ANNEX C

IDENTIFICATION OF "USED SAFETY DEVICES"

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5. INTRODUCTION

In Europe, the operating sites of industry where an explosive atmosphere is or may be present, are usually divided in zones according to the expected frequency and duration of the explosive atmosphere. Electrical equipment intended for use in such areas is designed with special measures to reduce the likelihood of ignition of the explosive atmosphere; the different types of protection of electrical equipment are covered by CENELEC standards (see references).

Such equipment sometimes relies on the correct operation or control of protecting devices, like motor protection devices, in order to maintain certain characteristics of the apparatus within acceptable limits. Other safety-related devices such as gas detectors may also be used within potentially explosive atmospheres and contribute to the overall level of safety.

The approval and certification of electrical apparatus for potentially explosive atmospheres, therefore, requires that, where such safety devices are used, an assessment be made of their suitability for the intended purpose.

2. OBJECTIVE

The SAFEC project has the overall objective to produce a harmonised system for subdivision of safety devices which are used in electrical equipment for use in potentially explosive atmospheres, together with a methodology for selecting the appropriate subdivision of safety device for any particular application.

Task 3, which is described in this report, is aimed at the identification of the safety devices currently used as control and protection devices for electrical apparatus intended for use in potentially explosive atmospheres. The safety devices should be identified and related, when it is possible, to the CENELEC standards which define them.

3. SCOPE

The scope of the SAFEC project is limited to:

a) electrical apparatus which comes under the requirements of the ATEX Directive, i.e. the focus is on what can be done by the manufacturer of the equipment which is for sale (rather than by the user).
b) electrical apparatus for use in flammable atmospheres for which safety devices are relevant. Examples of this are type “e” (increased safety) and type “p” (pressurisation). More types are defined in this report.
c) all types of safety devices. This includes those which are electrical, electronic or programmable electronic in nature. Some such devices may be relatively complex so that the type and consequence of failure may be indeterminate. Less complex safety devices are also included such as, for example, a switch which cuts off the power of

the flameproof equipment if it is opened, or thermal fuses (if provided by the manufacturer).

The project is then focused on safety, controlling and regulating devices. These are parts of equipment or protective systems, and have an autonomous safety function.

The ATEX Directive, in the annex II, clause 1.5 defines the requirements for the safety devices.

The directive 94/09/EC requires, that safety devices must function independently of any measurement or control devices required for operation. As far as possible, failure of a safety device must be detected sufficiently rapidly by appropriate technical means to ensure that there is only little likelihood that dangerous situations will occur.

For electrical circuits the fail-safe principal is to be applied in general.

Safety-related switching must in general directly actuate the relevant control devices without intermediate software command.

In the event of a safety device failure, equipment and/or protective systems shall, wherever possible, be secured.

Emergency stop controls of safety devices must, as far as possible, be fitted with restart lockouts. A new start command may take effect on normal operation only after the restart lockouts have been intentionally reset.

Where control and display units are used, they must be designed in accordance with ergonomic principals in order to achieve the highest possible level of operating safety with regard to the risk of explosion.

In so far as they relate to equipment used in explosive atmospheres, devices with a measuring function must be designed and constructed so that they can cope with foreseeable operating requirements and special conditions of use. Where necessary, it must be possible to check the reading accuracy and serviceability of devices with a measuring function. The design of devices with a measuring function must incorporate a safety factor which ensures, that the alarm threshold lies far enough outside the explosion and/or ignition limits of the atmosphere to be registered, taking into account, in particular, the operating conditions of the installation and possible aberrations in the measuring system.

If the design of software controlled equipment, protective systems and safety devices, special account must be taken of the risks arising from faults in the programme.

4. REVIEW OF CENELEC STANDARDS RELATING TO SAFETY DEVICES

In the different CENELEC standards, mentioned above to the different protection types, there are numerous references to safety devices, when the apparatus relies on the correct operation of such devices. This section includes a list of the references found throughout the standards (the review tries to be as complete as possible but it may not be exhaustive, and so, some references may not appear below).

Below, a review of the safety devices mentioned in each standard is described, relating each device to the clause of the text in which the reference has been found. The references found in text are not reproduced textually in the report. Most of the times, only a fragment of the standard clause has been extracted. When similar or equal safety devices are mentioned several times through a particular standard, the repeated references have been omitted.

Note: In the standards, sometimes, the level of safety achieved by measures that imply the use of safety devices, e.g. disconnectors or interlocking devices, can also be achieved by marking safety warnings such as "DO NOT OPEN WHEN ENERGIZED". At other times the marking of such safety warnings is obligatory, e.g. EN 50014 6.2. - "DO NOT OPEN WHEN AN EXPLOSIVE GAS ATMOSPHERE MAY BE PRESENT".

4.1 "EN 50014". GENERAL REQUIREMENTS

- **10. Interlocking devices.**

  Interlocking devices used to maintain a type of protection shall be so constructed that their effectiveness cannot readily be defeated by the use, for example, of a screwdriver or pliers.

- **15. Connection facilities for earthing or bonding conductors**
- **18. Switchgear:**

  - 18. 2 Disconnectors (which are not designed to be operated under the intended load) shall be *electrically or mechanically interlocked with a suitable load breaking device***.**

  - 18.3 When the switchgear includes a disconnector, *an interlock* between it and the cover or door of the switchgear shall allow the cover or door to be opened only when the separation of the disconnector contacts is effective.

  - 18.5 For group I, *short-circuit and earth fault relays* of swithgear shall latch out after actuation.

  - 18.6 doors and covers giving access to interior of enclosures containing remotely operated circuits with switching contacts that can be made or broken by non

manual influences *shall be interlocked with a disconnector* which prevents access to the interior unless it has been operated to disconnect unprotected internal circuits.

- **19. Fuses**

  - *enclosures containing fuses shall be interlocked* for the insertion and removal of replaceable elements, etc..

- **20. Plugs and sockets**

  - 20.1 *shall be interlocked* so that they cannot be separated when the contacts are energized

  - 20.2 some kinds of plugs and sockets (see standard) shall not comply with the requirements of 20.1 if they comply with:

    - the plug and socket *breaks the rated current with delayed release* (*temporization relay*).

- **21. Luminaires**

  - 21.2 covers giving access to the lampholder shall be *interlocked* with a device *automatically disconnecting all poles* of the lampholder when the opening of the cover begins.

4.2.“EN 50015”. OIL INMERSION “o”

- **4.3.1**. Apparatus which is sealed shall be provided with a *pressure relief device*, that shall be set and sealed by the manufacturer of the liquid filled apparatus to operate at least at 1,1 times the pressure above the liquid level at the maximum permissible protective liquid level.

- **4.3.2** Apparatus which is not sealed shall be provided with a *breathing device* complete with a suitable drying agent, so that gas or vapour which may evolve from the liquid in normal service can readily escape.

- **4.4** Means shall be provided to guard against accidental loosening of external and internal fasteners, as well as of *devices to indicate the liquid level*, plugs and other parts for filling or draining the liquid.

- **4.5** A protective *liquid level indicating device* shall be provided, ...

- **4.9** *Devices for draining the liquid* shall be provided with an effective sealing device, and shall be secured by fasteners that are shrouded or secured against unauthorised removal.

- **4.11** Non sealed enclosures shall be provided with an oil expansion facility and be equipped with a *manually only resettable protective device which causes interruption of the supply current* if there is an internal fault in the liquid-filled enclosure such as would create evolution of gas from the protective liquid.

4.3."EN 50016". PRESSURIZED APPARATUS "p"

- **3.3**. *a safety device* shall be fitted by the manufacturer *to limit the maximum internal overpressure* to a level below that which could adversely affect the type of protection

- **3.6.1** For group I *interlocking devices* shall be provided, for cases of static pressurization, *disconnecting the power supply* when the doors and covers are opened,…

- **3.6.2** For group II, similar to 3.6.1

- **4.2** If during normal service the temperature of any internal surfaces exceeds the maximum value permitted in EN 50014, appropriate means shall be taken to ensure that, if pressurization ceases, any explosive atmosphere that may exist cannot reach the heated surface before they have cooled below the permitted maximum value, …, *e.g. by bringing an auxiliary ventilation system into operation*, etc..

- **5 Safety provisions and devices**

- **5.6** *Safety devices such as time-delay relays and devices for monitoring the flow of protective gas*, shall be provided to ensure that pressurised electrical apparatus cannot be energized until it has been purged by a quantity of protective gas,…

- **5.7** where the protection gas is air, the flammable gas concentration after purging shall not exceed 25% of the LEL (it could be monitored with a *gas analyzer*).

- **5.7** where the protection gas is other than air, oxygen concentration after purging shall not exceed 2% by volume (an *oxygen analyzer* could be used).

- **5.7** The *purging flow rate shall be monitored* at the outlet of the pressurized enclosure

- **5.8** *One or more automatic safety devices* shall be provided to *operate when the overpressure falls below the minimum value specified by the manufacturer*. Also when given by the manufacturer, *safety devices shall be* provided to operate when the protective gas flow rate falls below the prescribed value. (The purpose for which

the safety device is used, e.g. to disconnect power or to sound *an alarm*, or other means to ensure safety, is the responsibility of the user).

- **6. Safety provisions and devices for static overpressure**

- **6.2** The protection gas shall be inert. The oxygen concentration after filling shall be less than 1%. (*Oxygen analyzers*).

- **6.5** *Two automatic safety devices* shall be provided to operate *when the overpressure falls below the prescribed value*

- **7.** *Supply of protective gas*

- **10.2** Containment systems with limited release. The flow shall be limited by flow limiting devices, fitted outside the pressurized enclosure. *The flow limiting device* may be or not a part of the material.

- **12. Note**. The use of *flame arrestors* could be necessary to avoid an ignition source within the containment system back into the plant

- **13 Hot internal surfaces**. If the pressurized enclosure contains any surface having a temperature which exceeds the ignition temperature of the flammable substance released from the containment system, the sample flow into the containment system shall be cut off automatically following the operation of the *safety devices* specified in 5.8

- **ANEX A. A.1** When the gas protection inlets in the supply ducts are placed in classified zones, the following precautions shall be taken:

    - *two independent firedamp detectors*, independently, shall be fitted at the discharge side of the fan or compressor, each *arranged to disconnect automatically the electricity supply* if firedamp concentration is higher than 10% of the LIE

- **ANEX A. A.2** Ducts for exhausting the protection gas should preferably have their outlets in a non-hazardous area, etc… Otherwise consideration should be given to the *fitting of barriers* (to guard against the ejection of ignition capable sparks or incandescent particles).

4.4.“EN 50017”. POWDER FILLING “q”

- **10**. Each powder filled electrical apparatus, part of electrical apparatus Ex shall be *protected against fault conditions such as short-circuit or thermal overload* so that the permissible limit temperature is not exceeded, etc…

- **11.2** *Temperature limitation shall be achieved by an internal or external, electrical or thermal, protective device*. The device shall not be self-resetting.

- **11.2** when *fuses are used as protective devices*, the fusing shall be of the enclosed type in glass or ceramic

- **11.3** Power supply prospective short circuit current. If a *current limiting device* is necessary to limit the prospective current to a value not greater than the rated breaking capacity of the fuse, this device shall be a resistor according to 11.1…

- **14.** Associated power supply with limited ratings

4.5."EN 50018". FLAMEPROOF ENCLOSURES "d"

- **12.6** However if the above-mentioned materials (insulating materials subjected to electrical stresses capable of causing arcs in air such as circuit-breakers, contactors, isolators, etc...) do not pass this test (see standard) they may be used if…, or if a *suitable detection device enables the power supply to the enclosure to be disconnected, on the supply side, before possible decomposition of the insulating materials leads to dangerous conditions*. The presence and effectiveness of such a device shall be verified by the testing station.

- **17.2.1 Switchgear.** *Quick acting doors or covers shall be mechanically interlocked with an isolator* so that the isolator can only be closed when the doors or covers ensure the properties of the flameproof enclosure.

- **18.1 Lampholders and lampcaps.** Devices preventing lamps working loose, required in EN 50014, may be omitted for threaded lampholders *provided by a quick-acting switch in a flameproof enclosure, which breaks all poles of the lamp circuit before contact separation.*

4.6."EN 50019". INCREASED SAFETY "e"

- **4.7.4** the windings will be protected with *appropriate devices* ensuring that the maximum temperature is not exceeded. These devices can be installed in the winding or externally.

- **5.1.4.3** protection against non permitted overheating with *current dependent safety devices*.

- **5.1.4.4** *protection against overloads* (e.g. motor stalled) *with temperature sensors* in the windings

- **5.1.4.5** motors fed from a variable *frequency and voltage converter*, shall be tested together with the specified converter, and with the *protecting device* incorporated.

- **5.3** lampholders and lampcaps with its own power supply

    - the commutation devices, producing sparks in normal operation, including relays like the "reed" type producing sparks in hermetic enclosures, *shall be electrically or mechanically interlocked in order to avoid the separation of contacts in a hazardous zone*.

- **5.4 Measuring transformers and instruments**. Ammeters circuits fed by *a current transformer*.

- **5.6.2.3** Batteries. All the elements requiring the maintenance of the electrolyte level shall be provided with a *device indicating* that the *level* is within the permitted values. (or electrolyte flow if there is recirculation).

- **5.8.3** The resistance heating devices shall be constructed with *an electrical protecting device*, *limiting the heating effect due to abnormal earth fault and earth leakage currents*:

    - **f**or TT and TN systems a *residual current protective device* should be used.

    - for TI an *insulator monitoring device* should be used to disconnect the supply whenever the insulation resistance is not greater than 50 Σ/V of rated voltage.

- **5.8.8** The resistance heating device or unit shall be prevented from exceeding the limit temperature when energized. This shall be ensured by a *protective system* according to 5.8.9 consisting of one or more electrical protective devices which at a predetermined surface temperature, *isolate all energized parts of the resistance heating device or unit*.

- **5.8.9** The protection shall be achieved by

    - *sensing the temperature* of the resistance heating device

    - or by *sensing that temperature and other parameters (e.g. level, or flow*)

    - or by *measuring one or more parameters other than temperature*

4.7."EN 50020". INTRINSICAL SAFETY "i"

- **6.3.1** Separation between terminals for intrinsically safe circuits from non-intrinsically safe circuits, can be separated by insulating partitions or earthed metal partitions
- **6.4.13** Coils of relays connected to an intrinsically safe circuit...

- **6.5** Protection against the reversal of polarity. This may be achieved with a single diode
- **6.6** Earth conductors, connections and terminals. Sometimes the maintenance of this type of protection depends on these devices.
- **6.7** where fuses are used to protect other components, 1,7 In shall be assumed to flow continuosly
- **7.4.5** current limiting devices for batteries in associated apparatus
- **7.4.8** external contacts for charging batteries. To prevent short-circuit or the delivery of ignition-capable energy, blocking diodes or infallible resistors shall be placed in the charging circuits.
- **7.5.2** Shunt voltage limiters: diodes, diode connected transistors, thyristors, zener diodes
- **7.5.3** Series current limiters: blocking diodes
- **8.1.2** The input circuit of mains transformers intended for supplying intrinsically safe circuits shall be protected by fuses or by a suitable circuit breaker**.** Also an embedded thermal fuse or other thermal device shall be used for overheating protection.
- **8.3** Damping windings to minimize the effect of inductance
- **8.4** Current limiting resistors
- **8.5** Blocking capacitors
- **8.6.1** Safety shunts. Where diodes or shunt diodes are used as shunt components in an infallible shunt safety assembly they shall form at least two parallel paths of diodes.
- **8.6.2** Safety shunts
  - for limitation of discharge from energy storing devices such as inductors or piezoelectric devices
  - for limitation of voltage to energy storing devices such as capacitors
- **8.6.3** Galvanic separation components. Isolating elements other than transformer and relays shall be considered, e.g. optocouplers.
- **9** Diode safety barriers: shunt diodes or diode chains protected by fuses or resistors or a combination of these. The barriers are interface between intrinsically safe circuits and non-intrinsically safe circuits.

4.8.“EN 50028”. ENCAPSULATION “m”

- **4.4** *Temperature limitation*: this can be achieved by a *non self-resetting internal or external, electrical or thermal, protecting device*.

4.9.“EN 50284”. Special requirements for construction, test and marking of electrical apparatus of equipment group II, category 1 G

- **4.2.2** associated apparatus to category 1 equipment

- **4.2.3** where a fault of an internal component may lead to failure of the encapsulation system due to increasing temperature, protection shall be ensured by the use of *a duplicated, non self-resetting thermal protection devices, positioned as necessary throughout the circuit.*

- **4.2.3** where protection is dependent on application of correct voltage to the connections to the apparatus, all connections shall be to *other apparatus or associated apparatus having control over voltage and current limitation equivalent of that of a category "ib" circuit according to EN 50020, though not necessary at the same levels of voltage, current or power*.

- **4.2.5** apparatus, which is mounted across the boundary wall to the hazardous area requiring category 1 equipment and contain electrical circuits not intrinsically safe category "ia", shall comply at least with one of the standardised types of protection. Additionally, they shall contain *a mechanical separation element* inside the apparatus to seal off the electrical circuits of the apparatus from the explosive atmosphere. In the case, the type of protection fails, the separation element shall also prevent flame propagation through the apparatus into the hazardous area of the application.

  Separation elements consist of a partition wall, possibly combined with a flameproof joint or an air gap with natural ventilation.

  Note: The requirements and performance of the separation wall, the flameproof joint and the air gap with natural ventilation are described in the standard.

- **4.5** Apparatus according to 4.2.5 (see above) mounted across the boundary wall of a hazardous area requiring category 1, shall avoid ignition caused by the apparatus of the atmosphere external to that requiring category 1 equipment. Hence *the mechanical connection to the boundary shall be flameproof* in such a way that in the case of an atmospheric propagation from outside into the hazardous area requiring category 1 equipment is excluded.

4.10."EN 50281-1-2". Electrical apparatus for use in the presence of combustible dust. Part 1-2: Electrical apparatus protected by enclosures. Selection, installation and maintenance

7. The special requirements for Zone 20 can be met *by a system power limitation*, with or without inherent temperature control, which shall be investigated under simulated working conditions.

4.11."EN 50281-1-1". Electrical apparatus for use in the presence of combustible dust. Part 1-1: Electrical apparatus protected by enclosures. Construction and testing

4.1.2. (Cat 1&2) Enclosures which can be opened more quickly than the time necessary, to allow incorporated capacitors to discharge to a value of residual energy of ....
4.3. (Cat 1&2) *Fasteners*: parts necessary to achieve a specified degree of dust ingress protection...
4.4. (Cat 1&2) *Interlocking devices* used to maintain a specified degree of dust protection...
4.8. (Cat 1&2) Connection facilities for earthing and bonding conductors
5.2. Switchgear (cat 2)
- **5.2.2**. Disconnectors (which are not designed to be operated under the intended load) shall be electrically or mechanically *interlocked with a suitable load breaking device*, or...
- **5.2.3.** *Any interlock* between such disconnector and the cover or door of the switchgear shall allow this cover or door to be opened only when the separation of the disconnector contacts is effective.
- **5.2.4.** doors and covers giving access to interior of enclosures containing remotely operated circuits with switching contacts that can be made or broken by non manual influences *shall be interlocked with a disconnector* which prevents access to the interior unless it has been operated to disconnect unprotected internal circuits.

5.3. Fuses (cat 2)
- *enclosures containing fuses shall be interlocked* for the insertion and removal of replaceable elements, etc..

5.4. Plugs and sockets (cat 2)
- **5.4.1** *shall be interlocked* so that they cannot be separated when the contacts are energized
- **5.4.2** some kinds of plugs and sockets (see standard) shall not comply with the requirements of 5.4.1 if they comply with:
- the plug and socket *breaks the rated current with delayed release* (*temporization relay*).

5.5. Luminaires (cat 2)
- **5.5.2** covers giving access to the lampholder shall be *interlocked* with a device *automatically disconnecting all poles* of the lampholder when the opening of the cover begins.

6.3. (Cat 3) *Fasteners*: parts necessary to achieve a specified degree of dust ingress protection...
6.4. (Cat 3) *Interlocking devices* used to maintain a specified degree of dust protection...
6.8. (Cat 3) Connection facilities for earthing and bonding conductors
7.2. Switchgear (cat 3)
- **7.2.2.** Disconnectors (which are not designed to be operated under the intended load) shall be electrically or mechanically *interlocked with a suitable load breaking device*, or...
- **7.2.3.** *Any interlock* between such disconnector and the cover or door of the switchgear shall allow this cover or door to be opened only when the separation of the disconnector contacts is effective.

7.3. Fuses (cat 3)

- *enclosures containing fuses shall be interlocked* for the insertion and removal of replaceable elements, etc..

7.4. Plugs and sockets (cat 3)

- **7.4.1** *shall be interlocked* so that they cannot be separated when the contacts are energized
- **7.4.2** some kinds of plugs and sockets (see standard) shall not comply with the requirements of 7.4.1 if they comply with:
- the plug and socket *breaks the rated current with delayed release* (*temporisation relay*).

7.5. Luminaries (cat 3)

- **7.5.2** covers giving access to the lampholder shall be *interlocked* with a device *automatically disconnecting all poles* of the lampholder when the opening of the cover begins.

4.12.“EN 50177”. Automatic electrostatic spraying installations for flammable coating powder

5.1.2.2. Provisions shall be made *for a device which automatically switches off the high voltage*, when the electrical supply current rises to a non-admissible level, discharges the spraying system and interrupts any further supply of spraying material.

5.1.3.2 Any parts under high voltage shall be discharged within 2 seconds to a discharge energy not exceeding 350 mJ before gaining access *(voltage discharges).*

5.2.1 ... *An exhaust ventilation system* shall be provided so that the average concentration of powder in air is not exceeding 50% of the LEL....

5.2.2 ... The exhaust ventilation system shall be *interlocked with other equipment* so that neither the high voltage supply can be switched on nor spraying material be fed as long as the exhaust system does not properly operate. *Devices shall be installed to monitor* the actual flow of the exhaust ventilation system air *and arranged to interrupt* immediately the high voltage supply if the volumetric flow falls ...

5.2.4. Where necessary to prevent danger in the case of an enclosed spray cabin it shall be equipped *with either explosion suppression or explosion relief venting* to discharge to an area where it will not be dangerous to personnel or other means offering equivalent safety.

5.2.6. For systems of type C, any access to the spraying area intended for use by personnel shall be *interlocked so that the high voltage supply system will be switched off* in the event of any access being opened

5.2.10. For spraying devices of type B and C and powder collection units shall be fitted with *automatic local fire extinguishing systems*.... As soon as it starts operating, the high voltage supply system and the coating powder feed shall be *switched off by automatic means.*

5.3.1. *Interlocking shall be provided to prevent the high voltage being applied* in types of system in accordance with 5.1.3 (type C) causing dangerous situations for personnel.

5.5. ***Earthing measures***

4.13"EN 50176" Automatic electrostatic spraying installations for flammable liquid spraying material

5.1.2.2 Similar to the device mentioned in 5.1.2.2. of EN 50177
5.1.3.2 Similar to the device mentioned in 5.1.3.2. of EN 50177
5.2.1 Similar to the device mentioned in 5.2.1. of EN 50177
5.2.2 Similar to the device mentioned in 5.2.2. of EN 50177
5.2.8. Similar to the device mentioned in 5.2.10 of EN 50177
5.3.1 Similar to the device mentioned in 5.3.1. of EN 50177
5.5. Similar to the device mentioned in 5.5. of EN 50177

4.14 "EN 50053-1" Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials. Part 1. Hand-held electrostatic paint spray guns with an energy limit of 0,24 mJ and their associated apparatus

5.3.1 ... *An exhaust ventilation system* shall be provided so that the average concentration of flammable vapour or mist is below 25% of the LEL....
5.3.2 *the exhaust ventilation system shall be interlocked* with the electrostatic spraying equipment, so that electrostatic spraying cannot be carried out unless the exhaust ventilation is in operation.
5.4.5 ***earthing and bonding***
6.1.1 Before starting to clean the gun or carrying out any other work in the spraying area *the high voltage supply shall be switched off in such a manner that it cannot be re-energised* by operating the trigger of the spray gun.

4.15 "EN 50053-2" Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials. Part 1. Hand-held electrostatic powder spray guns with an energy limit of 5 mJ and their associated apparatus

5.3.1. Similar to the device mentioned in 5.3.1. of EN 50053-1, but for a LEL of 50% (see standard).
5.3.2. Similar to the device mentioned in 5.3.2. of EN 50053-1
5.3.3. The powder collection unit should for example be fitted with *an explosion suppression system, an explosion relief, explosion barriers, or other explosion protection systems*, designed to reduce the effects of an explosion to a safe level.
5.5. Earthing and bonding
6.1.1 Similar to the device mentioned in 6.1.1 of EN 50053-1

4.15 "EN 50053-3" Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials. Part 1. Hand-held electrostatic flock spray guns with an energy limit of 0,24 mJ or 5 mJ and their associated apparatus

5.3.1 The average concentration of flock in air shall be maintained always below 50% of the LEL, if necessary by a *ventilation system...*

When spraying is carried out in association with adhesives, then *an exhaust ventilation system* to ensure concentration of flammable gases below 25% of the LEL is required.

5.3.2. Similar to the device mentioned in 5.3.2. of EN 50053-1
5.3.3. Similar to the device mentioned in 5.3.3. of EN 50053-2
5.5. Earthing and bonding
6.1. Similar to the device mentioned in 6.1.1. of EN 50053-1

4.16 "EN 50021" Electrical apparatus for potentially explosive atmospheres – Type of protection "n"

10.9.2.1 Motors intended to be *supplied at varying frequency and voltage by a converter* shall be tested for this duty as a unit in association with the converter...
Motors intended to be connected *to a supply other than that derived from a converter*, but which is non-sinusoidal, shall be tested ...
Generators intended to be connected to a *non sinusoidal load (e.g. thyristors)* shall be tested...

11. ***Fuses and fuse assemblies***

12.1 Luminaries. Lamps with *internal ignitors* can cause uncontrolled voltages that can damage ballasts or electronic ignitors...
12.2.5.2 Auxiliaries for luminaries. ***Glow type starters***
12.2.5.3 Auxiliaries for luminaries. ***Electronic starters and ignitors***
12.2.5.5 Auxiliaries for luminaries. ***Ballasts (electronic ballasts)***
15.1 Plugs and sockets for external connections: they shall *be interlocked mechanically or electrically* or otherwise designed so that they cannot be separated when the contacts are energised and the contacts cannot be energised with plug and socket separated.
16.3.2 ***Chargers for type 1 cells and batteries.***
16.4.2 ***Chargers for type 2 cells and batteries***
21.2 Associated energy-limited apparatus. The apparatus shall contain ***a reliable means of limiting the voltage and current available to energy storing components or at any normally sparking contact, e.g. by the use of zener diodes and series resistors....***
21.7 ***Protection against polarity reversal*** for energy limited apparatus, for example with *a single diode*
21.8.2 *Fuses* to protect other components and to limit the current flowing in energy-limited circuits

21.8.3 ***Shunt safety components*** such as ***diodes or voltage limiting devices...***

4.17 "EN 60079-14" Electrical apparatus for explosive gas atmospheres. Part 14: Electrical installations in hazardous areas (other than mines)

6.2.3 Type IT system

- Insulation monitoring device, indicate the first earth fault.
- Safety isolating transformers for SELV and PELV.

7 Electrical protection

For rotating electrical machinery
- Overload protective device
- Time lag protective monitoring all three phases
- Device for direct temperature control
- Warning device as an alternative to automatic disconnection

8.1 Emergency switch-off

- Emergency switch off electrical device

11.2.1 Overload protection

- Inverse-time delay overload protective devices

11.4 Resistance heating device

- residual current device (RCD), limit the heating effect due to abnormal earth-fault and earth-leakage currents

12.3 Installation for zone 0

- Surge protection device

13.1 Ducting

- Device to guard against the ejection of ignition-capable sparks or particles (spark and particle barriers)

4.18 "EN 1127-1" Explosion prevention and protection Part 1: Basic Concepts and methodology.

6.2.2.2 Gas warning devices

6.2.2.2 Flow-control devices

6.4.8 Lightning protection
6.5.3 Explosion pressure relieve devices

6.5.4 Explosion suppression

- Explosion suppression systems.

6.5.5.2.1 Deflagration arrester
6.5.5.2.2 Flame arrester
6.5.5.2.3 Detonation arrester
6.5.5.2.4 Flashback preventer

Flow control valves

6.5.5.2.5 Extinguishing barrier

6.5.5.3.2 Rapid-action valves
6.5.5.3.3 Rotary valves
6.5.5.3.5 Double valves with its controls

4.19 "EN 50054" Electrical apparatus for the detection and measurement of combustible gases. General requirements and test methods

- Externally adjustable means of setting either one or more alarm set points.

5. SUMMARY OF GENERIC SAFETY DEVICES

In this section a summary of safety devices is described. The devices have been taken from different sources: CENELEC standards, draft proposal "Reliability of safety related devices" from TC31-WG09, LOM database, catalogues of equipment from different manufacturers, etc. Each item includes an indication whether the safety devices are already specified in existing CENELEC standards or whether the safety device would need to be handled by the standard that is being developed by CENELEC TC31/WG9:

- ➔ Motor protection; specially for type ‘e’: thermal and current relays, PT100, switches. (existing CENELEC standards)

- ➔ Overload monitoring devices for ‘e’ motors, which models the temperature-time characteristic. (existing CENELEC standards)

- ➔ Thermal protection devices and electronic control units for heating systems. (existing CENELEC standards)

- ➔ Overvoltage protection. (existing CENELEC standards)

- ➔ Monitoring units for concentration of flammable gases, oxygen or inert gas levels, e.g. gas detectors, limit detectors for end of line. (existing CENELEC standards)

- ➔ Systems for transmission and data acquisition (SCADA) for safety purposes, e.g. mining power shut-off in Group 1. (existing national standards and code of practice).

- ➔ PLC (programmable logic control) units, including the application software, for safety purposes. (to be covered by WG9 standard)

- ➔ Level indicators and switches for liquids used to provide safety for submersible equipment. (to be covered by WG9 standard)

- ➔ Protection relays for no load operation of submersible pumps e.g. monitoring of the power factor (cos φ) during normal operation. (to be covered by WG9 standard)

- ➔ Adjustable protection elements of AC converters for ‘p’, ‘e’, ‘d’. ‘n’ type motors (current limitation, overload protection, thermal limitation, etc...). (to be covered by WG9 standard)

- ➔ Devices controlling flow, temperature and/or level of cooling (liquid or gas) for ‘d’, ‘p’ and ‘e’ motors. (to be covered by WG9 standard)

- ➔ Control devices for bearings in big rotating machines. Lubrication and temperature control devices. (to be covered by WG9 standard)

- ➔ Pressure monitoring systems for ‘p’ type. Air and/or protective gas supply for the same type of protection; including e.g. detectors, auxiliary ventilation systems, if required. (to be covered by WG9 standard)

- ➔ In belt transportation systems, devices for controlling the alignment and slip of the belt. (to be covered by WG9 standard)

- ➔ For bucket elevators anti-runback devices and belt speed meters to detect belt slip. Also control of bearings. Detectors of feed rate to avoid overloads. (to be covered by WG9 standard)

➔ Interlocking devices, may be electrical switchgear or mechanical devices used for safety purposes.

Annex 3 includes useful information about currently used safety collected from commercial catalogues that can be found in the market.

6. CONCLUSIONS

- A review of available information of devices currently used in explosive atmospheres and the standards applicable to them has been carried out, with the objective of establishing a guide list of the safety devices that should be studied or considered within the SAFEC project.

Anyhow, the list is neither definitive nor exhaustive, and so, other devices from different sources, different considerations of the standards or different conceptions of use of the device may lead to changes in the review.

- In some cses it may be difficult to differentiate components and safety devices. This has to be carefully considered, because otherwise a large number of components could be considered as safety devices (for example safety barriers separating intrinsically from non intrinsically circuits).

- The same device can have different safety or protecting levels depending on the particular situation in which it is applied (for example, a thermocouple the signal of which can be used just for monitoring temperature or to activate a disconnecting switch).

7. REFERENCES

1. EN 50014 Electrical apparatus for potentially explosive atmospheres. General requirements.

2. EN 50015 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode "o" oil immersion.

3. EN 50016 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode : pressurised apparatus "p".

4. EN 50017 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode : powder filling "q".

5. EN 50018 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode : flameproof enclosure "d".

6. EN 50019 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode : increased safety "e".

7. EN 50020 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode : intrinsic safety "i".

8. EN 50028 Electrical apparatus for potentially explosive atmospheres. Specific requirements for the protective mode : encapsulation “m” [8].

9. EN 50284 Special requirements for construction, test and marking of electrical apparatus of equipment group II, category 1 G

10. EN 50281-1-2 Electrical apparatus for use in the presence of combustible dust. Part 1-2: Electrical apparatus protected by enclosures. Selection, installation and maintenance

11. EN 50281-1-1 Electrical apparatus for use in the presence of combustible dust. Part 1-1: Electrical apparatus protected by enclosures. Construction and testing

12. EN 50177 Automatic electrostatic spraying installations for flammable coating powder

13. EN 50176 Automatic electrostatic spraying installations for flammable liquid spraying material

14. EN 50053-1 Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials. Part 1. Hand-held electrostatic paint spray guns with an energy limit of 0,24 mJ and their associated apparatus

15. EN 50053-2 Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials. Part 1. Hand-held electrostatic powder spray guns with an energy limit of 5 mJ and their associated apparatus

16. EN 50053-3 Requirements for the selection, installation and use of electrostatic spraying equipment for flammable materials. Part 1. Hand-held electrostatic flock spray guns with an energy limit of 0,24 mJ or 5 mJ and their associated apparatus

17. EN 50021 Electrical apparatus for potentially explosive atmospheres – Type of protection “n”

18. EN 60079-14 Electrical apparatus for explosive gas atmospheres.
Part 14: Electrical installations in hazardous areas (other than mines)

19. EN 50054 Electrical apparatus for the detection and measurement of combustible gases. General requirements and test methods

20. ATEX Directive.

21. EN 1127-1 Explosive atmospheres - Explosion prevention and protection. Part 1: Basic concepts and methodology

22. ATEX Directive.

23. IEC 61508 Functional safety of electrical, electronic and programmable electronic safety-related systems

24. 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)

25. CENELEC TC3 I/WG09, Draft proposal for a European Standard, "Electrical Equipment of Potentially Explosive Atmospheres - Reliability of safety-related devices", 12.02.99.

26. “Determination of safety categories of electrical devices used in potentially explosive atmospheres”. Technical annex. Annex 1 of SAFEC Project.

27. Guide to Dust Explosion Prevention and Protection. Part 2-Ignition, prevention, containment, inerting, suppression and isolation. C. Schofield and J.A. Abbott. The Institution of Chemical Engineers. (1988 Edition).

28. Laboratorio Oficial Madariaga internal database of Ex electrical equipment.

29. Commercial catalogues of equipment used in potentially explosive atmosphere

ANNEX 3

EXAMPLES

TABLES OF CURRENTLY USED SAFETY DEVICES FOR EXPLOSIVE ATMOSPHERES

Device	Description
Motor protection circuit breakers	They are suitable both for use with explosion-protected motors (types EEx d and EEx e) and also for system protection. The circuit breaker is equipped with a fixed setting, fast short-circuit trip and thermal over current trip.
Manual motor starters	Motor protection switches are used for direct-on-line starting and overload protection of motors. They are fitted with an adjustable thermal over current release and an electro-magnetic fast-acting short circuit release. They are suitable and approved for the protection of Ex e and Ex d motor
Circuit interrupters / motor switches	Load and motor switch
Small fuse bases	
Fuse bases	
Miniature circuit breaker (m.c.b.)	The miniature circuit breakers are current limiting circuit breakers and have non-adjustable thermal and electromagnetic trips.
Earth leakage circuit breaker	It has an earth fault current detector.
Contactor	
Motor protection relays	
Thermistor motor protection	It is used for monitoring the temperature of electrical machines and other apparatus
Time relays	
Relay repeater units	They transmit binary signals from intrinsically safe control circuits to non intrinsically safe signal circuits
Valve type arrester-over voltage protection	Due to its non-linear resistance it gives a low residual voltage, even with heavy current surges
Control units	Enclosures integrating various functions, e.g. Diodes, resistors, small fuses and small relays.
Motor starters	Different starters assemblies optionally provided with line fuses, main isolators, and control circuit fuses.

Device	Description
Control and distribution panels with EEx-modules	Fuses and m.c.b. distribution panels. Panels completely wired to terminals. It has a main switch, main fuses, m.c.b., contactors, thermal relays
Temperature controller and limiter with contactor	Capillary tube thermostats are suitable for monitoring and controlling temperatures of solids, liquids or gases. It has mechanical or electrical interlock
Explosion protected control panels for pressurized type of protection apparatus	This control is used to maintain a positive pressure into the enclosures
Air supply unit for installations of type of protection pressurized apparatus EEx p	This device controls the flow of inert gas into the enclosure. The air supply unit consists of a pressure regulator with attached manometer, a solenoid valve, and a fine control valve.
Control unit for installations using pressurized apparatus-protection type EEx p	This unit provides the pressure control unit differential pressure with switch intrinsically safe power supply to the control switch and the pressure control switch; receive and process the switch signals from the differential pressures switches; control of the purging phase timing; actuation of the air-supply unit solenoid valve;....
Protection unit for installations of protection pressurized apparatus EEx p	This protection is crucial during the purge phase. The inert gas flow must be monitored during this operation.
Heater block, heater plate	For anti-condensation heating of enclosures
Power supply unit	The power supply unit serves as an I.S. isolator for data transfer between the terminal and an automation system and provides the power necessary to operate the terminal.
Resistance transmitters for Pt 100 resistance thermometers	It converts the input measure value into a linearly-proportional standardized signal. The power supply and the input and output circuits are all galvanically isolated fron each other.
Voltage transmiters for thermocouples	The units are intended for operation as temperature transmitters for IEC and DIN thermocouples
RTD transmitters	Temperature transmitter

Device	Description
P/I transmitters for standardized pneumatic signals	The apparatus serves as an intermediate unit for the transmission of pneumatic measurement signals from a sensor, to an electrical instrumentation/process control system
P/I transmitters for standardized signals	This transmitter is intended for the conversion of a standardized electrical signal to a standardized pneumatic signal
Inductive proximity switches	It can control relays or contactor. It can be used to open the voltage source if we are opening an enclosure.
Relay unit for binary signal	In telemetering and control circuits using binary signals, relays can be used for the transmission of the information and instruction.
Limit value detector for standardized signals	It is used for the purpose of signalling and indicating limiting values.
Limit switch with contact-break distance	This element can be used for switching, controlling and regulating in Ex-areas, for example, for disconnecting voltage source when opening an enclosure.
Miniature switches	It could be used in valves, thermostats, push switches, servo components, level meters and switching gear.
Limit monitor for valves	This modules is used in a situation involving pneumatic actuators for valves, and it needs the aid of limit switches.
Photo-electric proximity swicth / Infra-red photo-electric proximity swicth	It could be used in environments that preclude the use of conventional sensors. It could be used as switching operation or transmit information
Voltage monitor DC	This module operating voltage for over or undervoltage. In both cases the built-in relay de-energizes.
Precision resistor	For monitoring switching contacts, open circuit monitoring
Freewheeling diode	Suppressors for electrical and electronic control systems, for the prevention of overvoltage in inductive loads.
Lamp test diode modules	Signal isolation in lamp testing

Device	Description
Surge voltage limiter	Measuring and control or data processing from transient voltage surges
RC element	This device acts as a suppressor on contacts, coils, solenoids and inductive circuits
Power relay	It is suitable for switching load current circuits up to 12 A
Opto-relays	
Opto-coupler	IS circuits
DC-barriers	isolate IS-circuits and non-IS-circuits
Transmitter power supply unit	It is used for supplying transmitters and the transmission of measured signals
Input isolator / repeater; Output repeater/isolator	This module isolates intrinsically safe circuits from non intrinsically safe circuits at the same time that ensuring the electrical isolation of the analogue signal.
CAN interface 4x4 ... 20 mA input	This module enables 4x4 .. 20mA analoge signals to be connected with a CAN bus
Interbus-S interface 4x4 ... 20 mA input	This module enables 4x4 .. 20mA analoge signals to be connected to the interbus-S bus
Leakage detector system	It is a safety system designed to give an alarm when a little leakage is collected inside the sump of a tank or a storing deposit.
Bonding integrity monitor	This device continuously monitors a bonding conductor and warns of any significance change in resistance or large current being conducted, for example monitoring of the safety earth in a barrier system
Field bus system	It is a system that can be used to transmit a large number of process signals between field units installed in a hazardous area and an automation system. Field devices such initiator contacts, resistance thermometer (Pt 100), thermocouples, transmitters, actuators and solenoid valves can be connected directly to its I/O units
PC-software	Configuration, diagnosis and communication software for field bus system.
Intrinsically safe digital multiplexer	