction belt drive, operating near the limit of its capability is not expected to exceed 50°C above ambient temperature (e.g. 90°C maximum) | | X | | | 3D Dc | N |
| E.3 | Mechanical sparks (external) | Contact between guards and moving parts e.g. shafts, pulleys | | X | | | Contact between moving and non-moving metal parts could create impact sparks. | See Hot Surfaces above | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | X | | | 3D Dc | N |
| E.4 | Mechanical sparks (external) | Drive system bearing failure | | | | X | Electric motor bearings | Electric motor bearings are covered by EN 60079-14 & 60079-17 inspections | | | | | X | -- | -- |
| E.7 | Static electricity (external) | Charge accumulation on metal or conductive elements caused by belt movement | | X | | | Contact and separation occurs as part of normal operation, but metal / conductive elements are earthed | **Recommendation; Use anti-static (dissipative) belts e.g. ISO 1813 on friction belt drive systems.** These provide an element of earthing, but should not be relied on to earth metallic or conductive pulleys or shafts | Pulleys are the only conductive element affected and these are earthed via the drive shafts and bearings | | X | | | 3D Dc | N |
| E.8 | Static electricity (external) | Charge accumulation on non-conductive elements e.g. belts | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Wheat flour has high MIE > 30 mJ | | | | X | 1D Da | 2 |
| E.9 | Various | Ignition sources from within the equipment | | | X | | See below | See below, internal ignition sources only in the event of rare malfunction | See below | | | X | | 2D Db | N |

**B.3 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Bran Finisher
**DUTY:** Separation of grades of flour products

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.1 | Hot surfaces (internal) | Rotor or beaters rubbing against fixed parts e.g. screen mesh, supports or end plates | | | X | | Friction between rotor or beater and fixed parts is possible in the event of bearing failure, incorrect assembly or loosening of beater bar holding bolts | Minimal heat input into material during operation, natural heat losses from casing and by conduction from metal rotor via drives shaft minimises operating temperature. Rotor and beater alignment and clearances between rotor / beaters and key fixed parts checked as part of commissioning and planned maintenance procedures **Ensure quality build plan and check sheets with independent sign off for key checks are in place** | Minimum clearances between rolls and fixed part is **** mm (specified by manufacturer) which means metal on metal rubbing will not occur in normal operation There is no significant history of wear greater than manufacturers expected wear and tear, over many years. | | | | X | 1D Da | N |
| I.2 | Hot surfaces (internal) | Excessive friction caused by foreign material in caught between beaters and screen e.g. tramp metal or stones | | | X | | Large items of foreign material in the feed material could cause increased frictional heating | Upstream sieve and destoner prevents large pieces of foreign material entering mill system. Clearance of ****mm between beaters and screen mean that foreign material is unlikely to become trapped. Screen is fine steel mesh or fabric and would likely puncture and allow trapped foreign material to be released **Ensure there is a magnetic trap in the upstream feed system at an appropriate point** | Several upstream controls have to fail before significantly sized tramp enters the bran finisher. There is no significant history of damage caused by foreign material, over many years. Localised temperatures < 100°C. | | | | X | 1D Da | N |
| I.4 | Hot surfaces (internal) | Rotor shaft bearing friction | | | X | | Friction within bearing, but heat is dissipated by conduction through bearing housing | Lubrication checks as part of commissioning. Auto-lubrication or periodic manual lubrication of bearings in line with manufacturer's instructions **Ensure periodic thermal imaging is used to monitor rotor shaft bearing temperature. Ensure compliance with the defined lubrication schedule is formally audited to monitor compliance Ensure quality build plan and check sheets with independent sign off for key checks are in place Recommendation; Consider installing rotor shaft bearing temperature monitoring / trips** | In normal operation, the temperature of rolling element bearings is not expected to exceed 100°C for plain bearings. Note; bearing failure could lead to other caused of ignition (see above) | | | X | | 2D Db | N |

**B.3 - EXAMPLE IGNITION ASSESSMENT**

**Site:** Illustrative Example
**Area:** Typical Flour Mill

**EQUIPMENT ITEM(S):** Bran Finisher
**DUTY:** Separation of grades of flour products

**ATEX External Requirement;** Group II, Category 3D (EPL Dc),
**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)
**Restrictions;** See numbered notes at end of the assessment

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.5 | Hot surfaces | Shafts rubbing on rotor shaft lip seals | | X | | | Friction between shaft and seal material particularly in the event of, incorrect assembly or use of incorrect sealing material | Heat dissipated from shaft through bearings and housing and from seal through seal housing and casing<br>Use of manufacturer's approved sealing materials made from synthetic fibres or elastomers<br>Routine inspection for seal & shaft wear as part of commissioning and planned maintenance procedures<br>**Note;** seal temperature can be monitored by thermal imaging (see above). | In normal operation, the temperature of a simple lip made from synthetic fibres or elastomers is not expected to exceed 100°C. | | | X | | 2D Db | N |
| I.6 | Mechanical Sparks (internal) | Contact between rotor / beaters and fixed parts e.g. screen mesh, supports or end plates | | | X | | Contact between moving and non-moving metal parts could create impact sparks. Rotor / beater tips speeds > 10 m/sec are high enough to cause impact sparks for steel / steel impacts | See Hot surfaces above.<br>Flour dust clouds are not particularly sensitive to ignition caused by mechanical impact sparks (see Section 2.2) | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, impact sparks are also controlled. | | | X | | 2D Db | 2 |
| I.7 | Mechanical Sparks (internal) | Contact between foreign material and beaters | | | X | | Large items of foreign material in the feed material could become trapped between beaters and fixed parts | See Hot surfaces above. | With appropriate controls in place to control ignition sources due to hot surfaces caused by friction, mechanical spark ignition sources are adequately controlled | | | X | | 2D Db | 2 |
| I.9 | Static electricity (internal) | Charge accumulation on metal or conductive elements caused by material movement or rotor / beater movement | | | X | | Charge on metallic / conductive components is possible | Commissioning and planned maintenance based on manufacturer's instructions, which includes checking of internal earthing connections and mill body / casing.<br>Earth continuity inspection and testing | Earthed by metallic internal components and internal earthing connection to casing or by metallic rolls, shafts and bearings. | | | | X | 1D Da | N |
| I.10 | Static electricity (internal) | Charge accumulation on non-conductive elements | | | | X | Low energy electrostatic discharges are not an effective ignition source | Not required | Wheat flour has high MIE > 30 mJ | | | | X | 1D Da | 1 |

**B.3 - EXAMPLE IGNITION ASSESSMENT**

| | | |
|---|---|---|
| **Site:** Illustrative Example<br>**Area:** Typical Flour Mill | **EQUIPMENT ITEM(S):** Bran Finisher<br>**DUTY:** Separation of grades of flour products | **ATEX External Requirement;** Group II, Category 3D (EPL Dc),<br>**ATEX Internal Requirement;** Group II, Category 2D (EPL Db)<br>**Restrictions;** See numbered notes at end of the assessment |

| Ignition Hazard | | | Assessment of frequency of occurrence without application of an additional measure | | | | | Measures applied to prevent the ignition source becoming effective | | frequency of occurrence incl. measures applied | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ref. No** | **Potential Ignition Cause** | **Description / Basic Cause** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | **Reason for assessment** | **Description of measures applied** | **Basis** | Normal Operation | Foreseeable Malfunction | Rare Malfunction | Not to be considered | Resulting Category / EPL | Restrictions |
| I.11 | Chemical reaction (internal) | Smouldering / burning material generated by dust trapped between parts (see I.1 to I.5 hot surfaces above) | | X | | | Flour dust within parts of rotary finishers has been known to be heated to smouldering. | The wheat flours under consideration do not burn to produce flames or incandescent particles and they are unlikely to become effective ignition sources for a flour dust cloud. Restriction placed on material duty | See discussion in Sections 2.2 and 2.3 of the main body of this report | | | X | | 2D Db | 2 |
| I.12 | Chemical reaction (internal) | Internal explosion | | | X | | Potential for internal explosion | Ignition controls defined above | Explosion risk assessment has determined internal explosion as a rare event. | | | X | | 2D Db | 3 |

**Recommendations;**

- Use fire resistant / anti-static (dissipative e.g. ISO 1813) belts on friction belt drive systems
- Consider installing rotor shaft bearing temperature monitoring / trips
- Assign the appropriate level of safety criticality to the key maintenance and inspection control measures for internal ignition source control identified above

**Restrictions;**

1. Powder MIE must be > 30mJ
2. Wheat bran duty only; White bread making flour and Wholemeal flour
3. Applicable to equipment where explosion risk assessment has determined an internal explosion is a rare event

**Conclusions;** the equipment assessed has been determined be suitable for the ATEX requirement defined provided

- Quality build plan and check sheets with independent sign off for key checks are in place
- There is a magnetic trap in the upstream feed system at an appropriate point
- Periodic thermal imaging is used to monitor rotor shaft bearing temperature.
- Compliance with the defined lubrication schedule is formally audited to monitor compliance
- Overhaul / reassembly is carried out by OEM approved 3rd party or competent personnel following an appropriate engineering procedure.
- The commissioning and planned maintenance regime is based on manufacturer's instructions and covers all the required control measures identified in the assessments
- An appropriate maintenance and inspection regime is in place based on guidance in Appendix B, with appropriately documented information as listed in Section 2.8

## APPENDIX C. GUIDANCE; PREVENTIVE MAINTENANCE AND INSPECTION

In the UK, the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) contains a legal requirement to demonstrate adequate arrangements are in place for the safe use of work equipment in accordance with the Provision and Use of Work Equipment Regulations (PUWER), which lists fire and explosion hazards as specific hazard types. Similar legislation also applies in Ireland.

Incorrect installation or incorrect re-installation, deterioration or other circumstances could lead to failure of ignition controls on non-electrical equipment in hazardous areas and lead to significant risk. The main requirements relating to maintenance and inspection of non-electrical equipment in hazardous areas are summarised below;

- Ensure work equipment is maintained in an efficient state, in efficient working order and in good repair
- Inspect equipment to ensure that it has been installed correctly and is safe to operate after installation or re-assembly.
- Inspect equipment to ensure ignition controls are maintained and that any deterioration can be detected and remedied in good time.
- Ensure the results of the above inspections are recorded and kept until the next inspection is recorded.
- Provide appropriate information, instructions and training

Guidance is given below relating to

1. Risk based inspection and maintenance
2. Lubrication and simple inspection
3. Seals and bearings
4. Information, instructions and training

### C.1 Risk based inspection and maintenance

It is recommended that the principles of risk-based inspection and maintenance are applied to the management of equipment in hazardous areas. Guidance is presented below in relation to non-electrical equipment using four example levels of criticality;

| Criticality | Equipment | Required risk-based maintenance and inspection regime / strategy Notes 1 & 2 |
|---|---|---|
| **Low** | Equipment outside classified zoned areas | Normal maintenance practices e.g. “good engineering practices” including simple pre-use or daily / weekly / monthly “look, listen, feel” checks; often carried out by operators or technicians during part of their normal duties. |
| **Medium** | Equipment in Zone 2 / 22 areas. | As above, plus additional selective preventive maintenance and inspection e.g. formal maintenance schedules, proof tests, inspections or condition monitoring to a formally documented scheme. |

| Criticality | Equipment | Required risk-based maintenance and inspection regime / strategy Notes 1 & 2 |
|---|---|---|
| **High** | Equipment in Zone 1 / 21 areas. | As above, plus periodic comprehensive focussed preventive maintenance and inspection e.g. formal maintenance schedules, proof tests, inspections or condition monitoring to a formally documented Examination / Maintenance / Inspection Scheme. |
| **Very High** | Equipment in Zone 0 / 20 areas. | As above, plus consider alternative techniques if practicable |

**Notes;**

1. Increase the criticality level where explosion risk assessment has determined that equipment requires a higher equipment protection level or higher integrity equipment category than is required than the minimum required by DSEAR
2. To demonstrate compliance with PUWER aspects of DSEAR, there is a requirement to formally document the maintenance and inspection regimes and to keep physical evidence (documents and records) of maintenance and inspections for medium, high and very high criticality equipment,

**General Recommendation;** Users should use the above definitions as the basis to assign appropriate levels of criticality to equipment and to maintenance / inspection routines, for non-electrical equipment in hazardous areas (Priority 1).

For non-electrical equipment / machinery meeting the requirements of the ATEX Equipment Directive; the minimum inspection, operation and maintenance requirements for the equipment are defined by the manufacturer in the Declaration of Conformity and the Original Equipment Manufacturer (OEM) Instruction Manual.

For non-electrical equipment / machinery which does not meet the requirements of the ATEX Equipment Directive (e.g. which pre-dates the ATEX Equipment Directive); the minimum inspection, operation and maintenance and inspection are defined by the ignition risk assessments.

Where equipment is CE marked, meeting the “non ATEX” requirements of the Machinery Directive; the inspection, operation and maintenance requirements defined in the OEM Instruction Manual can be used as a starting point, with additional requirements defined by the ignition assessment.

A quality build plan (e.g. a formal re-assembly or re-build procedure) is recommended for all non-electrical equipment in hazardous areas to ensure equipment is correctly installed, assembled / re-assembled before it is commissioned / re-commissioned and put into use. The quality build plan should describe the activities, standards, tools and processes necessary to achieve quality in the build or re-build of an item of equipment or of parts of the equipment. To effectively manage human failure for Category 1 and

2 equipment, it is important to use check sheets with independent sign off for key checks e.g. packed gland tightening, checking key clearances / alignment.

**General Recommendation;** Ensure suitable quality build plans are in place, with appropriate check sheets, for all non-electrical equipment in hazardous areas;

- Priority 1; equipment in Zone 20 and Zone 21 areas
- Priority 2; equipment in Zone 22 areas

Different grades and types of inspection are generally required to ensure non-electrical equipment is safe and remains safe to use, e.g.

- Simple pre-use, “look, listen, feel” or visual checks; often carried out daily, weekly or monthly by operators during part of normal duties
- Formal inspections or checks; carried out by competent mechanical technicians. These are similar in principle to formal visual inspections for electrical equipment. These checks could include lubrication schedules, general reliability tours or formal inspections. They should utilise a simple checklist to record their completion, compliance with the requirements of the inspection and any adverse findings or non-conformances.
- Working inspections; carried out by a suitably competent person e.g. similar in principle to formal close inspections for electrical equipment. Depending on their complexity, these inspections can follow a checklist as outlined or follow an inspection procedure with production of a formally documented inspection report.
- Thorough inspections; carried out by a competent person with a detailed understanding and knowledge of failure modes of the equipment and machinery concerned e.g. similar in principle to a detailed inspection for electrical equipment. These inspections should follow a detailed inspection procedure or written scheme and be recorded in a formally documented inspection report.

Several common types of inspection or checks are required on many items of non-electrical equipment as outlined below;

- Alignment procedures and checks are a key requirement e.g. on couplings, belt drives, chain and sprocket drives, and it is important to record alignment measurements to demonstrate that alignment is being carried out to the required standard. Simple methods such as the use of rulers or gauges is suitable for many items of equipment, but laser alignment methods may be required for some high criticality items.
- Machinery guarding checks are a key requirement and it must be clear to those carrying out guarding checks on equipment in hazardous areas that, in addition to any checks needed for general machinery safety, they need to check the condition, security of guards, to ensure they provide sufficient clearance to

prevent contact with moving or rotating parts. The security and condition of guards on non-electrical equipment in hazardous areas should be recorded as part of formal inspections.

Condition monitoring can also be used; a range of techniques are available and should be selected by a competent specialist to focus on early detection of failures which could cause an ignition source. Typical techniques include;

- Vibration monitoring, with or without diagnostics
- Oil / lubricant analysis
- Infrared thermography (thermal imaging)
- Acoustic or ultrasonic emission
- Monitoring of the motor system

**General Recommendation;** Ensure suitable formal maintenance and inspection regimes are in place, for all non-electrical equipment in hazardous areas;

- Priority 1; equipment in Zone 20 and Zone 21 areas
- Priority 2; equipment in Zone 22 areas

*Note; risk-based prioritisation of improvements should be based on the findings of the user's explosion risk assessment for the plant / process.*

**General Recommendation;** Ensure appropriate physical evidence, documents and records, are generated, for formal maintenance and inspection regimes;

- Priority 1; equipment in Zone 20 and Zone 21 areas
- Priority 2; equipment in Zone 22 areas

**General Recommendation;** Ensure systems are in place for an appropriate engineer to approve formal maintenance and inspection regimes and approve any changes to them. (Priority 1).

*Note; the above recommendations are linked to the recommendations made in Section C.2 relating to lubrication schedules and "look, listen, feel" inspections*.

Overall responsibility for maintenance and inspection lies with the site operator (user), even when the work is carried out by 3rd parties. Compliance with maintenance, inspection and monitoring regime, review of the findings and implementation actions and recommendations should be managed by appropriate engineers / managers.

**General Recommendation;** Ensure engineering / maintenance management roles and responsibilities for non-electrical equipment in hazardous areas are formally defined, including liaison with and management of 3rd parties. See roles, responsibilities and competencies identified in Section C.3 (Priority 1)

## C.2 Lubrication and simple inspection

For moving parts needing lubrication to avoid excessive temperatures or mechanically generated sparks, effective lubrication should be provided, e.g.

- Oil splash lubrication
- Constant oil feed e.g. using a reservoir and pump
- Automatic greasing
- Manual lubrication, using appropriate maintenance procedure to provide routine greasing or oil level verification

If lubrication measures do not achieve the required EPL, additional measures to monitor adequate lubrication are required, e.g. level, flow, pressure or temperature sensors which operates an alarm or switch function before a critical lubricant condition is reached.

Lubrication schedules, including simple visual inspection, should be carried out, based on a combination of manufacturer's guidance, lubricant supplier's guidance and experience of operating the equipment. Lubrication and simple inspection will provide mitigation against ignition sources becoming effective as described in the individual risk assessment sections, provided they are followed and reviewed / revised based on inspection and maintenance findings.

It must be ensured that compliance with the lubrication schedules and simple visual inspections can be demonstrated, particularly for Category 2 or Category 1 equipment. Ideally formal auditing of lubrication schedules and visual "look, listen, feel" inspections should be managed and recorded as part of the SAP Maintenance regime.

**General Recommendation;** Ensure appropriate lubrication schedules and "look, listen, feel" inspections in place for all non-electrical equipment in hazardous areas;

- Priority 1; equipment in Zone 20 and Zone 21 areas
- Priority 2; equipment in Zone 22 areas

**General Recommendation;** Ensure systems are in place for an appropriate engineer to approve lubrication schedules, "look, listen, feel" inspections and approve any changes to them. (Priority 1)

**General Recommendation;** Carry out formal auditing to monitor compliance with lubrication schedules on non-electrical equipment in hazardous areas;

- Priority 1; equipment in Zone 20 and Zone 21 areas
- Priority 2; equipment in Zone 22 areas

## C.3 Seals and Bearings

Where unlubricated seals are required for moving parts, e.g. lip seals on drive shafts, it is important that the seal does not become an effective ignition source.

- Light metals such as aluminium should not be used due to the risks associated with thermite sparks.
- Non-metallic materials such as elastomers (e.g. plastic, rubber) and fabrics (e.g. felt), should be resistant to distortion and degradation. Swelling or hardening can lead to increased friction and breakdown can lead to seal failure allowing process materials to enter bearings.

Care should also be taken when specifying and installing bearings;

- They must be suitable for the equipment's intended duty e.g. speed, temperature, loading and variations of speed and loading
- For rolling element bearings conforming to ISO 281; the basic rated life of the bearing should be considered when developing the maintenance and inspection regime, remembering that sealed-for-life bearings have a defined lifetime
- Bearings must be properly fitted in their housing and on the shaft and must be correctly aligned
- Axial and radial loading of the bearings caused by thermal expansion of the shaft and the housing under the most severe operating conditions should be considered.
- Bearings should be protected against ingress from water and solids, and powder entering bearings is a known cause of premature failure. Appropriate seals should be used to prevent ingress of powder or water
- Bearings should be suitably lubricated (see C.2 above) and should be checked periodically e.g. for vibration and / or temperature increase (see C.1 above)
- Bearings should be replaced if unacceptable wear is detected or at the end of their recommended life, whichever comes first
- Where a special initial running-in period is necessary e.g. after initial installation or on equipment start-up; this should be clearly given to operators in maintenance or operating instructions (see C.4 below).

## C.4 Information, instructions and training

The main requirements relating to information, instructions and training are summarised below;

- Ensure work equipment is maintained in an efficient state, in efficient working order and in good repair.

- Inspect equipment to ensure that it has been installed correctly and is safe to operate after installation or re-assembly.
- Inspect equipment to ensure ignition controls are maintained and that any deterioration can be detected and remedied in good time.
- Ensure the results of the above inspections are recorded and kept until the next inspection is recorded.
- Provide users, supervisors and managers of equipment with easily understood information and appropriate written instructions, which cover the following;
    - The conditions in which the equipment can be used
    - The way in which the equipment can be used
    - Foreseeable difficulties and how to deal with them
    - Conclusions drawn from experience using the equipment
- Ensure that users, supervisors and managers of equipment have received adequate training, including training in
    - Methods to be adopted when using the equipment
    - Any risks resulting from equipment use
    - The precautions to be taken to control those risks

General explosion hazard awareness training will provide a good general introduction of the key requirements, but further training will be required to effectively manage non-electrical equipment in hazardous areas. The key roles, responsibilities and competence requirements relating to management of non-electrical (mechanical) equipment in hazardous areas are outlined in the table below;

| **Role / Responsibility** | **Competence Requirement** |
|---|---|
| Responsible Manager; management of equipment in hazardous areas | Engineering Manager with competence in asset integrity management, particularly equipment criticality and risk-based maintenance and inspection. |
| Responsible Person; non-electrical equipment in hazardous areas | Mechanical Engineer with competence in the specification & management of non-electrical equipment in hazardous areas e.g. a mechanical equivalent to CompEx Module Ex11 (see table below) |
| Deferment of non-electrical equipment inspection in hazardous areas | Joint approval by;<br>• Nominated Responsible Engineer<br>• Responsible Manager |
| Modification; non-electrical equipment in hazardous areas | *Must be approved by site Management of Change systems, including approval by the nominated Responsible Person and Responsible Manager* |
| Maintenance and inspection of non-electrical equipment in hazardous areas | Mechanical Technician with Practitioner level competence in the installation, inspection and maintenance of the relevant mechanical equipment<br>e.g. CompEx Modules Ex F and Ex 11 (see table below) |
| People carrying out engineering / maintenance work in hazardous areas | General awareness explosion protection, site explosion hazards and use of site systems. Demonstrated by site training / competence records. |

| Role / Responsibility | Competence Requirement |
|---|---|
| Operations Managers, Supervisors & Operators; plants with hazardous areas | General awareness of explosion protection plus plant specific explosion hazard awareness. Demonstrated by site training / competence records |

Where possible, training and competence assessment for the selection / specification and management of equipment in hazardous areas should be provided by 3rd party accredited bodies e.g. accredited to ISO/IEC 17024: Conformity Assessment - General requirements for bodies operating certification of persons.

Relevant assessed / certified training is available from several accredited 3rd parties for competencies relating to the installation, inspection and maintenance of equipment in hazardous areas. These are typically referred to as CompEx Modules, and are summarised below;

| Module Ref. | Description<br>*Note; electrical equipment modules included for reference.* |
|---|---|
| Ex F | Foundation Course; Provides an understanding of the requirements of safe working practices within potentially explosive atmospheres |
| Ex 01-04 | Gas Vapour; Installation, Maintenance & Inspection of electrical equipment in explosive atmospheres<br>• Ex 01; preparation and installation of Ex ‘d’, ‘n’, ‘e’ and ‘p’ equipment<br>• Ex 02; inspection and maintenance of Ex ‘d’, ‘n’, ‘e’ and ‘p’ equipment<br>• Ex 03; preparation and installation of Ex 'i' equipment and systems<br>• Ex 04; inspection and maintenance of Ex 'i' equipment and systems |
| Ex 05-06 | Dust; Installation, Maintenance & Inspection of electrical equipment in explosive atmospheres<br>• Ex 05; preparation and installation of Ex ‘t’, equipment<br>• Ex 06; inspection and maintenance of Ex ‘t’, equipment |
| Ex07-08 | Industry specific modules for fuel filling stations |
| Ex09-10 | Industry specific modules for the water industry |
| Ex 11 | Competency requirements for operatives working with mechanical equipment in explosive atmospheres<br>• Aimed at mechanical technicians and engineers who install, inspect or maintain mechanical equipment in potentially explosive atmospheres |
| Ex 12 | Core Competence for Designers and Project Engineers - electrical equipment in explosive atmospheres<br>• Aimed at engineers responsible for design and selection of electrical installations for use in explosive atmospheres<br>*Note; there is currently no accredited training for Designers and Project Engineers for mechanical equipment* |
| Ex 14 | Core Competence for Site Responsible Personnel - electrical equipment in explosive atmospheres<br>• Aimed at engineers in a senior supervisory / responsible role; directly responsible for the management of inspection and maintenance of electrical equipment in potentially explosive atmospheres<br>*Note; there is currently no accredited training for Site Responsible Personnel for mechanical equipment* |

**General Recommendation**; Carry out a training needs analysis using the guidance above and develop a prioritised plan to address any deficiencies.

## APPENDIX D. GUIDANCE; EARTHING – IGNITION PREVENTION

There are three types of earthing within industrial process plant

- Primary earthing systems, for electrical safety
- Earthing systems to control electrostatic hazards
- Lightning protection systems

For the non-electrical equipment in a flour mill, the primary focus is on earthing systems to control electrostatic ignition hazards. Potential ignition sources due to stray currents and lightning are discussed in the main body of the report and can generally be ruled out in a typical flour mill.

Based on Minimum Ignition Energy (MIE) data quoted in Section 2 of the main body of this report, restrictions on use will normally be placed on most equipment used in a typical flour mill and electrostatic ignition sources will be adequately controlled by ensuring all metal and conductive components are earthed.

The main structure of the plant and its main plant items, such as silos, hoppers, vessels and other large items of equipment, are permanent metallic installations with bolted or welded joints. They are usually in direct contact with the primary earthing system, their resistance to earth should be low and there is little risk of it deteriorating to a value above $10^6$ Ω (the upper limit for electrostatic ignition source control). Satisfactory earthing of main equipment items with resistance to earth ≤10 Ω should be achievable without special earthing connections.

Special earthing connections are required only when the plant / equipment design and usage make it difficult to maintain a low resistance to earth e.g. where non-conducting parts, bellows, joints make metal to metal contact unreliable. In these cases, the use of antistatic parts should be considered or special earthing connectors should be installed.

Suitability of methods of earthing for equipment types is summarised below;

| **Method of Earthing** | **Suitability** |
|---|---|
| Metallic equipment earthed by bolted or welded joints via main plant items, plant structure and primary earthing system.<br><br>Target resistance to earth ≤10 Ω. Higher values indicate a potential fault or problem with this type of earthing of fixed equipment.<br><br>*Note; see below for driven systems.* | Equipment, where powder MIE is > 30 mJ, where charge generation is relatively low;<br>• Drag link (chain) conveyors<br>• En-mass (chain) elevators<br>• Screw conveyors<br>• Rotary valves<br>• Blowers and Fans<br>• Mill Feeders<br>• Bucket elevator casings |

| Method of Earthing | Suitability |
|---|---|
| Metallic equipment earthed by special earthing connections and / or the use of antistatic (dissipative) components.<br><br>Target resistance to earth ≤ 10 Ω, with an absolute limit < $10^6$ Ω e.g. where reliant on dissipative components.<br><br>*Note; see below for driven systems*. | Equipment, where powder MIE is > 30 mJ, but where charge generation may be high and / or components may be insulated by flexible mountings or components e.g.<br>• Vibrating Sieves & Destoners<br>• Rotary Sifters / Finishers<br>Zone 20 or 21 (internal) equipment e.g.<br>• Bucket Elevator metal buckets |
| Metallic elements (e.g. pulleys) of drive and transmission systems or driven systems within equipment, earthed by metallic bearings, supporting frame, or structures via plant structure and primary earthing system.<br>Tests have shown the resistance across a lubricating film in a bearing is unlikely to exceed $10^3$ Ω.<br>Note; the electrical connection to earth, for electric motors, can be taken into account for metallic elements driven directly by an electric motor. | Gearboxes, belt drives, chain drives and simple couplings on Zone 22 equipment e.g.<br>Internal components on;<br>• Internal sprockets / chains<br>  ○ Drag link conveyors<br>  ○ En-masse elevators<br>• Bucket elevator pulley wheels<br>• Screw conveyor augers<br>• Rotary valve rotors<br>• Blower and Fan impellers<br>• Mill Feeder Roll and/or auger<br>• Mill Rolls<br>• Rotary Sifter / Finisher rotors |
| Earthing requirements as detailed in Original Equipment Manufacturer (OEM) Manual for installation | Ex categorised equipment |
| Note; in some assessments, the use of antistatic components may be recommended to provide an additional earthing path for metal and conductive parts where metal to metal contact cannot be guaranteed | |

Where equipment requires special earthing connections, the following important features should be in place;

- Primary earthing systems should comply with the relevant standards for electrical safety. These often form the backbone of electrostatic earthing of equipment in zoned areas.
- They should be recognised as such and be accepted as essential to the safe operation of the plant e.g. identified with the appropriate level of criticality within the maintenance management system and clearly identified in the field and within operating / maintenance instructions.
- They should either be clearly visible or be essential to the correct functioning of the plant, so that any shortcomings are quickly detected e.g. typically identified by green / yellow colour coding
- They should be robust and installed so that they are not affected by high resistivity contamination, such as corrosion products or paint
- They should be easy to install and to replace

Earth monitoring e.g. continuity testing plays an important part in ensuring electrostatic ignition sources are controlled. But it should be recognised as distinct from that for other reasons, such as primary earthing for electrical safety and lightning protection.

The basis of monitoring is the measurement of the resistances between the different parts of the plant / equipment and earth. It is important that this is supplemented by visual inspection e.g. checking earthing connections are in place, tightly fastened and no signs of deterioration, wear and tear or contamination. The monitoring system should be capable, not only of monitoring resistances, but also of drawing attention to any changes in resistance. It is therefore important to record actual resistance values so that variation can be checked as this may give early indication of problems.

Continuous or automated monitoring is not generally required for the equipment in a typical flour mill. The following methods of monitoring are reasonably practicable to implement.

| **Method of Earthing** | **Recommended method of monitoring** |
|---|---|
| Metallic equipment earthed by bolted or welded joints via main plant items, plant structure and primary earthing system. | Earthing of main plant items checked as part of primary earthing monitoring. No additional requirements for electrostatic ignition control unless specified in an individual equipment assessment. |
| Metallic equipment earthed by special earthing connections and / or the use of antistatic (dissipative) components. | Formally documented periodic visual inspection of special earthing connections should be included as part of the general preventive maintenance / inspection regime for the equipment item.<br>Formally documented earth continuity testing (resistance to earth) carried out;<br>• Before equipment is put into use following installation, modification or maintenance<br>• Periodically (e.g. annually) as part of a formal earth continuity testing regime for electrostatic ignition control. |
| Metallic elements (e.g. pulleys) of drive and transmission systems or driven systems within equipment, earthed by metallic bearings, supporting frame, or structures via plant structure and primary earthing system. | Earthing of main plant items checked as part of primary earthing monitoring. No additional requirements for electrostatic ignition control unless specified in an individual equipment assessment. |
| Earthing requirements as detailed in Original Equipment Manufacturer (OEM) Manual for installation | Earth monitoring as recommended in OEM Manual for operation & maintenance |

**General Recommendations;**

- Ensure the standard of earthing connections used meets the requirements listed
- Review the standard of earth monitoring and ensure they meet the requirements listed

## APPENDIX E - BUCKET ELEVATOR EXPLOSION PREVENTION AND PROTECTION

The guidance outlined below has been taken from PD CEN/TR 16829:2016 Fire and explosion prevention and protection for bucket elevators, which is a BSI Published Document that is the UK implementation of CEN/TR 16829:2016.

Bucket elevators require special attention since they have been involved in dust explosions and they have many potential ignition sources. The most common ignition sources are due to mechanical problems, for example due to friction between the belt and the casing, heating up of mechanical rotating parts on elevator head and boot, impact of damaged buckets or foreign objects. These same mechanical problems may also create explosive atmospheres: impact or vibrations will cause dust deposits in the legs to fall down and create an explosive atmosphere. Therefore if, during normal operation, there is no explosive dust-air mixture present inside a bucket elevator, mechanical problems are still likely to cause an explosion.

A bucket elevator might be considered as two volumes (head and boot) between which there are one or two long ducts (the legs). The buckets affect flame acceleration: especially metal buckets which will cool the flame (and reduce flame acceleration), but they also form repeated obstacles which cause increased turbulence and hence promote flame accelerations.

A fire or explosion inside a bucket elevator is a large hazard due to the flame and/or pressure effects to the surroundings which may lead to damage to the bucket elevator itself and can lead to damage to the connected equipment, surroundings of the equipment and to personnel. Consequences of ignition can be a smouldering fire, fire with flames, explosion and a propagating explosion. Following a dust explosion, a fire is likely to continue inside or outside the bucket elevator. If an explosion occurs inside a bucket elevator, it will tend to accelerate, because of the large L/D ratio. Without adequate protection, this may cause failure of the bucket elevator and endanger the surroundings: adjacent equipment, buildings and personnel.

When no precautions are included to prevent fire propagation, a highly hazardous situation can occur where a fire or explosion may spread to adjacent sections of the installation, such as silo cells. With explosion propagation, increased turbulence, pre-compression and jet ignition may trigger very violent secondary explosions in these installations.

In bucket elevators, the explosion hazard depends very strongly on the bulk material conveyed. In particular, the fine fraction of the bulk material with particle sizes less than 500 µm and the dustiness (how easy a dust cloud is formed) play a decisive role here.

Even in the case of low dust concentrations, in time dust can adhere to the bucket elevator casing forming layers inside the bucket elevator that can be a few mm thick. The adhered dust layers are not in themselves explosive mixtures but do form a continuous potential for an explosive mixture: e.g. due to a malfunction of a bucket elevator (belt misalignment) the casing

may start vibrating and the adhered dust could become whirled-up and dispersed as an explosive dust cloud.

Two example elevators are described in the PD CEN/TR 16829:2016, along with guidance relating to materials such as grain;

- **Example A;** The bucket elevator is conveying a combustible product with an average particle size smaller than 500 µm or a dusty product containing a considerable amount of fines (here fines are defined as particles less than 100 µm). This implies that during normal operation dust clouds may arise frequently inside the bucket elevator and are likely to be above the lower explosion limit (LEL). For this situation, it is assumed that a potential explosive atmosphere is frequently present.

- **Example B**; The bucket elevator is conveying a coarse product (typically > 1,000 µm) with a very limited amount of fines. For this situation, it is assumed that a potential explosive atmosphere is likely to occur occasionally during normal operation.

The process conditions and specific product properties like moisture content, friability, granulometry, flow characteristics and impurities will influence the occurrence of explosive atmospheres A or B.

In both situations dust can stick to the inner surfaces of the bucket elevator. Such dust deposits can pose a fire hazard depending on the burning characteristics. In time these dust layers may accumulate sufficient quantity of material to form an explosive atmosphere should they become dispersed by the action of vibration, shaking etc. For most situations, a layer with a thickness of 0.1 mm is sufficient to create a potential explosive atmosphere. Since vibrations and other mechanical movements can be expected, those dust layers can be disturbed to create a potential explosive atmosphere.

Only for a specific application, where it can be proven that no hazardous dust deposits will be created, a zone 22 situation could be considered.

Note that inside a bucket elevator transporting a coarse granular product, due to friction of the product granules, dust may be formed. Examples are given;

- Grain (such as wheat, barley, corn) that has not been cleaned may be rather dusty and should be considered to as example A. Only after thorough cleaning, such as with an aspirator, example B can be assumed. Remarks:
- Cleaning of grain with the help of an aspirator means that fines are removed from grain in free fall by a strong counter airflow. Dust extraction on a bucket elevator or on the inlet chute may reduce the dust concentration to a certain extent, but cannot be considered as cleaning.

- Depending on the origin of the product it may contain different fines content and consequently the fines content may vary in time. For the purpose of this analysis it is recommended to assume worst-case condition.

An ignition hazard assessment should be carried out by the manufacturer according to EN 13463-1. This will identify the equipment related ignition sources able to ignite an explosive atmosphere (potential ignition sources) and the effective ignition sources depending on the frequency of occurrence i.e. in normal operation, expected malfunction or rare malfunction.

PD CEN/TR 16829:2016 clearly states that ignition sources related to other influences should be considered by the **user**:

- Ignition sources introduced from connected equipment e.g. hot, glowing and burning product, embers, explosion from connected equipment etc.
- External ignition sources due to smoking, maintenance, welding, cutting etc. (hot work) - these should be prevented by organisational measures.
- Ignition sources that may arise from the conveyed product e.g. by self-heating deposits inside the bucket elevator

PD CEN/TR 16829:2016 also states that the **user** normally selects a bucket elevator based upon the category (related to internal zone) and should perform a risk assessment based upon the local circumstances. The risk analysis should include the probability that ignition sources enter from outside and consider the potential consequences of an explosion. The explosion risk assessments in Tables 5.2A and 5.2B assess the parameter discussed above.

## E.1 Requirements for all bucket elevators (Category 1, 2 or 3)

PD CEN/TR 16829:2016 lists requirements and provides information for all bucket elevators (e.g. Category 1, 2 or 3);

**Table E1.1; Requirements for all bucket elevators**

| Requirement | Information |
|---|---|
| **Ignition Hazard Assessment** | **Expected malfunction**: For the purposes of bucket elevators made according to this document this can happen for a variety of reasons, including:<br>• Malfunction of bearing and/or seal<br>• Slip of belt on pulley due to overload, stray object causing obstruction, belt tension problems, belt/pulley wear, too warm product or environment leading to belt elongation etc.<br>• Misalignment of belt due to overload etc.<br>• Misalignment of pulley due to bearing malfunction or failure of pulley/shaft connection.<br>• Loss of buckets or fixation elements due to wear or vibration leading to obstruction of belt and pulley.<br>• Loss of pulley friction elements due to wear or vibration leading to obstruction of belt and pulley<br>• Choking of bucket elevator |

| Table E1.1; Requirements for all bucket elevators | |
|---|---|
| **Requirement** | **Information** |
| | **Rare malfunction:** A rare malfunction is a type of malfunction which is known to happen but only in rare instances. An example of a rare malfunction is sudden breakage of a belt or chain. Two independent expected malfunctions which, separately, would not create an ignition hazard but which, in combination, do create an ignition hazard, are regarded as a single rare malfunction. As an example, misalignment of belt with failure of misalignment detector |
| **Speed** | Typically, 1 to 4 m/s, keep as low as practical. |
| **Material combinations** | Prevent combinations of light metal and carbon steel. |
| **Pulleys** | Crowned drive and return pulley design and if cover is required then use antistatic flame retardant material. If pulley is assembled out of several parts, then measures should be taken to ensure integrity is maintained. |
| **Belt and chain: material and construction** | Use dissipative material (surface resistance on both sides < $3 \times 10^8$ Ohm, according to IEC/TS 60079–32–1). Use fire retardant material. Adequate joint construction to prevent premature failure. Chains are to be selected to ensure acceptable low corrosion and wear. |
| **Earthing and bonding** | All conductive fixed and moving parts should be earthed and bonded to limit ground resistances to < $10^6$ Ohm (for metal items having fixed metal earthing a ground resistance of < 10 Ohm should usually be achieved). |
| **Prevention of deposits** | Prevent horizontal ledges and surfaces. The boot part should be designed such that easy cleaning is possible. |
| **Clearing between moving parts and casing** | 25 mm, depending upon height and capacity. Specific situations (such as strong wind load) may require additional clearances or controls. |
| **Shaft seals** | Seals should be safe in accordance with EN 13463–5. |
| **Bearings** | Preferably located outside the casing in accordance with EN 13463–5 |
| **Belt tension system** | Measures should be taken to ensure integrity is maintained in accordance with EN 13463–5. |
| **Brakes and braking systems** | Anti-runback system is recommended for bucket elevators > 10 m high and with capacity of > 10 $m^3$/hour. |
| **Pulley-shaft attachment head pulley and boot pulley** | Head: key or welded and tapered locking device<br>Boot: key or tapered locking device |

## E.2 Additional requirements for bucket elevators with internal Category 2.

PD CEN/TR 16829:2016 lists the following additional requirements and provides information for bucket elevator to achieve Category 2

| Table E2.1; Requirements for all bucket elevators with internal Category 2 | |
|---|---|
| **Requirement** | **Information** |
| **Slip detection device** | Monitor the speed of drive and boot pulley: at difference of > 10 % activate alarm and stop bucket elevator. |
| **Misalignment detection device** | Monitor the horizontal belt movement. Should the distance to the casing become too small for a maximum period of 5 seconds; activate alarm and stop bucket elevator. If misalignment is detected by temperature detection device on friction plates alarm and stop should occur without time delay. |
| **Bearing temperature detection** | Monitor the bearing temperature. Should the bearing temperature increase significantly above the temperature in normal operation activate alarm and stop bucket elevator. |
| Systems for the control of ignition sources should comply to IPL 1 according to EN 13463-6. | |

## E.3 Requirements for all bucket elevators with internal Category 1.

PD CEN/TR 16829:2016 states that because of the complexity of the mechanical systems in bucket elevators, it is not possible to give general precautions for Category 1 equipment. It states that an individual risk assessment taking rare malfunctions into account has to be executed and makes the following points;

- For Category 1 bucket elevators measures are also required to prevent transport of ignition sources from the bucket elevator into connected equipment. If it is concluded from the risk analysis that such potential ignition sources are acceptable, these measures are not required, but the bucket elevator cannot become Category 1 equipment at its boundaries.
- If ignition sources cannot be prevented during rare malfunctions, explosion mitigating measures are to be installed in addition to Category 2 requirements.

In addition to the guidance outlined above, PD CEN/TR 16829:2016 also provides detailed guidance sections on explosion mitigation measures including;

- Explosion venting
- Explosion suppression
- Explosion resistant design
- Explosion isolation

## APPENDIX F – EXAMPLE; GENERIC ASSESSMENT VERIFICATION CHECKLIST

| **Generic Equipment Ignition Risk Assessment; Verification Checklist** | | | **Equipment Type;** | Drag-link (chain) conveyors |
|---|---|---|---|---|
| **Ignition Risk Assessment Ref;** | | Table 3.1 & Appendix A.1 | | |
| Description | ID Ref. | C1 | C2 | C3 |
| | Duty | Raw Wheat Intake Conveyor | | |
| | Dust | Wheat dust | | |
| Requirements | External zone | 22 | | |
| | Internal zone | 22 | | |
| | Ambient temp | <= 40°C | | |
| Motor | Power (kW) | 4.0 | | |
| | Speed (rpm) | 1440 | | |
| | Fixed / Variable | Fixed | | |
| | Couling | Close coupled to gearbox | | |
| Transmission 1 | Type | Gearbox | | |
| | Lubrication | Oil filled, splash lubrication | | |
| | Ratio | 16.0:1 | | |
| | Couling | Pulley direct to shaft | | |
| Transmission 2 | Type | V-belt | | |
| | Lubrication | Not applicable | | |
| | Ratio | 1.5:1 | | |
| | Couling | Pulley direct to shaft | | |
| Chain Speed | m/s | <= 0.5 m/s | | |
| Materials of Construction | Casing | Carbon steel; external galvanised | | |
| | Wear rails | Carbon steel | | |
| | Chain & sprockets | Carbon steel | | |
| | Flights | Carbon steel | | |
| | Clearing flights | Plastic | | |
| Shaft Bearings | Type | Rolling elements | | |
| | Mounting | Pad mounted on casing | | |
| | Lubrication | Manual lubrication | | |
| Shaft Seals | Type | Simple lip seals | | |
| | Material | Felt | | |
| Maintenance / Inspection Regime | Overhaul | OEM approved 3rd party | | |
| | Re-assembly | Mech. Tecnicians | | |
| | PM regime | Formally documented | | |
| | Thermal imaging | No, but consider for future | | |
| | Casing wear | Annual inspection | | |
| | Wear rail checks | Annual inspection | | |
| | Sprocket checks | Annual inspection | | |
| | Chain tension | 3-monthly | | |
| | Chain wear | Annual inspection | | |
| | Bearing lubr. | Monthly lubrication | | |
| | Bearing checks | Annual inspection | | |
| | Seal / shaft checks | Annual inspection | | |
| | Guard clearances | 3-monthly | | |
| | Drive belt checks | 3-monthly | | |
| | Gearbox lubr. | Monthly lubrication | | |
| Design Features | Drive belts | Anti-static & fire resistant | | |
| | Earthing | Metal construction, supports etc | | |
| | Special earthing | Not required | | |
| | Drive shear pin | Yes | | |
| | Upstream grid | Grid on raw wheat intake | | |
| | Magnet trap | No | | |