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Mechanical Equipment for Explosive Atmospheres – Standardization Work in IEC Subcommittee 31M and its Benefit for International Projects

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As a consequence of international projects in the process industry there is a strong worldwide demand to use established non-electrical ("mechanical") equipment for areas with potentially explosive atmospheres. For electrical equipment such standardized equipment has a long lasting history finally in the form of the standards of the IEC 60079 series.
Within Europe a successful approach exists for explosion protected mechanical equipment, designed and built according to the standard EN 13463 series. This series is harmonized under the European ATEX-Directive for free trade of explosion protected equipment and autonomous protective systems (Directive 94/9/EC). Due to the lack of alternative approaches, such equipment is used around the world in international projects.
The next step from European to an international level is the development of ISO standards within the project teams ISO 80079-36 and ISO 80079-37 for explosion protected mechanical equipment. These project teams are part of the unique IEC SC 31M that develops either ISO/IEC or ISO standards for explosive atmospheres, depending on the subject addressed, under the umbrella of IEC TC 31. ISO 80079-36 will contain "Basic methods and requirements", including a mandatory ignition hazard assessment, which is a principle difference to the well known electrical explosion protection standards, whereas ISO 80079-37 will include so called "types of protection" as explosion protection concepts in the form of "Constructional safety", "Control of ignition sources" and "Liquid immersion".

1. Introduction

Since the1st July 2003, non-electrical ("mechanical") equipment for potentially explosive atmospheres must be placed on the harmonized European market under the European Directive 94/9/EC. This procedure gives both manufacturers and users the chance to sell and purchase, install and use safe and established equipment with the same design requirements throughout Europe. The technical standards for the manufacturer are available in the form of the EN 13463 series with general requirements and types of ignition protection for mechanical equipment.
The next step from European into worldwide harmonized standards for mechanical equipment is done within the Technical Committee IEC TC 31 by its subcommittee SC 31M that develops the ISO 80079 series which adopts relevant parts of the EN 13463 series. This will provide the opportunity for internationally operating companies to use the same safe and reliable mechanical equipment around the world without modifications.

2. Subcommittee SC 31M of IEC TC 31

IEC TC 31 "Equipment for explosive atmospheres" is the international Technical Committee responsible for equipment intended for explosive atmospheres. In the past, it dealt mainly with explosion protected electrical equipment. In 2007 its subcommittee SC 31M "Non-electrical equipment and protective systems

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for explosive atmospheres” was created to develop standards for non-electrical equipment and protective systems. “Protective systems" means devices which are intended to halt incipient explosions immediately and/or to limit the effective range of an explosion. Later on SC 31M also took over standards for safety data of flammable gases, vapors and dusts. The projects currently under development in SC 31 M are listed in Table 1.

Table 1: Current Projects in the IEC SC 31 M (August 2012)

Project Team Status	Title of standard	Remarks
PT 80079-36 Status CDV/DIS ISO 80079-36	Explosive atmospheres - Non-electrical equipment for use in explosive atmospheres - Basic method and requirements (basis: EN 13463-1)	This document deals primarily with non-electrical issues. Following the agreement between ISO/TMB and IEC/SMB this document will become an ISO-standard.
PT 80079-37 Status: CDV/DIS ISO 80079-37	Explosive atmospheres - Non-electrical equipment for use in explosive atmospheres - Non-electrical type of protection constructional safety “ch”, control of ignition source “bh”, liquid immersion “kh” (basis: EN 13463-5, EN 13463-6, EN 13463-8)	This document deals primarily with non-electrical issues. Following the agreement between ISO/TMB and IEC/SMB this document will become an ISO-standard.
PT 80079-38 Status: CDV ISO/IEC 80079-38	Explosive atmospheres - Non-electrical equipment for use in explosive atmospheres - Part 38: Equipment and components in explosive atmospheres in underground mines (basis: EN 1710)	This document deals with electrical as well as non-electrical issues. Following the agreement between ISO/TMB and IEC/SMB this document will become an ISO/IEC-standard.
MT 80079-20-1	Explosive atmospheres - Part 20-1: Material characteristics for gas and vapor classification	This document deals with test methods for combustible gases and vapors
MT 80079-20-2	Explosive atmospheres - Part 20-2: Material characteristics - Combustible dusts test methods	This document deals with test methods for combustible dusts
MT 80079-34	ISO/IEC 80079-34 Ed. 1.0: Explosive atmospheres - Application of quality systems for electrical and non-electrical equipment	The document was published 2011
AHG 3	Protective systems, including explosion venting and suppression	AHG 3 to check protective systems to be suitable for international standards

PT: Project Team (developing new standards), MT: Maintenance Team (maintaining existing standards), AHG (Ad-hoc Group with limited lifetime for special tasks)

Whereas the first standard of SC 31M (ISO/IEC 80079-34) has already been published, the standards for mechanical equipment (ISO 80079-36 and ISO 80079-37) and mining equipment (ISO/IEC 80079-38) are expected to be available in 2014.

3. Structure of the future ISO 80079-36

The future standard ISO 80079-36 is intended for mechanical equipment for explosive atmospheres under standard atmospheric conditions (temperatures -20°C to +60°C pressures 80 kPa to 110 kPa in air) and is linked to the standard IEC 60079-0 that includes general requirements of electrical equipment.
The main parts are listed below:

3.1 Equipment groups

The standard ISO 80079-36 is suitable for the following equipment groups:

Group I intended for mines susceptible to firedamp
Group II intended for use in places with an explosive gas atmosphere
Group III intended for use in places with an explosive dust atmosphere

3.2 Ignition hazard assessment

ISO 80079-36 requires the manufacturer to outline whether the ignition hazard assessment demonstrates that the equipment has no effective ignition sources during rare malfunctions, during expected malfunctions or during normal operation, depending on the equipment protection level (“EPL”) Ga/Da, Gb/Db or Gc/Dc, for which the equipment shall be qualified. EPL Ga/Da means equipment that is suitable for zone 0/20, EPL Gb/Db for zone 1/21 and EPL Gc/Dc for zone 2/22.

This assessment is done in a stepwise approach to be followed by the manufacturer. At the beginning of the ignition hazard assessment procedure the manufacturer has to decide which of the 13 “possible ignition sources” are relevant (i.e. related to the equipment and present) for his mechanical equipment. These are called “equipment related” ignition sources.

The following is the list of possible ignition sources

- Hot surfaces
- Flames and hot gases (including hot particles)
- Mechanically generated sparks
- Electrical apparatus
- Stray electric currents, cathodic corrosion protection
- Static electricity
- Lightning*
- Radio frequency (RF) electromagnetic waves*
- Electromagnetic waves including optical radiation*
- Ionizing radiation*
- Ultrasonics*
- Adiabatic compression and shock waves
- Exothermic reactions, including self-ignition of dusts

*: Lightning, radio frequency (RF) electromagnetic waves, optical radiation, Ionizing radiation and ultrasonics are not significant for the manufacturer of mechanical equipment, so normally the user has to care about these ignition sources if they can arise in conjunction with non-electrical equipment.

In the case of equipment related ignition sources the manufacturer has to decide whether those have the capability to ignite an explosive atmosphere i.e. to become potential ignition sources. Finally, if the potential ignition source is actually able to ignite the explosive atmosphere it becomes an effective ignition source. The frequencies of the presence of effective ignition sources must be determined by the manufacturer. This frequency determines the EPL without applying protective measures. If it is not in line with the intended EPL, types of protection (see part 4, CDV/DIS ISO 80079-37) have to be used.

The standard also provides energy limits to decide whether impact sparks are to be considered as potential ignition sources or not, or even as effective ignition sources. These tables should not be misunderstood as no-go-limits but mainly as a help for the manufacturer to decide whether his equipment comes under the scope of the standard ISO 80079-36 (or in Europe under the DI 94/9/EC “ATEX ”) or not, as equipment without potential ignition sources is not covered by DI 94/9/EC. If potential ignition sources are detected their frequency of becoming effective determines the EPL.

This part of ISO 80079-36 containing the ignition hazard assessment is a basic difference to the standard IEC 60079-0 for explosion protected electrical equipment which mainly contains prescriptive design requirements.

3.3 Tests

In this section tests are described to assess potential ignition sources and to determine whether effective ignition sources are prevented as required by the intended EPL, as well as tests for general properties required for explosion protected equipment.

3.4 Documentation

The documentation which has to be prepared by the manufacturer is differentiated into technical documentation and instructions.

The technical documentation includes full and correct specification of the explosion prevention and (if relevant) explosions protection measures (e.g. types of protection) used for the equipment. The instructions include a summary of the relevant ignition hazards and measures to be applied by the user to maintain the safety measures and characteristics of the equipment (i.e. EPL) during its lifetime.

A certificate prepared by the manufacturer or a third party shall confirm that the equipment is in conformity with ISO 80079-36 and the standards addressed here.

3.5 Marking

The marking made by the manufacture provides (together with the instructions) the required information to the user concerning the safety aspects of the equipment (EPL, types of protection, gas subgroup, temperature class, special conditions etc). A new marking (compared to the parent ENs) is the use of the “h” for all mechanical equipment conforming to ISO 80079-36. This allows the user to identify that at least an ignition hazard assessment for the mechanical equipment according to ISO 80079-36 was performed by the manufacturer or, in other cases, that additional types of protection are applied (see chapter 4 below). The standard is in the CDV stage for the moment of preparing this text. Marking is expected to be different in the published standard.

4. Structure of the future ISO 80079-37

The future standard ISO 80079-37 is used in cases where the ignition hazard assessment shows that the frequency of an effective ignition source is too high for the intended EPL of the mechanical equipment. In such cases the manufacturer has to apply types of protection for his equipment. The ISO 80079-37 includes the technical content of the types of protection dealt with in EN 13463-5 “Protection by constructional safety (c)”, EN 13463-6 “Protection by control of ignition sources (b)” and EN 13463-8, “Protection by liquid immersion (k)”.

EN 13463-2, “Protection by flow restricting enclosure (fr)” and EN 13463-3, “Protection by flameproof enclosure (d)” are not included in ISO 80079-37. If these concepts need to be applied on the ISO/IEC level, it is foreseen that the corresponding electrical standards can also be used for non-electrical equipment.

4.1 Type of protection “Constructional safety ch”

The aim of this type of protection is to avoid ignition sources by well known design principles of mechanical equipment (“good construction”) which is similar to the “Increased safety”-concept for electrical equipment. The constructional safety gives guidance for the design elements for the parts listed below.

- Ingress protection
- Seals
- Moving parts
- Bearings
- Power transmission systems
- Hydrostatic, hydrokinetic and pneumatic equipment
- Couplings
- Brakes
- Conveyor belts

4.2 Type of protection “Control of ignition sources bh”

The basic idea of this type of protection is to control ignition sources by monitoring safety critical parameters (e.g. temperature, speed, pressure, flow) used for alarm and/or switch function before potential ignition sources become effective. For control, suitable ignition prevention systems of different quality can be applied. These are:

b1: Systems with components having a suitable reliability, assembled and installed in accordance with any relevant standards, adopting well tried safety principles, able to withstand expected influences during operation.

b2: In addition to b1 systems, such b2 systems keep their safety function, if a single fault occurs in the ignition prevention system.

4.3 The application of the different types of ignition prevention is shown in Table 2.Type of protection “Liquid immersion kh”

The concept of this type of protection is to avoid contact of the explosive atmosphere with ignition sources and to provide cooling by total immersion or continuous coating of parts of the mechanical equipment with the protective liquid so that the potential ignition source of the equipment cannot become effective. Insofar it is a similar approach as the “oil immersion” for electrical equipment.

Table 2: Minimum ignition prevention types required when Ex "bh" is selected to achieve the intended EPL for Group II and III equipment

Intended EPL of the equipment	Result of the ignition hazard assessment for the existing equipment	Ex 'bh' control system necessary	Ignition prevention type
Gc, Dc	effective ignition source to be expected during normal operation	a single system to avoid effective ignition sources during normal operation	b1 (alarm or switch)
	no effective ignition sources to be expected during normal operation	none	does not apply
Gb, Db	effective ignition source to be expected during normal operation	an independent or fail-safe system to avoid effective ignition sources during normal operation and foreseeable malfunctions	b2 or two b1 devices (b1(switch), b1(switch or alarm))
	no effective ignition sources to be expected during normal operation	a single system to avoid effective ignition sources during foreseeable malfunctions	b1(alarm or switch)
	no effective ignition sources to be expected during normal operation and foreseeable malfunctions	none	does not apply
Ga, Da	no effective ignition sources to be expected during normal operation	an independent or fail-safe system to avoid effective ignition sources during foreseeable malfunctions and rare malfunctions	b2 or two b1 devices (b1(switch), b1(alarm or switch))
	no effective ignition sources to be expected during normal operation and foreseeable malfunctions	a single system to avoid effective ignition sources during rare malfunctions	b1(switch)
	no effective ignition sources to be expected during normal operation, foreseeable malfunctions and rare malfunctions	none	does not apply

5. Mechanical equipment within international projects

In future, the ISO 80079-36/-37 standards for mechanical explosion protected equipment will allow internationally operating companies to further optimize safety aspects and costs by the use of the same safe and reliable equipment worldwide.

The current situation within international projects can be described by two general approaches. One approach uses mechanical equipment designed and manufactured according to the European Directive 94/9/EC with types of protection according to the EN 13463 series. This type of mechanical equipment can also be used for a number of places outside Europe, if there are no contradicting national requirements. This is the current practice for mechanical equipment such as gears, pumps (outer side) and fans (inner and outer side). In such cases the manufacturer has performed the ignition hazard assessment for his mechanical equipment using his experience, and the user can buy well established equipment (known e.g. from projects in Germany or Europe).The user can operate this mechanical equipment safely after proper installation and the introduction of a strict maintenance regime in areas with potentially explosive atmospheres. For this type of equipment establishing ISO standards with harmonized requirements for

mechanical equipment is quite helpful instead of starting new national or regional standardization work in different continents.
A different approach is taken frequently by users of mechanical equipment within the interior of process plants (“process-equipment”). This type of equipment is often not used permanently but only during certain well defined phases of the process where the occurrence and nature of explosive mixtures can deviate from the overall occurrence of explosive mixtures of the complete process and from atmospheric conditions. In such cases a tailor-made or optimized ignition hazard assessment to prevent effective ignition sources requires the knowledge of the detailed process information which is only available to the user. The user then frequently performs a specific ignition hazard assessment for mechanical process equipment based onto technical information from the manufacturer and about the process.

6. Conclusions

As a consequence of international projects in the process industry there is a strong worldwide demand to use established non-electrical (“mechanical”) equipment for areas with explosive atmospheres.
Within Europe a successful approach exists for explosion protected mechanical equipment, designed and built according to the standard EN 13463 series. Due to the lack of alternative international approaches, such equipment is used around the world in international projects.
A step from European to an international level is now the development of ISO standards for explosion protected mechanical equipment. ISO 80079-36 will contain “Basic methods and requirements”, including a mandatory ignition hazard assessment, which is a principle difference to the well known electrical explosion protection standards, whereas ISO 80079-37 includes so called “types of protection” as explosion protection concepts in the form of “Constructional safety”, “Control of ignition sources” and “Liquid immersion”. As these standards are in the CDV stage at the moment of preparing this text they may change before publication.
These standards (like other EN, IEC and ISO standards) do not contain formal conformity assessment procedures as this is the matter of national or regional regulations (like the Directive 94/9/C in Europe). Insofar they will not affect the legal situation in Europe. It is not clear at the moment which kind of mandatory conformity assessment procedures will be established in other parts of the world for non-electrical equipment covered by these standards.

References

Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres (OJ L 100, 19.4.1994)
EN 1710 Equipment and components intended for use in potentially explosive atmospheres in underground mines, 2008
EN 13463-1, Non-electrical equipment for use in potentially explosive atmospheres – Part 1: Basic method and requirements, 2009
EN 13463-2, Non-electrical equipment for use in potentially explosive atmospheres - Part 2: Protection by flow restricting enclosure “fr”, 2005
EN 13463-3, Non-electrical equipment for use in potentially explosive atmospheres - Part 3: Protection by flameproof enclosure "d", 2005
EN 13463-5, Non-electrical equipment for use in potentially explosive atmospheres - Part 5: Protection by constructional safety “c”, 2011
EN 13463-6 Non-electrical equipment for use in potentially explosive atmospheres - Part 6: Protection by control of ignition source “b”, 2005
EN 13463-8 Non-electrical equipment for potentially explosive atmospheres - Part 8: Protection by liquid immersion “k”, 2003
IEC 60079-0 Explosive atmospheres – Part 0: Equipment – General requirements, 2011
ISO/IEC 80079-34 Explosive atmospheres - Part 34: Application of quality systems for equipment manufacture, 2011