# DUST

## areas at risk of explosion

Brochure No. 0006

SAMCON
Prozessleittechnik GmbH

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| Title: | Areas at risk of dust explosion |
| Doc. ID | 210531-TAU-SS-Staubexplosionsgefährdete Bereiche_en_rev.00.docx |
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| Compiled on: | 1st June 2021 / rev.01 |
| URL: | www.samcon.eu |

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# 1 Introduction

This document is predominantly aimed at owners and builders of systems at risk of dust explosion. It is intended to provide an introduction to the topic of dust, advise of dangers and use practical examples to make sensible project planning suggestions. This document does not claim to be correct or complete despite thorough research and many years of experience. Rather, it is intended as a guideline.
The legal principles are not dealt with in detail, firstly because this is a very dry subject and secondly because it is more important to provide a technical explanation as to why some things make sense and why others do not. Furthermore, the legal principles remain a “country matter” despite great efforts to harmonise them internationally. Comprehensive elaboration on the legal principles would therefore go beyond the scope of this elaboration.

# 2 What causes an explosion?

An explosion occurs when an explosive mixture and an inflammable spark occur at the same place at the same time. The best way to illustrate this statement is with an example from an area at risk of a gas explosion:

> *Ms Miller is filling up with petrol at a petrol station. This causes a petrol cloud, technically known as an “explosive mixture of petrol and air”. This petrol cloud occurs in a specific location, let’s say at pump 3 where Ms Miller is filling up with petrol. As Ms Miller is filling up with petrol at exactly 10:00, the aforementioned petrol cloud only occurs from 10:00 to 10:02. Before 10:00, the petrol cloud was still in Ms Miller’s petrol tank and after 10:02, the petrol cloud has mixed with the air sufficiently that it no longer poses a danger.*
> *Mr Meyer is smoking. This is unhealthy in a normal atmosphere. Smoking in a petrol cloud can be fatal. Let's go back to the petrol cloud at pump 3. As long as Mr Meyer is smoking at pump 1 or 2, this has little effect on our petrol cloud at pump 3. Even if Mr Meyer is smoking at pump 3 when our petrol cloud doesn’t exist (i.e. before 10:00 and after 10:02), this does not affect our petrol cloud: nothing can happen if it doesn’t exist.*
> *An explosion will only occur if Mr Meyer smokes his cigarette between 10:00 and 10:02 at pump 3 in our petrol cloud. A “gas explosion” occurs.*

If you can follow this example, you already have a good basic understanding of explosion protection: It is about the probability of an explosive mixture occurring at the same time as a source of ignition in the same place.

Or to put it another way:

The more likely that an explosive mixture and an inflammable spark “meet”, the more likely it is that an explosion will occur.

Inflammable dusts behave in a very similar way. Here is an example of a risk of a dust explosion:

*Mr Meyer and Ms Miller have filled up their cars with petrol without an explosion occurring, and are driving to work. Mr Meyer works as an electrician in the same building as Ms Miller who works as a system supervisor. The modern mill has a flour silo that is only filled occasionally if excess flour is produced. The bulb in the flour silo broke the day before. Mr Meyer’s job is to change the bulb, something that he has often done successfully.*
*When he wants to change the bulb at 11:00, he does not worry that “there’s so much dust in the air”. Ms Miller added fresh flour to the silo at 10:55 and therefore “stirred up the dust” a lot. Mr Meyer thinks nothing of changing the bulb. The spark that occurs when screwing the light into its base ignites the flour dust and a serious flour dust explosion occurs.*

It’s also clear here: The probability of an explosive mixture (flour dust) and a source of ignition (electrical spark) occurring at the same time is a very good indicator for the probability of an explosion:

Flour dust without sparks: no problem.
Sparks without flour dust: no problem.
Flour dust with sparks: Boom!

This provides an important consideration that is basically the main consideration when selecting suitable equipment technology:

The more likely it is that an explosive mixture will occur, e.g. our flour dust or the petrol cloud, the <u>safer</u> the installed or carried equipment technology should be!

Installed or carried equipment technology? What does that mean exactly? In the most frequent cases, inflammable sparks are caused by installed equipment technology, the lamp in our dust example, or by carried equipment technology, the cigarette in our petrol station example. If the lamp in the flour silo had been “safe”, e.g. with an integrated power disconnector, Mr Meyer would still be alive. There are two important terms for areas at risk of explosion: <u>Ex zones</u> and <u>equipment groups</u>.

## 2.1 Ex zones

As is clear from the examples above, it makes sense to divide areas at risk of explosion up by the probability of an explosive mixture occurring. Whether this division comprises 2 stages or, to familiarise ourselves directly with the term zones, 5 zones is completely arbitrary. In addition, whether the “lowest zone” or the “highest zone” is the most dangerous zone has been defined by clever people arbitrarily for a long time. Nowadays, the probability of dust explosion is defined in four zones, in which “zone freedom”, i.e. the safe zone, is included[1]:

| | |
|---|---|
| Zone 20 | is extremely dangerous! This is a place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently! |
| Zone 21 | is dangerous! This is a place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally! |
| Zone 22 | is not very dangerous. This is a place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is not likely to occur in normal operation but, if it does occur, will persist for a short period only! |
| Even safer Area | is non-hazardous. An explosive dust cloud NEVER occurs. This type of area is known as a “safe area” or a “zone-free area”. |

The ambiguous term “frequently” is normally interpreted as “for the majority of the time”. Concrete definitions are difficult here. The reference period is a frequent source of conflict. For example, the reference period may depend on the type of system. Therefore, for a flour silo that is being filled constantly, you would take 24/7 as the reference period: As a result, inflammable dusts would occur for more than 12 hours per day, which would result in a classification of zone 20. A system that is de-energised 6 days per week and is only in operation for, let’s say 8 hours one day per week would be evaluated based on this reference period. It would probably be sufficient to define a place as zone 0 if an explosive atmosphere occurred there for 4 of the 8 hours. “Normal operation” is the status in which systems are used within their design parameters. The term “short period” is normally interpreted as a duration of no more than 30 minutes. The reference period is also difficult here, as the 30 minutes would refer to systems in 24/7 operation in general.

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[1] E.g: Appendix 1 point 1.6 and 1.7 of the Ordinance on Hazardous Substances or Directive 1999/92/EC

## 2.2 Ex equipment

We have now divided the probability of an explosive dust atmosphere occurring into zones and we now know that going for a walk with a lit cigarette through zone 20 causes death significantly more often than taking a nicotine break in zone 22. But what does that mean for the equipment technology, i.e. the potential sources of ignition that are to be installed there? What criteria are used to select these?

As safe as possible?
If you follow your gut feeling, you would say: As safe as possible? But what does that mean? Any equipment can develop a fault that can become dangerous which then leads to the question of how many significant faults you should prevent when designing the equipment. One fault? Two? 50? As safe as possible is difficult to define.

As safe as necessary?
In the subsequent approach, it makes sense to think about what is required to design a equipment not to be as safe as possible but rather as safe as necessary. This approach leads back to an important consideration from the previous sections:

The more likely it is that an explosive mixture will occur, e.g. our flour dust or the petrol cloud, the safer the installed or carried equipment technology should be.

Or to put it another way:
Continuously occurring Ex-atmospheres (zone 20) require extremely safe equipment.
Occasionally occurring Ex-atmospheres (zone 21) require very safe equipment.
Ex-atmospheres that only persist for a short period (zone 22) require safe equipment.
The equipment technology does not matter in an Ex-atmosphere that never occurs.

The best way is to imagine the equipment as the "opponents" of the Ex-atmosphere. The more dangerous the Ex-atmosphere, the safer the equipment must be, where the hazardousness of the Ex-atmosphere must be equated with the probability of occurrence (we will come to dust classes and temperatures later). As the safety of equipment basically "reacts" to the zones, it makes sense to oppose each defined zone with a defined "equipment protection level". A different "number" of attackers requires a different "number" of defenders. If we stick to the formulations above, we need:

Extremely safe equipment to fight against zone 20
Very safe equipment against zone 21
Safe equipment is sufficient in the fight against zone 22
And any equipment is OK if we are free of zones.
The authors of standards and directives do not talk of "extremely safe equipment" so here is a translation:

| | *Clearly expressed* | The Europeans say | The international standard setters say |
|---|---|---|---|
| | | Equipment category in accordance with Directive 2014/34/EU | Equipment protection level[2] in accordance with IEC 60079-0 |
| Zone 20 requires | *.. extremely safe equipment* | D1 | Da |
| Zone 21 requires | *.. very safe equipment* | D2 | Db |
| Zone 22 requires | *.. safe equipment* | D3 | Dc |
| Zone-free requires | *..whatever* | - | - |

Tab. 2-1: Zones versus equipment

[2] English: Equipment Protection Level (EPL)

## 2.3 The risk of explosion

If you illustrate the “battle” of the device technology against the Ex zone graphically, you can create a risk graph (see below). The best way is to imagine the bottom bar as “filled with an Ex-atmosphere”. The more likely this is, the higher the bars are. Therefore, the zone 20 bar is higher than the bar for zone 21 and this in turn is higher than that for zone 22.
The equipment is the “opponents”. Their bars are filled with “possible faults”: the more faults a piece of equipment can have, the longer the bar is.

If the equipment technology is selected correctly, you can see at first glance: the explosion risk remains constant. If you install equipment with equipment protection level Dc in zone 22, this results in the same risk of explosion as installing Da equipment in zone 20.

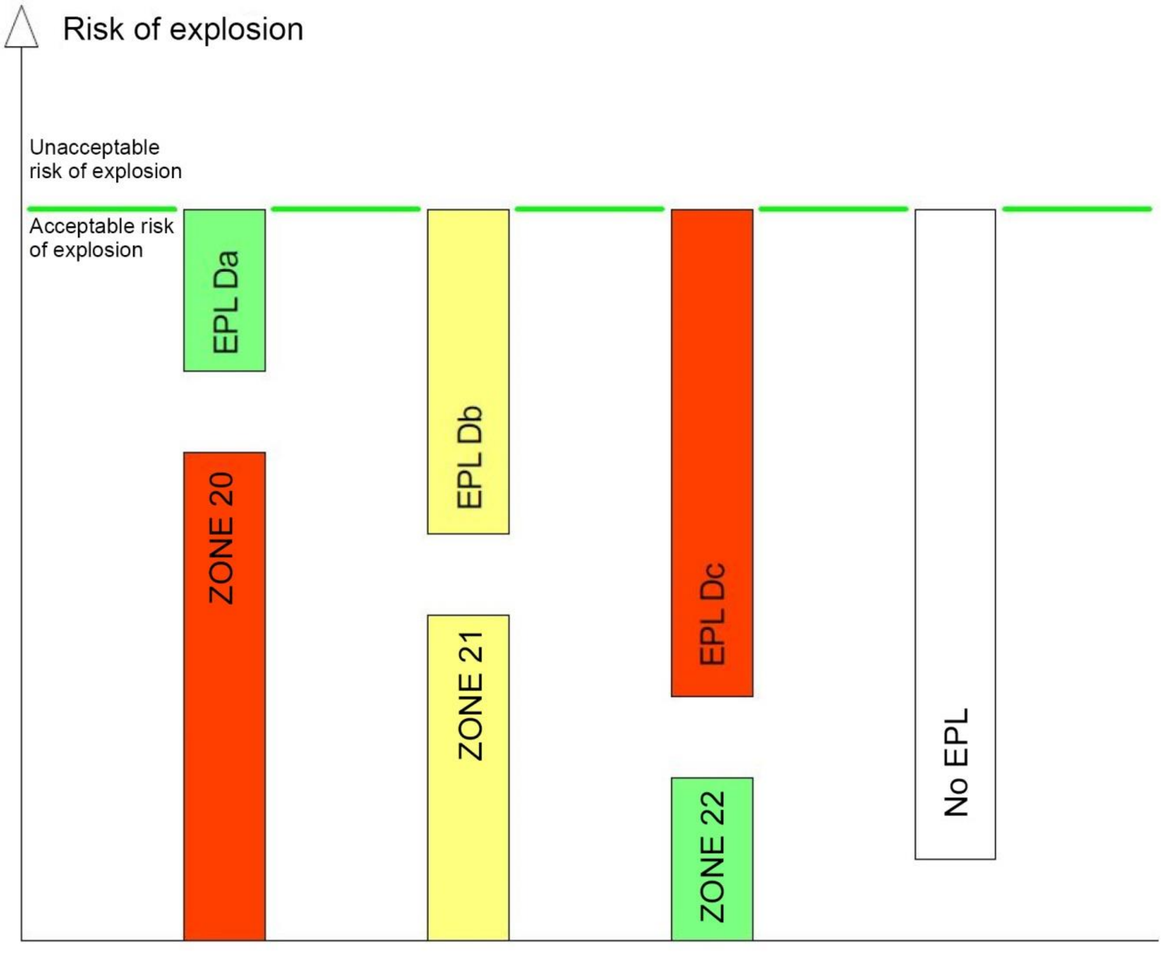


Figure 2-1: Explosion risk: correct equipment selection

The graphs for the explosion risk do not just illustrate the “correct” equipment selection but also clarify what would happen if the equipment were to deviate from the “correct” equipment selection. Let’s swap the “equipment opponents” against zone 21 and those against zone 22 (see the risk graph below).

At first glance, you can see that the interaction between zone 21 and equipment protection level Gc poses an increased risk of explosion.

*This would be as if you had to defend a fortress that is being attacked by a large army with fewer fighters. Since FORT ALAMO, we know that such an undertaking does not always go well.*

You can also see that you can reduce the risk of explosion significantly by using “higher class”, i.e. safer, equipment technology. If you install equipment protection level Db in zone 22, you are “safer than you need to be”.

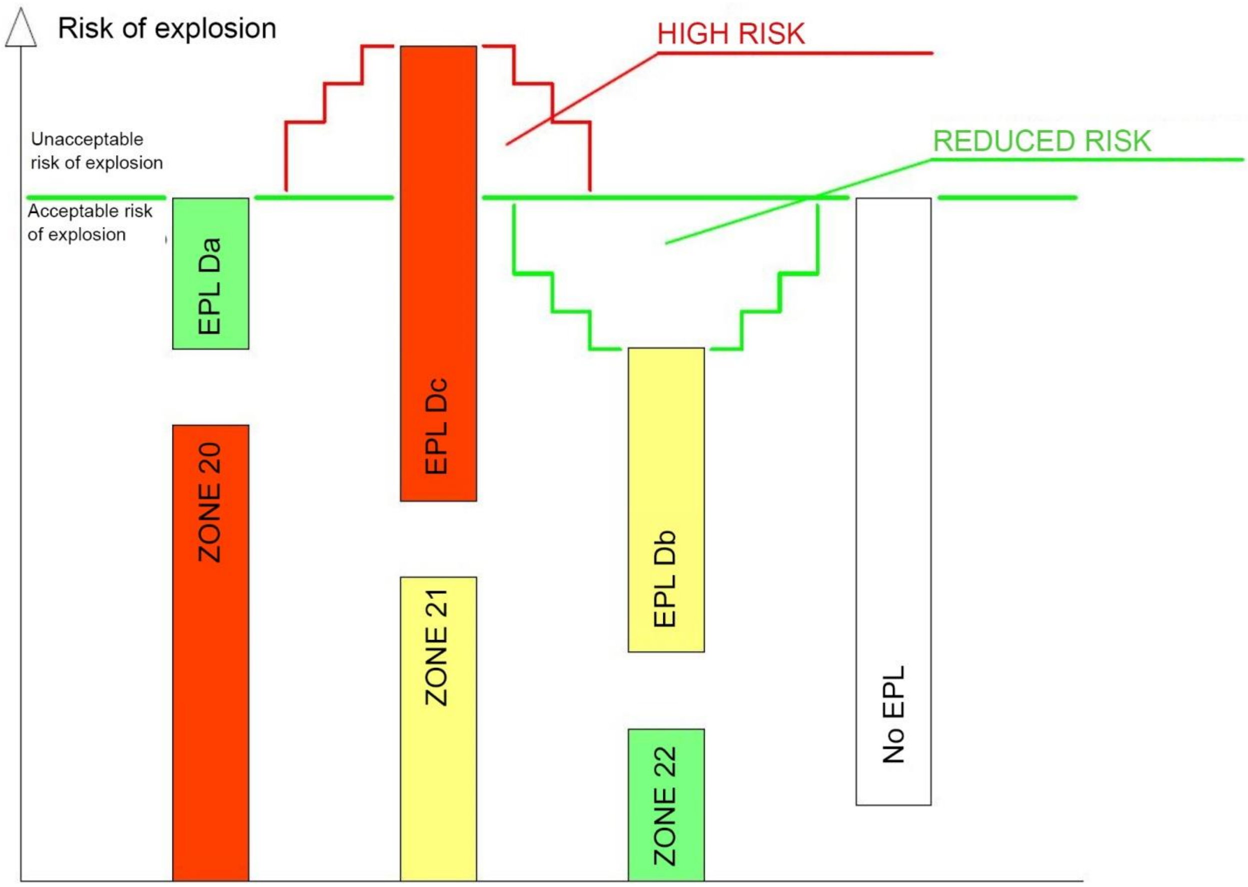


Figure 2-2: Explosion risk: “incorrect” equipment selection

This principle of “better than you need” is very frequent in practice. The philosophy of a large system operator and customers was and is:

*“…We only differentiate between Ex and non-Ex. As a result, we only use equipment with equipment protection level Db on the entire system, i.e. in the safe area, in zone 22 and in zone 21. Fortunately, we do not have to take any equipment into zone 20. We realise that our equipment is safer than we need in zone 22 but the benefits for us outweigh this: on the one hand, we only have one equipment type in spare parts*

*stock: we can use the equipment anywhere as soon as something breaks down. On the other hand, we are playing it safe in case process changes would result in zone 22 becoming zone 21. Imagine the cost of then having to replace all Dc equipment with Db equipment…"*

As with all philosophies, you can follow it but you do not have to. The following are the most important considerations:

The equipment technology must NEVER be weaker than required by the zone. "Better than you need" is always OK.

Only use equipment with category Da in zone 20. Equipment in categories Da and Db can be used in zone 21 and equipment in categories Da, Db or Dc can be installed in zone 22.

# 3 Dust groups versus equipment groups

Of course, not all dusts are inflammable. It is also obvious that inflammable dusts are more or less difficult to ignite and pose different hazards with regard to their explosion spread. It also makes sense to work with groups here. Inflammable dusts are divided into "dust groups":

| GROUP | DUST | EXAMPLE |
|---|---|---|
| IIIA | Combustible flyings | Cotton, filter materials |
| IIIB | Non-conductive dust | Sugar dust, flour |
| IIIC | Conductive dust | Aluminium dust |

Tab. 3-1: Dust groups

The rule is that dust group IIIC is more dangerous than dust group IIIB, while IIIB is in turn more dangerous than IIIA.

It is also important that the opponents, i.e. the equipment, must be "equipped" accordingly in order to guarantee explosion safety for the corresponding dust group. Equipment is developed in accordance with design requirements for the relevant piece of equipment as defined in standard DIN/EN/IEC 60079-31.
There are several technical options for designing a device with a consideration that would exceed the scope of this elaboration. A simple example is dust proofing on a housing (e.g. IP6x). For example, the standard defines that equipment for less hazardous dusts also does not have to be as dust proof. With "protection by housing", you define the equipment protection level "ta", "tb" and "tc". The safest equipment is "ta".
If we now move away from the protection category, i.e. the way in which a piece of equipment is made safe, it also makes sense to divide into equipment groups here. The equipment groups have the same names as the corresponding dust group. This sometimes

leads to confusion. You should therefore always specify whether you are referring to dust group IIIC or equipment group IIIC. It does however make equipment selection easier: you use IIIC equipment for IIIC dusts, IIIB equipment for IIIB dusts, and so on…

*If we stay with the example of weapons or resistance, you could say:*
*If there are spears on the one side, the opposition should have at least shields. If there are catapults, castle walls are already required and the air raids in the 2nd World War were only counteracted with bunkers.*

The “better than you need” principle also applies here. IIIC equipment is designed so well that it can be used in all dust groups. IIIB is sufficient for IIIB and IIIA dusts, and IIIA can be used for IIIA dusts at least.

*A bunker is also safe if the opponent attacks with spears or catapults. On the other hand, a hand-held wooden shield would not really help to defend against an air raid or catapults.*

Regardless of the equipment’s design technology, this results in an assignment or, more to the point, a minimum assignment:

| Dust group | *Weapon type* | *Defence type* | Equipment group |
|---|---|---|---|
| IIIA | *Spears* | *Shields* | IIIA or IIIB or IIIC |
| IIIB | *Catapults* | *Castles* | IIIB or IIIC |
| IIIC | *Air raids* | *Bunker* | IIIC |

Tab. 3-2: Equipment groups versus dust groups

The equipment group must always correspond to or be better than the dust group. “Better than you need” is always OK.

# 4 Hot and ~~greasy~~ dusty!

Temperatures are an important parameter in the complete explosion protection and must have some standards behind them in order to be able to assign the terms of the temperature class, ignition temperature, ATEX standard temperature, ambient temperature, maximum surface temperature, storage temperature, etc. The most important things first:

## 4.1 Ambient temperature

A permissible ambient temperature is always specified for a piece of Ex equipment if the piece of equipment is permitted to be operated beyond the ATEX standard temperature range (-20°C to +40°C). Some of our cameras are safe from -60°C to +60°C for example. This temperature range is the “approved temperature range for the equipment”. Ensure that these specifications meet your system’s requirements.
Are you permitted to operate the aforementioned camera on a sight glass that is at +120°C? NO! That is too hot, as the camera is only approved for up to +60°C.
Are you permitted to operate the camera at +45°C at the equator? YES. That works.

Compare your system’s temperature range with the equipment’s permissible ambient temperature.

## 4.2 Ignition temperature

The ignition temperature of a dust cloud is the lowest temperature on a heated surface at which an explosion occurs. [3]

*Wheat dust, for example, ignites at +270°C. If you therefore imagine a flour cloud that is floating over a +450°C soldering iron, an explosion would occur. The heat of the soldering iron itself is sufficient to ignite the flour. A “spark” is no longer required.*

Consequence: the maximum surface temperature for pieces of equipment must be lower than the dust cloud’s ignition temperature.

[3] Here are two links regarding ignition temperatures for dusts:
https://de.wikipedia.org/wiki/Z%C3%BCndtemperatur - St%C3%A4ube
https://www.dguv.de/medien/ifa/de/pub/rep/pdf/rep02/biar1297/12-97.pdf

## 4.3 Smouldering temperature

In comparison to gas, dust has an attribute that has not yet been evaluated: it can settle. These deposits can have different thicknesses depending on when "cleaning" last took place. There is an additional hazard posed by these dust deposits: they can smoulder.

Figure 4-1: Checking the smouldering temperature[4]

The smouldering temperature is generally lower than the ignition temperature and the thickness of the dust layer is also decisive with regard to smouldering. The thicker the dust layer, the more energy it has and therefore, the more hazardous it is. Our standardising organisations have analysed layer thicknesses of 5mm, thicker layers were not considered. This means: try to avoid layer thicknesses of more than 5 mm. If you cannot manage this for structural reasons, these deposits must be evaluated separately in your explosion protection document.

[4] Source: https://www.bgn-branchenwissen.de/daten/bgn/akzente/akzente09/kenngroessen.htm

## 4.4 Maximum surface temperature for equipment

Let's apply our example of the flour cloud and the soldering iron.

> *It is obvious that an explosion will occur if a soldering iron at +450°C enters a flour cloud that has an ignition temperature of +270°C.*
> *But how hot can the soldering iron get before something happens? That is, what is the maximum surface temperature that it may have? You would certainly have a good feeling at +100° C, more of a bad feeling at +269°C and no feeling at all at +450°. ;-)*

The attentive reader will surely think that you can calculate the maximum permissible surface temperature based on the ignition and smouldering temperatures. And they would be right.

ⓘ The maximum surface temperature for a piece of equipment must be lower than 2/3 of the lowest ignition temperature.[5]

ⓘ The maximum surface temperature must be 75K below the dust layer's smouldering temperature.[6]

Let's go back to our example of Ms Miller and Mr Meyer from section 2.

> *The lamp in the silo gets hot when it's on, in the same way as a light bulb gets hot when you switch it on. Let's calculate how hot they may get:*
>
> *Let's assume the following values:*
> $T_{ignition} = +270°C$
> $T_{smouldering} = +250°C$
>
> *This results in:*
> $T_{max\ (dust\ cloud)} = 2/3 \times 270°C = +180°C$
> $T_{max\ (dust\ layer)} = +250°C – 75K = +175°C$
>
> $T_{max} < +175°C$
>
> *Mr Meyer's authorised Ex person has therefore found a lamp with a surface that may not get hotter than +175°C. It is therefore impossible for the lamp to ignite the dust cloud when it is illuminated and Mr Meyer is not screwing around on it.*

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[5] TRBS 2152 part 3, No. 5.2.6, paragraph 1
[6] TRBS 2152 part 3, No. 5.2.6, paragraph 2, No. 5.2.7, paragraph 2 and No. 5.2.8, paragraph 2).
The prerequisite is that the dust deposit layers are not thicker than 5 mm. If the layer thickness is > 5 mm, the maximum permissible surface temperature reduces significantly, as the dust has an insulating effect!

We now also know how hot our soldering iron may become in order that we can solder safely in the dust cloud: no more than +175°C!

At this point, here is one more important point that is often unclear to our customers: Equipment generally does not generate an *absolute surface temperature*, but rather a *temperature difference to its ambient temperature*. This becomes clear in the example: Mr Meyer’s silo lamp generates a temperature difference of 20K to the ambient temperature in operation. If it is already +40°C in the silo, the lamp’s surface will be +60°C.
And in winter? How hot will the lamp get if it is only +10°C in the silo? That’s right! +10°C + 20K = +30°C. The lamp will therefore be a perfect hand warmer at +30°C!

The equipment manufacturer’s specifications for the maximum surface temperature relate to equipment operation at the maximum permissible ambient temperature.

The equipment manufacturer’s specifications for the maximum surface temperature are not provided in temperature classes, but are rather specified as concrete values in degrees Celsius.

# 5 What to do?

The following section is mainly written for “laypeople”. It is intended to provide a common thread through the most important points. The legal regulations are more or less ignored. I beg the indulgence (or better the comments) of “explosion protection experts”! There are numerous online “basic principles brochures” to which I would like to refer. They more or less answer questions regarding project planning, the ignition protection classes or the legal requirements, which will not be discussed here.

## 5.1 Avoiding dust

Both dust deposits and dust clouds can be inflammable and therefore explosive. The first approach: we speak of primary explosion protection which means: avoid dust!

Figure 5-1: Dust filters

You probably know best how to avoid dust in your particular situation, as you know your system and your equipment. There is dust-generating equipment that has its own dust filters. A dust filter is particularly common on professional woodworking machines nowadays.

Avoid inflammable dusts in your system wherever possible. Use dust filter systems wherever you can.

### 5.1.1 Clean, clean, clean!

Sometimes, dust cannot be avoided, but you can remove it from wherever it has accumulated. Therefore, removing inflammable dust on a regular basis is a significant safety-related preventive measure when it comes to explosion protection.

Figure 5-2: Dust deposits

### 5.1.2 Extraction systems for inflammable dusts

An extraction system is nothing more than a professional version of a vacuum cleaner.

> *Have you ever drilled a hole in a concrete wall in the lounge? If you have, you know that it causes lots of dust. You can handle this in three different ways: 1. You can vacuum the dust away after drilling, which is more work for you but will make your wife very happy. 2. You can leave the dust where it is, which will not please your wife at all. 3. Before you start drilling, you ask your wife for help so that she can hold the vacuum cleaner next to the hole that you are drilling during the drilling process and therefore vacuum away the dust at its point of occurrence. An industrial extraction system does not do anything else.*
> *Option 3 has 2 benefits: The dust is vacuumed away from the "source" and your wife feels like she helped with the drilling. If you are a woman and want to do the drilling yourself, the same also applies to you of course: ask your husband to help with the vacuuming.*

If you google "Dust extraction for zone 22", for example, you will already have many equipment options.


Figure 5-3: Extraction system for zone 22

Use suitable extraction systems and ensure that the extraction system is suitable for your dusts and your Ex zone.

### 5.1.3 Air purge systems

Air purge systems are not so popular in dust Ex zones. The reason for this is obvious: inflammable dusts are swirled up by air purge systems and therefore “turned into” an explosive dust cloud. This is potentially so dangerous that project planning for air purge systems has to be particularly good.

They only make functional sense if the dust is problematic “*in a specific location*”. For example, on a camera lens, on a sight glass or a temperature hotspot. The motto here is: “There shouldn’t be any dust here, it should settle somewhere else.”

The following MUST be considered for air purge systems.

Air purge systems must be considered when classifying the zones!

For example, your zone 22 can quickly become zone 21 if you purge the air *“every half hour“*.

Equipment in the air purge systems, e.g. solenoid valves, must correspond to the zone classification!

For example, use a solenoid valve that is approved for zone 21 in zone 21.

Design the air purge device to be fail-safe! Air purging must not take place continuously, in order to prevent dust being swirled up continuously.

This can be ensured using two solenoid valves that are switched in sequence, for example, or by a combination of manual and automatic valves.

If possible, combine your air purge system with a suitable local extraction system so that your dust is collected immediately and cannot settle again.

For more information regarding air purge systems for explosion-protected camera systems, see:

https://www.samcon.eu/en/products/equipment/air-blade/

Or:


If you have exhausted all opportunities for avoiding an explosive dust atmosphere, the next step is as follows: Avoid sources of ignition!

## 5.2 Avoiding sources of ignition

There are many sources of ignition such as the cigarette from the introduction section, an electrical or mechanical spark, light with a high power density, etc. The following assumes that the potential source of ignition is a piece of equipment that is installed and/or to be used in the Ex zone. The first important question when planning the project for equipment in the Ex area is:

does the equipment have to be installed in the Ex area?

Avoided Ex equipment is safe Ex equipment! Check whether the task that the equipment must fulfil REALLY requires installation in the Ex zone! This is often the case but often not!

> *Zone 22 cameras are often requested from us for use outdoors. During the project planning talks, we then explain that the zone 22 limit is defined as up to 4 metres above the dust. When we then explain to our customer that a simple 7-metre mast solution is then in the safe area by 3 metres, our customer is first dumbfounded by how easily their Ex problems can be solved and then happy because they have saved a lot of money.*

Avoid having to install equipment in the Ex area wherever possible!

### 5.2.1 Selecting the correct equipment protection level

If Ex equipment must be used, first define the required equipment protection level. Remind yourself of the information in section 2 of this brochure and remember: “Safer than you need” is always OK.

Define the required equipment protection level: Only use equipment with category Da in zone 20. Da and Db can be used in zone 21. And Da, Db and DC can be installed in zone 22.

### 5.2.2 Selecting the correct equipment group

Which dusts or flyings occur in your system? Which equipment group is required for your dusts? Section 3 describes what you must pay attention to.

Define the required equipment group: Only use IIIC equipment in dust group IIIC. IIIB and IIIC equipment is suitable for dust group IIIB. And IIIA, IIIB and IIIC equipment may be used in dust group IIIA.

### 5.2.3 Observe the temperatures

Remind yourself of the explanations in section 4.

Define the **ambient temperature range** for your equipment. How hot does it get in your system? Can the equipment cope with that? Is the equipment still safe when it is that hot? How cold does it get in your system? Can the equipment cope with that? Is the equipment still safe when it is that cold?

What is the **maximum surface temperature** that the equipment may have? Determine the maximum surface temperature that equipment in your system may have, as described in section 4. If the temperature specifications for the maximum surface temperature are listed on the equipment's type plate, everything is OK. If not, find a piece of equipment that does not get too hot.

# 6 Miscellaneous

## 6.1 Dust and/or gas?

What actually happens if I have an atmosphere that is at risk of dust and gas explosion *at the same time*? Many customers think this isn't a problem because both the marking for dust and the marking for gas are on the type plate. But this is a misconception. The equipment is approved for dust and gas but simultaneous occurrence is a special situation that has not been simulated and that is not covered in the standard. So it is therefore possible that, if a gas explosion occurs in a pressure-resistant housing, hot ignition gas can ignite an exterior dust atmosphere. The following therefore applies:
Gas Ex equipment in a gas Ex atmosphere? Yes!
Dust Ex equipment in a dust Ex atmosphere? Yes!
Dust and gas Ex equipment in a *simultaneous* dust and gas Ex atmosphere: No!

## 6.2 Further links

Basic principles:
https://www.ptb.de/cms/de/ptb/fachabteilungen/abt3/exschutz/ex-grundlagen.html
https://www.bgrci.de/
https://de.wikipedia.org/wiki/Explosionsschutz

Parameters:
https://www.bgn-branchenwissen.de/daten/bgn/akzente/akzente09/kenngroessen.htm
https://www.dguv.de/medien/ifa/de/pub/rep/pdf/rep02/biar1297/12-97.pdf

## 6.3 Closing remarks

The requirements on this brochure were to explain the risk of dust explosion and dust explosion protection simply and basically. Much was omitted, such as topics regarding the lower or upper explosion limit, and we only scratched the surface of other topics such as the ambient temperature range. It is also clear that cables and lines, fire-retarding sealings, etc. are also part of clean project planning for Ex systems, but these were not mentioned even once in this brochure. In short: reading this brochure will not make you an Ex expert. Despite that, I hope that you remember some of the examples and that you now have a basic understanding of why the regulations are the way they are.
If you have any comments regarding this brochure, no matter what they are, feel free to contact me: s.seibert@samcon.eu

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