# Safety devices in Ex applications. Are you complying with Ex regulations ?

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# SAFETY DEVICES IN EX APPLICATIONS. ARE YOU COMPLYING WITH EX REGULATIONS?


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***Abstract*** - In Europe, the former ATEX Directive 94/9/EC[1] and the new Directive 2014/34/EU [2] provide mandatory requirements that are applicable for safety of equipment and protective systems intended for use in potentially explosive atmospheres (Ex).
For Ex motor driven systems for use in ATEX, regulations require safety devices for the removal of electrical power in case of over temperature or overload in the motor.
Those safety devices are covered in Europe by a harmonized standard [3] that is a strongly advised but not a mandatory requirement[1], based on EN 50495 standard [4]. At international standardization IEC level, a document is being prepared for worldwide use and should provide similar requirements: IEC 60079-42.
The compliance with requirements from these current EN and the future IEC standards IEC 60079-42 for safety devices can be done either by the manufacturer or end user. The choice of relevant safety devices would depend on the Ex motor protection mode.
As a European Notified Body for ATEX, and as an IECEx certification Body (ExCB), INERIS noticed that the compliance with these requirements are not always fulfilled for some end users' applications.
This paper describes these new mandatory requirements that shall be taken into account by the end user both:

- to guarantee the safety level of their process, based on a voluntary approach outside Europe and for mandatory compliance to regulation in Europe,
- to provide information to draw up the "*Explosion protection document*" defined in article 8 of the 99/92/EC Directive [5] in order to satisfy the minimum requirements.

This paper explains the objective and interest of these new mandatory requirements for end users in the case of drive systems or circuit breakers associated with Ex motors.

**This paper and associated examples are limited to the application of Ex 'd' and Ex 'e' motor protection. The other available protection modes (e.g. Ex 'p', which is also an option) are not considered in this paper.**

This paper deals with categories and not EPL because EN 50495 does not refers to EPL. More information about category and EPL is given in chapter V.

*Index Terms* — ATEX, Explosion motor protection, Safety Device, Power drive system, variable speed drive, thermal motor protection, overload motor protection, functional safety.

## I. INTRODUCTION

In Europe, two regulations apply for operation in potentially explosive atmospheres (Ex or ATEX) :

- ATEX 99/92/EC Directive that applies to the users of Ex equipment
- ATEX 2014/34/EU [2] Directive that applies to manufacturers of equipment, protective systems and safety devices [6] when they put products on the market.

### What are "safety devices"?

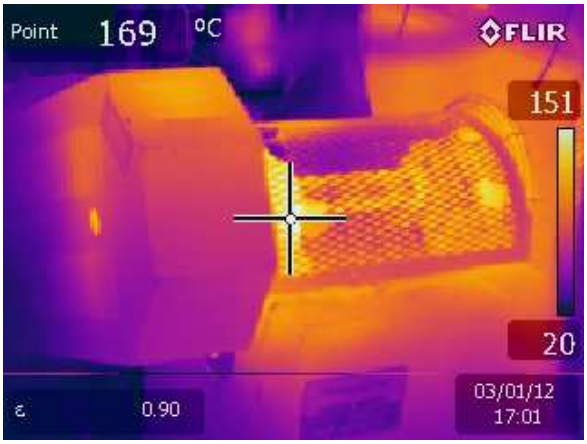
The modes of protection for equipment and protective systems are well known since 1994 when ATEX Directive was published, because they have existed for decades (IEC 60079-x series and previously EN 50xxx series). It was slightly different in the case of safety devices. A new issue was how to use them in order to comply with European regulations. At that time, manufacturers and Notified Bodies faced the need for definitions and limits of what was covered by the term "Safety Devices".

The European Commission identified a research project as a support to standardization on this topic: the **SAFEC** project [7]. Results from that study were available in January 1999 and have been introduced into the European harmonized standard EN 50495:2010 for requirements concerning Safety devices for the safe functioning of equipment with respect to explosion risks.

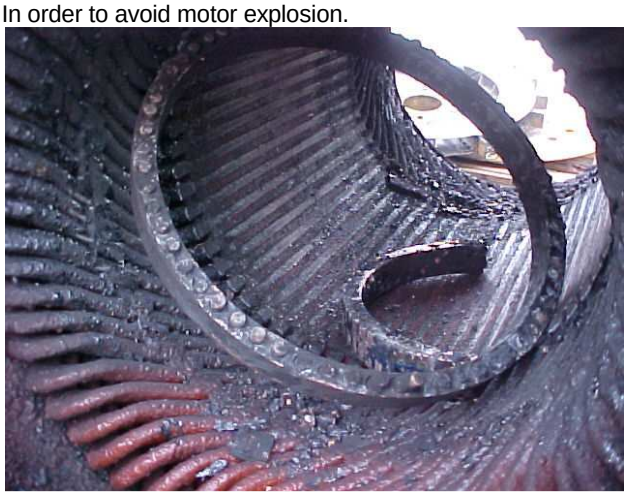
### Why are safety devices needed?

In order to detect over temperature or overload with high level of confidence.

[1] "*Manufacturers, other economic operators, or conformity assessment bodies can use harmonised standards to demonstrate that products, services, or processes comply with relevant EU legislation*.




In order to avoid motor explosion.



In Ex field, there are many safety devices for Ex applications. Nevertheless this paper focusses on different kinds of application implementing these safety devices: **The case of safety devices for drive systems or circuit breakers or other suitable motor overload protection appliances (overload relay, …) associated with Ex motors.**

Safety devices are not only used in Europe to increase safety and this document also provides information on the developments of standards at international level.

This paper presents:

- the history of safety devices in explosive atmospheres at European level;
- the application of safety devices for motor temperature protection;
- The current and forthcoming IEC standardization for safety devices in explosive atmospheres.

## II. THE HISTORY OF SAFETY DEVICES IN EXPLOSIVE ATMOSPHERES AT EUROPEAN LEVEL

In 1998, a pre-normative European project named SAFEC [7] was launched in order to determine and classify these safety devices. Even though these safety devices were covered by the ATEX 94/9/EC Directive [1], they were subject to issues and different interpretations for their assessment by notified bodies and by manufacturers.

The results of this SAFEC project are today included into a Harmonized European standard: **EN 50495:2010 "Safety devices required for the safe functioning of equipment with respect to explosion risks**" that came into force as a harmonized standard on 2010/09/17 for its first publication.

In order to clarify the scope and the definition of these safety devices from the Directive [1], the application guide of the ATEX 94/9/EC Directive [8], has since its second edition published in July 2005, incorporated the results of the SAFEC project in clause 3.10 *"Safety, controlling or regulating devices as defined in Article 1.2"*.

A similar text has been incorporated in the new guide published, as first edition of the ATEX 2014/34/EU Directive, in April 2016 [9], within Clause 36 *"Safety devices, controlling devices and regulated devices as defined in Article 1(1)(b)"*.

The second edition of the guide published in December 2017 [10] still defines the same information in clause 36.

EN 50495 standard applies to the manufacturers that put these kind of safety devices on the market. However, this standard is also used as a reference when equipment or protective systems require these safety devices but are put on the market separately. In this case the end user becomes a designer when they decide what kind of safety devices they implement in their final application. For that purpose, the standard identifies and covers Safety devices that are classified in 2 types or categories a) or b):

a) *devices, which are embedded as component in the equipment under control. The combined apparatus is considered as equipment.*
b) *devices, which are installed separately from the equipment under control and considered as associated apparatus exclusively for a specific type of protection or specific equipment under control. The combined apparatus is considered as a system.*

## III. THE APPLICATION OF SAFETY DEVICES FOR MOTOR TEMPERATURE PROTECTION

For Ex motor driven systems for use in ATEX, the European regulations require safety devices for motor protection (that limit the temperature rise during blockage or motor stall) in order to switch off the electrical power in case of over temperature or overload in the motor. The EN 50495 standard gives five examples for the definition of required safety level and for the selection of related safety devices.

Examples, based on Ex 'd' and Ex 'e' motor modes of protection are described hereafter.

### *A. Safety devices and Ex 'd' motor protection*

For Ex motors with enclosure protection mode, **IEC 60079-1: Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures 'd'** [11] does not explicitly mention safety device except for batteries. However, for all equipment and especially for Ex motor the temperature classification is requested by **EN 60079-0:2012: "Explosive atmospheres - Part 0: Equipment - General requirements"** [12] in tables 2 and 3.

In order to protect against auto-ignition of gas or dust by the surface temperature of the external parts of a motor with type of protection Ex 'd', a safety temperature switch or measure temperature safety system is required.

### *B. Safety devices and Ex 'e' motor protection*

For Ex motors with enhanced protection mode, **IEC 60079-7 "Explosive atmospheres – Part 7: Equipment protection by increased safety 'e'**, the safety is guaranteed with an overload safety device [13] e.g. an overload relay designed to control an Ex 'e' motor. In order to protect the motor and to protect against overload of the motor, an overload protection safety function is required.

A new edition of IEC 60079-7 has been published in 2015. Compared to the previous edition (2006), the term "safety device" appears 54 times instead of 22 times.

**The question is:**

**How can end users select safety temperature switches for implementation in motors or select the overload safety function to guarantee the complete protection for motors?**

The choice of the **temperature switch** or the **safety device for overload safety function** depends both on:

- the zone classification where the motor is installed and,
- the temperature classification depending on the gas and/or dust characteristics.

In some cases, the selection and the implementation of the switch or the overload safety function is under the responsibility of the end user or of the system integrator – and we can find on some plants, for example, a temperature switch connected to a general purpose drive with no specific assessment and in some case without any Ex protection mode.

The selection and the choice of these safety devices are presented hereafter in chapter C "*Safety devices and Ex motor system safety architectures".*

*C. Safety devices and Ex motor system safety architectures*

**C1) Motor associated to motor starter**

A motor starter in general has to provide the five basic functions: Isolation, Disconnection, Short-circuit protection, Overload protection and Switching. In practice this may be ensured by the following different technological associations:

- circuit-breaker with internal overload protection + contactor,
- circuit-breaker + separated overload relay + contactor,
- all-in-one motor management system.

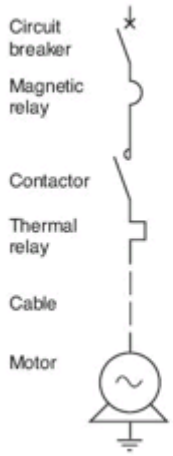



**Figure 1 – Motor associated to motor starter**

The relevant safety device for Ex 'e' motor protection provides the overload protection function by separated overload relay or by integrated function of circuit-breaker or by motor management system.

Corresponding EN 50495 (and future IEC 60079-42 standard) requirements apply to this motor overload protection function.

Motor starters are generally installed outside of ATEX zones. If the Ex motor starter is located within the ATEX zone, additional protection measures shall be taken in placing the Motor staters for example in a suitable "Ex-proof" enclosure.

**C2) Motor associated to variable speed drive**

Legend for Figures 2 to Figure 5 are defined as follows:

- PDS(SR): the Power Drive System (Safety Related) that is a PDS operating a safety function.
- PDS: is a CDM with a motor.
- CDM is the Complete Drive Module including the BDM with all devices, options, cables (the motor is not included).
- BDM is the Basic Drive Module, meaning the Power Electronic converter for command and control of the motor.
- SMT is the "Safe Motor Temperature" safety function as defined in the IEC/EN 61800-5-2.
- STO – Safe Torque Off (see [14]).

For a complete system including the motor and a variable speed drive (BDM/CDM), the following schematics (see Figures 2 to 5) should be considered in order to comply with Ex European regulations.

Two configurations for installation are considered in this paper:

- the case of variable speed drive (BDM/CDM) embedded inside an Ex enclosure that is placed within the Ex zone and that protects an Ex motor placed within the Ex zone. Both of them separately comply with Ex harmonized standards (see Figures 3 and 5), **but what about for the complete power drive system**? And,
- the case of the variable speed drive (BDM/CDM) that is placed outside the Ex zone with an Ex

motor placed within the Ex zone with a temperature sensor that comply with Ex harmonized standards.

- The case of an Ex ‘d’ motor and temperature sensor that are connected to the drive through an intrinsic safety barrier connected to a physical input of the Safe Motor Temperature (SMT) safety function of the Drive (BDM). The activation of this SMT safety function (temperature input or STO [14] safety function for example) switches off the electrical output power of the drive (see Figure 4).
- The case of an Ex ‘e’ motor with the drive that is outside the zone.
  - The overload protection performed by the safety function is embedded in the drive (see figure 2).
  - The overload safety function is not embedded within the variable speed drive but is performed by another external safety device, a circuit-breaker. **This case is not detailed in the present paper**.

Figures 2 and 3 suggest the architecture of different possible Power drive systems (safety related) “PDS(SR)” for use in explosive gas atmospheres, considering the motor type of protection ‘e’. Also, the different possible location of the CDM/BDM is considered.

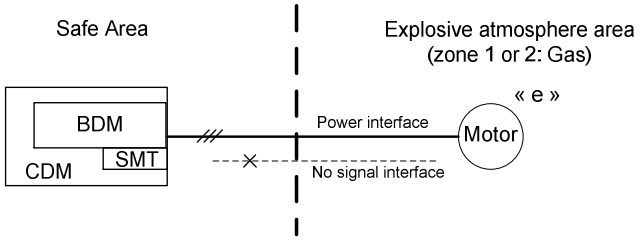



**Figure 2 - PDS(SR) with CDM in safe area and motor type of protection ‘e’ in Ex area**

In the Figure 3, the CDM/BDM is located is the Ex area, but it is not designed according to explosive atmosphere requirements. Consequently, in order to comply with ATEX regulations it has to support its own Ex type of protection, and is, for this reason, embedded within an Ex ‘d’ enclosure.

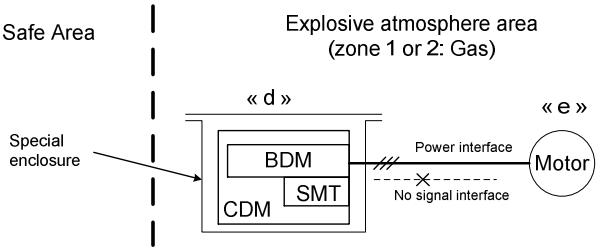



**Figure 3 - PDS(SR) with motor type of protection ‘e’ and CDM both located in explosive atmosphere**

Figures 4 and 5 give examples of PDS(SR) used in explosive atmospheres when the motor under control has a type of protection ‘d’ with flameproof enclosure. Unless if the CDM/BDM is also of type of protection ‘ia’ or ‘ib’ (according to IEC 60079-11 [15]) intrinsically safe, an intrinsic safety barrier is mandatory to separate explosive and non-explosive zones with temperature sensors mounted outside a motor with type of protection ‘d’. It is used for avoiding conditions which could cause the motor to ignite the explosive atmosphere.

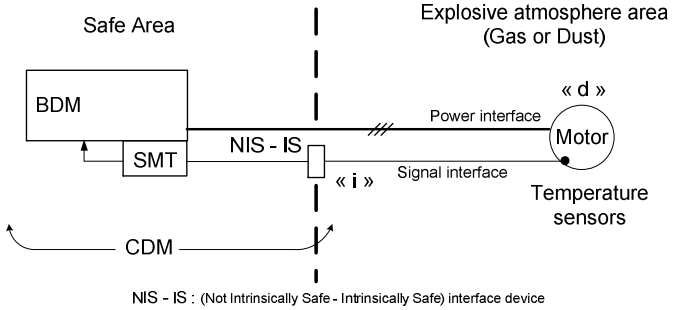



**Figure 4 - PDS(SR) with CDM in safe area and motor type of protection ‘d’ in Ex area**

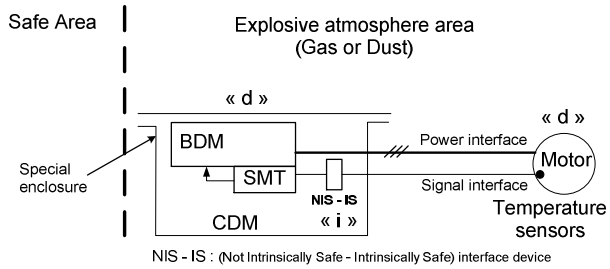



**Figure 5 - PDS(SR) with motor type of protection ‘d’ and CDM both located in explosive atmosphere**

The question is how to define the safety level of the safety function for the different cases described above? The EN 50495 standard provides the answers.

### *D. Safety devices and EN 50495 concepts*

The concept of the EN 50495 is based on both:

- the failure tolerance requirement for the equipment categories from Directives 94/9/EC and 2014/34/EU,
- the probabilistic classification of the hazardous areas into Zones according to the Directive 1999/92/EC.

For the failures tolerance requirements and for the probabilistic calculations, the standard introduces a set of requirements issued from IEC 61508: 2000 standard [16]. EN 50495 makes the link between two different areas of expertise that do not focus on the same way to consider failure effects.

- In Ex field the failures are the ones that can create a heat temperature point or a spark.
- In IEC 61508, the failures are the ones whose consequence is the loss of the safety function.

EN 50495 standard could be defined as the application of IEC 61508 in Ex field for safety devices. Its structure is similar to the one from IEC 62061 standards for the application of IEC 61508 for machinery.

The 94/9/EC and 2014/34/EU Directives consider the allowed faults for equipment under control in different categories as described below:

- equipment of category 1 must be safe with two faults (hardware fault tolerance of 2),
- equipment of category 2 must be safe with 1 fault (hardware fault tolerance of 1) and,

- equipment of category 3 must be safe under normal operation (hardware fault tolerance of 0).

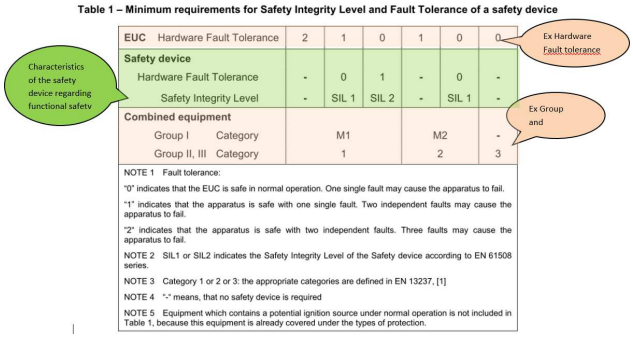



**Table 1: Minimum requirements for Safety integrity levels – Linking ATEX and Functional safety**

The next table adds the zone classification and Ex type of protection and especially motor protection.

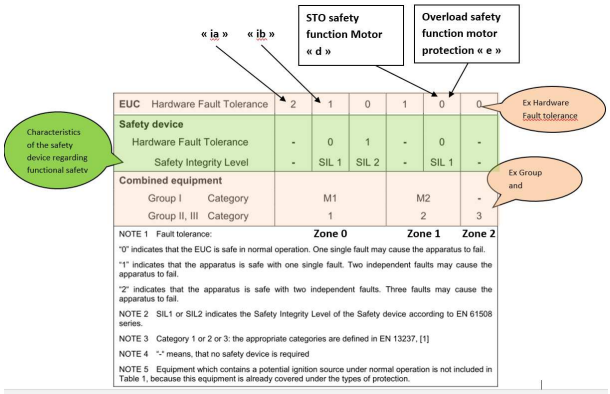



**Table 2: Minimum requirements for Safety integrity levels – the case of motor protection**

The above ATEX requirements are defined both:

- through the first line of Table 1 of EN 50495 with the wording "EUC" (Equipment under control) and "hardware fault tolerance".
- through the third line with the wording "combined equipment" for Group II, III category.

The second line "Safety device" defines the two requirements for the safety function under the wording "Hardware fault tolerance" and "safety integrity level".

This table 1 from the standard EN 50495 makes the link between requirements for the Ex area of applicative operation and functional safety.

The use of this table is based on ignition risk analysis. Ignition risk analysis of electrical apparatus starts with the evaluation of potential ignition sources even under the presumption of faults related to the equipment. If appropriate types of protection (EN 60079-X series of standards) are applied, the ignition risk of the protected equipment is reduced to comply with the required equipment category.

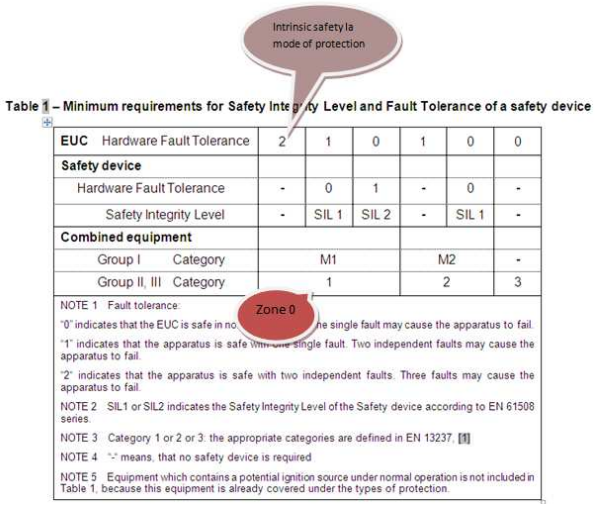



**Table 3: Minimum requirements for Safety integrity levels –the case of instrinsic safety "ia" mode of protection**

For example, if the Ex application requires a combined equipment for zone 0 (Category 1), then:

- One solution is to design the combined equipment with an intrinsic equipment of "ia" type of protection (that is safe with two faults) and no additional safety device is required (see [15]).
- A second solution is to design the combined equipment with an intrinsic equipment of "ib" type of protection (that is safe with one fault) and one additional safety device is required with hardware fault tolerance of zero and a safety function with SIL 1.

*E. Application of EN 50495 requirements to the over temperature and overload protection of an electrical motor*

If the minimum requirements from the previous table are applied to the protection of motor, the standard gives:

**Annex D.3 of EN 50495 for Ex 'e' Motor**

Overload of motor for Ex 'e' type of protection and annex D.3 Overload protective devices for electric motors of type of protection Ex 'e'

- According to EN 60079-7 the temperature rise for machines with cage rotors shall be limited. This can be done by using a current-dependent safety device.
- In this case the fault tolerance according to the temperature rise of the motor is 0.
- According to Table 1 a safety device with SIL 1 and a hardware fault tolerance of 0 is necessary to fulfill the requirements of Category 2 equipment. This has to be considered when designing a complex overload protective device for an Ex 'e' motor according to EN 60079-7.

**Annex D.2 of EN 50495 for Ex 'd' Motor**

The EC-Type Examination Certificate of a Category 2 Ex 'd' motor requires the use of a direct temperature control (e.g. a PTC thermistor triggering device).

- The motor has a fault tolerance of 0, i.e. the motor is not a source of ignition in a fault-free operational mode.
- According to Table 1 of EN 50495 (table 4 hereafter), the motor requires a safety device with a SIL 1 and a hardware fault tolerance of 0.
- In that configuration, the motor can be used as Category 2 equipment.

For these two examples from Annexes D.3 & D.2 of EN 50495, the required safety level for the over temperature electrical motor protection is SIL 1 with hardware fault tolerance of 0 for the Safety device.

Table 1 – Minimum requirements for Safety Integrity Level and Fault Tolerance of a safety device

| | | | | | | |
|---|---|---|---|---|---|---|
| **EUC** Hardware Fault Tolerance | 2 | 1 | 0 | 1 | 0 | 0 |
| **Safety device** | | | | | | |
| Hardware Fault Tolerance | - | 0 | 1 | - | 0 | |
| Safety Integrity Level | - | SIL 1 | SIL 2 | - | SIL 1 | - |
| **Combined equipment** | | | | | | |
| Group I Category | M1 | | | M2 | | - |
| Group II, III Category | 1 | | | 2 | | 3 |

Safety level of the safety device for motor protection

NOTE 1 Fault tolerance:
"0" indicates that the EUC is safe in normal operation. One single fault may cause the apparatus to fail.
"1" indicates that the apparatus is safe with one single fault. Two independent faults may cause the apparatus to fail.
"2" indicates that the apparatus is safe with two independent faults. Three faults may cause the apparatus to fail.
NOTE 2 SIL1 or SIL2 indicates the Safety Integrity Level of the Safety device according to EN 61508 series.
NOTE 3 Category 1 or 2 or 3: the appropriate categories are defined in EN 13237. [1]
NOTE 4 "-" means, that no safety device is required.
NOTE 5 Equipment which contains a potential ignition source under normal operation is not included in Table 1, because this equipment is already covered under the types of protection.

**Table 4: Minimum requirements for Safety integrity levels –Safety device levels for motor protection**

*F. Additional architectural constraints: EN 50495 versus IEC 61508*

This is what is mandatory in Europe when:

- Manufacturer sells motors with incorporated safety devices
- End users select a safety device to protect their motors for use in Ex fields.

However, the SIL certified products according to IEC 61508 standard are not sufficient to comply with the requirements of EN 50495 standard.

Some additional requirements in terms of architecture and fault tolerance have been introduced in the EN 50495 standard and are summarized in the following table for type A and type B technology as defined in IEC 61508-2 [17].

Table B.3 – Hardware safety integrity: Architectural constrains on Type A or B safety-related subsystems

| Safe Failure Fraction (SFF) | Type A Subsystem Hardware fault tolerance | | | Type B Subsystem Hardware fault tolerance | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 0 | 1 | 2 |
| < 60 % | SIL 1 | SIL 2 | SIL 3 | Not permitted | ~~SIL 1~~ | ~~SIL 2~~ |
| 60 % - < 90 % | ~~SIL 1~~ | SIL 3 | SIL 4 | SIL 1 | SIL 2 | SIL 3 |
| 90 % - < 99 % | SIL 3 | SIL 4 | SIL 4 | ~~SIL 1~~ | SIL 3 | SIL 4 |
| ≥ 99 % | SIL 3 | SIL 4 | SIL 4 | SIL 3 | SIL 4 | SIL 4 |

NOTE 1 Type A subsystem. Any system based on analogue technology (i.e. based on neither programmable electronics nor software) (cross reference EN 61511-1:2004, 3.2.47).
NOTE 2 Type B subsystem. Any system based on one or more programmable modules.
EXAMPLES:
– sensors equipped with microprocessors ("smart sensors");
– programmable systems of electronic logics such as
  - programmable control units,
  - PLC, programmable logic controller,
  - control units (cross reference EN 61511-1:2004, 3.2.55).
NOTE 3 Provided the conditions of EN 61511-1:2004, 11.4.4 (e.g. prior use reliability data, restricted and protected parameter adjustment, SIL < 4) are met, the SFF specified in Table B.3 may be reduced by one level (line).

**Table 5: IEC 61508 possibilities and EN 50495 restrictions**

## IV. ADDITIONAL REQUIREMENTS FOR INSTALLATION

In addition to the previous figures, the cabling schemes must also to comply with Ex standards and local regulations that are defined mostly in IEC 60079-14 [18]. Some cabling schemes according to Ex standards are suggested in the following figures.

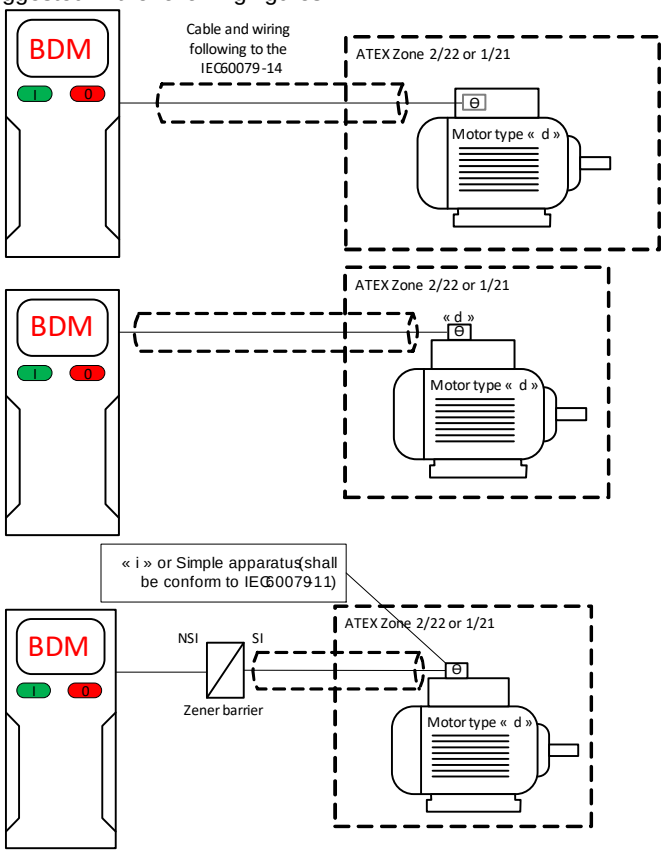



**Figure 6: Cabling schemes**

## V. CONVERSION CATEGORY - EPL

The present paper only refers to categories of equipment and not EPL because EN 50495 only deals with categories. A link between Ex type of protection and equipment protection level (EPL) for Minimum Risk Reduction Factor for a safety device for ignition risk reduction should be introduced in the forthcoming IEC 60079-42 ed. 1 and additional information are available in reference document [19].

## VI. THE CURRENT AND FORTHCOMING IEC STANDARDIZATION FOR SAFETY DEVICES IN EXPLOSIVE ATMOSPHERES

This European EN 50495 standard is considered today at international standardization IEC level within the technical Committee IEC/TC 31 (Equipment for explosive atmospheres), drafted by the Working Group TC 31/WG 42 (Safety Devices Related to Explosion Risk) under a project for the future IEC 60079-42 standard.

Two cases are to be considered:

1. When considering a motor system combining a motor starter with an Ex motor, the safety device implements the current-dependent overload protection function. Generally placed outside the hazardous area, its function is to monitor the motor current and to disconnect

the motor using an overload protective device that is able to operate within a suitable time and appropriate Risk Reduction Factor RRF.

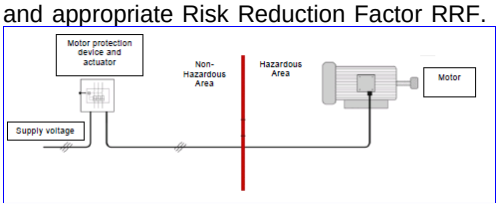



**Figure 7: Overload protective device under overload conditions**

2. When considering an adjustable speed electric drive system, incorporating semiconductor power converters (PDS) for command and control of electric motors used in potentially explosive atmospheres, some particular attention is to be given for protecting the electric motor against excessive temperature. The use of a Power Drive System, Safety related "PDS(SR)" can help by the application of Safety functions designed in accordance with the functional safety related international standard IEC/EN 61800-5-2, drafted by the IEC/SC 22G Committee.

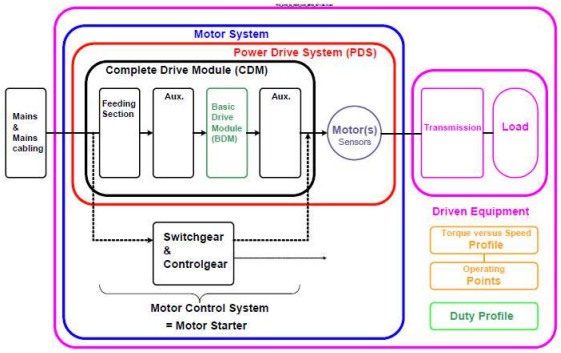



**Figure 8: Motor system description, as part of motor driven equipment**

Before publication of IEC 61800-5-2 (edition 2: 2016 - [20]), it was expected by the standardization team IEC/SC 22G/MT 12, to attach to this standard a dedicated annex describing recommendations for use of the safety sub-function "Safe Motor Temperature – SMT" with a motor performing explosive atmosphere applications. The purpose of that Annex was not to cover all possible cases exhaustively, but to provide some advice and guidance for explosive atmosphere system integrators and users. This Annex of the IEC/EN 61800-5-2 was considering the complete drive power electronic module (CDM) as a safety device performing the SMT safety function for thermal protection of the electric motor protected only by a flameproof enclosure or increased safety.

Cooperation between IEC Committees for delivering unique standard series.

- Because IEC standards related to Equipment for use in explosive atmospheres are referenced in the IEC/EN 61800-5-2, and because this standard has been drafted by experts other than from the IEC/TC 31 Committee, it has been decided by IEC/SC 22G Committee Officers and Members to offer the drafted Annex to the IEC/TC 31 Committee for an accurate update, or extension to other Equipment protection level (EPL) and for easier maintenance of the standard. A Liaison between both Committees was decided end of 2015. Mr. Patra, currently IEC/SC 22G Vice-Chairman has been appointed as IEC/SC 22G Liaison Officer with IEC/TC 31 Committee beginning of 2016 for starting cooperation between both Committees. The objective is now for IEC/TC 31 and IEC/SC 22G to work together on standards on their joint area of expertise.
- Joint meetings have been organized since end 2016 by IEC/TC 31/WG 27 "Electric Machines (motors and generators)" gathering experts and Liaison Officers from IEC/SC 22G and from IEC/TC 31/WG 42 "Safety Devices Related to Explosion Risk". For all participants, it was considered as a very fruitful technical cooperation. Further meetings are expected to be beneficial to a near future publication of updated IEC 60079 series of standards. This covers specification, design requirement, installation guidance, and other advice for use of PDS(SR) as safety device performing the SMT safety function for the electric motor thermal protection when used in explosive atmospheres.
- The protection concept requirement has been provided by IEC/TC 31/WG 22 for possible incorporation at FDIS stage as Informative Annexes (D and E) of IEC 60079-0 - future ed. 7. Also an interpretation sheet has been introduced in F1:2017 February of IEC 60079-14 – [21]) that gives additional requirements for electrical installations design, selection and erection of IEC 60079-14:2013 ed. 5.

In 2016 a New Work Item Proposal was suggested with the following title "*IEC TS 60079-42 Ed 1: Explosive atmospheres - Part 42: Electrical Safety Devices for equipment* ". The outcome of this work should be a Technical Specification. It was also been stated in October 2016 that the outcome of the SAFEC project is the basis for this document. The publication of this document is expected beginning of 2019.

## VII. CONCLUSION

Today, new kinds of devices are appearing in Ex world: the safety devices that are at the border between two areas of expertise : Ex IEC 60079-x product series standards and EN 50495 (based on IEC 61508 functional safety standard). These two areas of expertise do not consider failures on the same way. In Ex field the failures are the ones that can create a heat temperature point or a spark, and in EN 50495, the failures are the ones that result in the loss of the safety function. Such a situation shows how sometimes, there can be misunderstandings between experts and standards.

Border between two areas of expertise, EN 50495 standard is also a border between two different kinds of stakeholders:

- The manufacturers that can introduce these safety devices in their products.
- The end users that are managing a system and that have to define the safety devices when they are not embedded in Ex equipment. They also have to guarantee the complete safety loop when

they integrate different kinds of apparatus in their processes.

Because the EN 50495:2010 is today a harmonized standard in Europe its application is strongly advised even if the application of a harmonized standard is not mandatory. If you decide not to use this harmonized standard, you must demonstrate that the method you use, has at least the same level of technical confidence, and if a problem occurs in your plant, you will have also to convince the judge.

## VIII. REFERENCES


[1] ATEX Directive 94/9/EC
ATEX 94/9/EC Directive that came into force in July 2003

[2] ATEX Directive 2014/34/EU
Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast).

[3] Harmonized standard means that the compliance with the requirements of the standard gives presumption of conformity to the Essential Health and Safety Requirements of the Directive. The list of harmonized standards is published on the european website at http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/equipment-explosive-atmosphere/

[4] **EN 50495:2010 :** Safety devices required for the safe functioning of equipment with respect to explosion risks

[5] DIRECTIVE 1999/92/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

[6] ATEX Directive 2014/34/EU - CHAPTER 1 : GENERAL PROVISIONS : Article 1 : Scope

1. This Directive shall apply to the following, hereinafter referred to as 'products':

(a) equipment and protective systems intended for use in potentially explosive atmospheres;

(b) safety devices, controlling devices and regulating devices intended for use outside potentially explosive atmospheres but required for or contributing to the safe functioning of equipment and protective systems with respect to the risks of explosion;

(c) components intended to be incorporated into equipment and protective systems referred to in point (a).

[7] SAFEC project
http://www.industry-finder.com/machinery-directive/safec-project.html

[6] application guide of the ATEX 94/9/EC Directive Devices in the scope of Article 1.2 (edition 2 to edition 5)

1. Safety devices, controlling devices and regulating devices, if they contribute to or are required for the safe functioning of equipment or protective systems with respect to the hazards of ignition or - respectively - with respect to the hazard of uncontrolled explosion are subject to the Directive;
2. These devices are covered even if they are intended for use outside the potentially explosive atmosphere. Those devices are not classified into categories according to Article 1.
3. Safety instrumented systems (e.g. a sensor, PLC and an actuator) in the sense of items 1. and 2. The whole system must be considered as a safety device in the sense of Article 1.2. Parts of this safety device may be located inside (e.g. a sensor) or outside (e.g. PLC) potentially explosive atmospheres.
application guides for ATEX revision 1 to 5 http://www.industry-finder.com/machinery-directive/download-center.html

[9] First edition of the ATEX 2014/34/EU Directive guide, published in April 2016

[10] Second edition of the ATEX 2014/34/EU Directive guide, published in December 2017

[11] IEC 60079-1: Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures 'd'

[12] EN 60079-0:2012: "Explosive atmospheres - Part 0: Equipment - General requirements »

[13] **EN 60079-7 :2007: § 5.2.4.4.1**

*When intended for use with a current-dependent device to protect against exceeding the limiting temperature, the starting current ratio IA/IN and the time tE shall be determined and marked in accordance with 9.1.*

*The length of time tE shall be such that, when the machine is stalled, it can be disconnected by the current-dependent protective device before time tE has elapsed.In general, this is possible if the minimum values for tE given in Figure 2 as a function of the starting current ratio IA/IN are exceeded. Values of time tE below the values in Figure 2 are permissible* ***only if a suitable overload protective device is used for the machine*** *and it is shown to be effective by test. The devices shall be specified by marking on the machine in accordance with item g) of 9.1.*

Similar text in **EN 60079-7:2015: § 5.2.8.2 and annex C**

[14] STO: Safe Torque Off safety function as defined in IEC/EN 61800-5-2:2016

[15] IEC 60079-11:2012 Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"

[16] IEC 61508:2000 Functional safety of electrical/electronic/programmable electronic safety-related systems

[17] Defined in IEC 61508 part 2 in chapters:

7.4.4.1.2 An element can be regarded as type A if, for the components required to achieve the safety function

a) the failure modes of all constituent components are well defined; and

b) the behaviour of the element under fault conditions can be completely determined; and

c) there is sufficient dependable failure data to show that the claimed rates of failure for detected and undetected dangerous failures are met (see 7.4.9.3 to 7.4.9.5).

7.4.4.1.3 An element shall be regarded as type B if, for the components required to achieve the safety function,

a) the failure mode of at least one constituent component is not well defined; or

b) the behaviour of the element under fault conditions cannot be completely determined; or

c) there is insufficient dependable failure data to support claims for rates of failure for detected and undetected dangerous failures (see 7.4.9.3 to 7.4.9.5)

[18] IEC 60079-14: 2013 Explosive atmospheres – Part 14: Electrical installations design, selection and erection (AC1:2016) -

[19] IEC 60079-26: 2014: Explosive atmospheres – Explosive atmospheres – Part 26: Equipment with Equipment Protection Level (EPL) Ga

[20] IEC 61800-5-2: 2015: Adjustable speed electrical power drive systems - Part 5-2: safety requirements - Functional
[21] IEC 60079-14-F1 Explosive atmospheres – Part 14: Electrical installations design, selection and erection (interpretation sheet February 2017)

## IX VITA

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