

THE REVISED EN 13463-1 STANDARD FOR NON-ELECTRICAL EQUIPMENT FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES

Dipl.-Phys. Konrad Brehm
Bayer Technology Services GmbH, D-51368 Leverkusen
E-mail: konrad.brehm@bayertechnology.com

Dr. Richard L. Rogers†

As a consequence of the Directive 94/9/EC which defines the requirements for electrical and non-electrical "mechanical") equipment intended for use in explosive atmospheres there was a demand for harmonized standards. For electrical equipment those standards have a long history but not for mechanical equipment. On this field it was a quite new topic and the task of the European working group CEN/TC 305 "Potentially explosive atmospheres – Explosion prevention and protection". Within WG2, "Equipment for use in potentially explosive atmospheres", established in 1994, the mechanical standard series EN 13463 were produced. The first version of the EN 13463-1 (2001), "Basic methods and requirements", was revised after the first experiences with this standard. The revision ("revised EN 13463-1") was focused on the mandatory risk analysis, i.e. ignition assessment procedure carried out by the manufacturer. Furthermore, it now contains assessment tools for all possible 13 ignition sources, requirements for mechanical equipment, the ignition assessment procedure, including the evaluation of malfunctions.

Still discussed is the case were the mechanical equipment is an integral part of a process (i.e. pumps, dryers, mixers etc.) and the user has to integrate this equipment into the safety concept of the process.

1. INTRODUCTION

Starting July 1st, 2003, electrical and non-electrical (i.e. "mechanical") equipment has to fulfill the requirements of Directive 94/9/EC if the equipment is intended for use in explosive atmospheres and supposed to be placed on the European Market. Up to this time, only requirements for explosion protected electrical equipment were standardized and accompanied by a great number of product standards. Mechanical equipment was covered only by the less specific Machinery Directive 98/37/EC.

In line with the EU-Directives following the "New Approach", the Directive 94/9/EC sets out the essential safety- and health-requirements for the products, whereas harmonized standards linked to this Directive describe a way to comply with those requirements. Therefore, it was necessary to prepare specific standards for mechanical equipment. This is the task of the introduced European Working Group CEN/TC 305 "Explosive Atmospheres–Explosion Protection". Within CEN/TC 305/WG 2 is engaged in producing standards with requirements for mechanical equipment and started its work in 1994.

The seven different ignition protection concepts for mechanical equipment are described within the EN 13463-series. The first version of the EN 13463-1, "Basic Methods and Requirements" was published 2001 and was now revised.

2. THE STRUCTURE OF EN 13463-SERIES

EN 13463ff series comprises of a basic part, referred to as part 1 and a number of specific standards dealing with the individual ignition protection concepts. In Table 1 those standards are listed including there current status.

Technically, EN 13463-series follows as closely as possible the structure of the comparable standards for electrical equipment, especially with respect to the ignition protection classes, which are very close to those defined in EN 60079. The last of the standards were published in July 2005 and since then, no part of the EN 13463-series has been revised. EN 13463-1 (2001) has been in use by manufacturers and users of equipment since its publication in 2001 and feedback from users is incorporated in a revised version (revised EN 13463-1).

The original EN 13463-1 (2001) is structured such that any equipment designed in accordance with this standard will fulfill the requirements for equipment group II, category 3 according to Directive 94/9/EC. On one side, the other standards treating the different ignition protection classes should be aware of those ignition sources which cannot be avoided by the measures dealt with in EN 13463-1. On the other side, they enable a lower frequency of occurrence of the ignition source by their application. However, it must be noted that the type of protection "Protection by flow restricting enclosure 'fr' " is limited to equipment category 3.

One goal of assessing ignition sources – which must be facilitated by the manufacturer - is to identify whether or not the ignition sources, as listed in EN 1127-1 /3/, are potential ignition sources for the specific equipment being considered. As part of this

Table 1. Standards of EN 13463-series non-electrical equipment for potentially explosive atmospheres

EN 13463-1	Part 1: Basic method and requirements
EN 13463-2	Part 2: Protection by flow restricting enclosure (fr)
EN 13463-3	Part 3: Protection by flameproof enclosure (d)
EN 13463-4	Part 4: "Intrinsic safety" – cancelled – Note: Content to be taken into account by revising part 1
EN 13463-5	Part 5: Protection by constructional safety (c)
EN 13463-6	Part 6: Protection by control of ignition source (b)
EN 13463-7	Part 7: Protection by pressurized enclosures (p) (Protection by pressurization described in EN 60079-2 can also be used for non-electrical equipment.)
EN 13463-8	Part 8: Protection by liquid immersion "k"

assessment, it is distinguished, whether or not an ignition source becomes effective either during normal operation, in case of frequent (foreseeable) malfunction or in case of rare malfunction. Additionally, protective measures have to be taken to avoid the ignition sources becoming effective.

Depending on which of the described operation conditions might result in an ignition source becoming effective, the manufacturer can determine the relevant category for the equipment. The categories of equipment group II according to Directive 94/9/EC are given as follows:

Category 3: Ignition sources will not become effective under normal operating conditions

Category 2: Ignition sources will not become effective under normal operating conditions and in case of frequent malfunction

Category 1: Ignition sources will not become effective under normal operating conditions and in case of frequent malfunction and rare malfunction

Especially by implementing the assessment of the ignition sources by the manufacturer, it appears that the currently available standard EN 13463-1 (2001) does not provide sufficient support. Although this standard includes a great number of technical requirements, it turns out to be too complex for manufacturers to applyan assessment of ignition sources systematically. Moreover, without the knowledge of an experienced user, who pursues the specific applications of a graded safety concept, an assessment on non-electrical equipment is often done inappropriately.

Due to this reason, CEN/TC305/WG 2 initiated the revision of the EN 13463-series beginning with EN 13463-1.The core intention of the revision aims at accomplishing the risk assessment required by Directive 94/9/EC. It should be noted that according to 94/9/EC the risk assessment is an assessment of the ignition sources. The following sections discuss the revision of EN 13463-1.

3. REVISED EN 13463-1

3.1. OBJECTIVE OF REVISION

The main objective of the revised EN 13463-1 is to aid the manufacturer in carrying out the ignition hazard assessment by clearly outlining the requirements of the standard in chronological order. This was achieved by:

- extending the definition of ignition sources
- outlining a step-wise ignition hazard assessment procedure
- including statements about all (possible) ignition sources defined in EN 1127-1 (1997)
- providing details on the requirements for the prevention of ignition sources from becoming effective.

3.2. EXTENDED DEFINITIONS OF IGNITION SOURCES

Due to support the manufacturer during the identification of ignition sources which are related to the equipment and evaluating whether those ignition sources can become

potential ignition sources of the equipment was one of the main objectives in the revised EN 13463-1. Especially during the investigation under which circumstances an ignition source is classified as potential and evaluated as effective are the basic points of the ignition hazard assessment according to Directive 94/9/EC. During his assessment procedure the manufacturer has to answer the following questions:

a) Which of the ignition-sources mentioned in EN 1127-1 is a possible ignition source related to the equipment?
b) Which ignition source related to the equipment has the potential to ignite the explosive atmosphere the equipment is intended to be used in?
c) What is the frequency of the occurrence of effective ignition sources, i.e. turning those potential ignition sources into ignition sources leading to the ignition of the explosive atmosphere and thus determining the equipment category?

To arrive at a scheme for the ignition hazard assessment resulting from these questions, it was necessary to have explicit terms for these different types of ignition sources mentioned above.

As a consequence the CEN/TC305/WG2 agreed on to the following definitions:

- **Equipment related ignition source** (question a) Possible ignition source (remark of the authors: i.e. mentioned in EN 1127-1, (1997)), which is caused by the equipment under consideration regardless of its ignition capability.
- **Potential ignition source** (question b) Equipment related ignition source which has the capability to ignite an explosive atmosphere (i.e. to become effective) (remark of the authors: the equipment becomes subject to Directive 94/9/EC, if it has at least one own potential ignition source).
- **Effective ignition source** (question c) Potential ignition source which is capable to ignite an explosive atmosphere. The likelihood of presence of the ignition source (during normal operation, expected or rare malfunction) determines the equipment category.

3.3. IGNITION HAZARD ASSESSMENT

By using these definitions, it is possible to perform the ignition hazard assessment in the form of a table. An example of such a table for equipment related and potential ignition sources is shown in Tables 2 and 3 for a compressor for natural gas:

3.4. HOT SURFACES

This chapter now bundles all information and requirements relating to hot surfaces as an ignition-source. This includes the establishment of the maximum surface temperature, especially the determination of the temperature class, evaluation of small parts, the correction factors for process and design temperatures and thus the correct marking. For example surfaces with temperatures <200 °C an area <1000 mm² can be tolerated even for T4-equipment.

Table 2. Example of an initial assessment of equipment related ignition sources for a compressor conveying flammable gas (IIA, T2)

Possible ignition sources (List from EN 1127-1)	Equipment related Yes/No	Reason
Hot surfaces	Yes	Gas compression, moving parts of the coupling
Flames, hot gases	No	Not present
Mechanically generated sparks	Yes	Internal moving parts may come into contact housing due to male functions and create sparks
Electrical ignition sources	Yes	Used control devices
Stray electric currents and cathodic corrosion protection	No	Not present
Static electricity	Yes	Isolated metal parts (e.g. housing, rotor)
Lightning	No	Not present
Electromagnetic waves	No	Not present
Ionizing radiation	No	Not present
High frequency radiation	No	Not present
Ultrasonic	No	Not present
Adiabatic compression	No	But user has to consider the internal parts of the compressor (mention in the instruction for use)
Chemical reaction	No	User has to consider the suitability materials (e.g. corrosion) of the conveyed gases

3.5. MECHANICALLY GENERATED SPARKS

The definition of limits for mechanically generated sparks is important for the decision whether or not mechanical sparks are a potential or even effective ignition source. For a lot of manufacturers the assessment of this ignition source turns out to be problematic. To decide if this possible ignition source is an equipment related ignition source causes no problems for most manufacturers, but to decide if it is a potential ignition source leads to a lot of problems. In most cases, the design documentation allows to extract which equipment parts can impact with which relative velocity and thus what energy level can be reached. But it is very difficult for manufacturers to decide if these circumstances lead to mechanically generated sparks. Therefore, the revised standard includes chapters with energy and speed limits for different material combinations.

Table 3. Example of an ignition hazard report for a compressor conveying flamable gas (IIA, T2)

Ignition hazard assessment report according to the revised EN 13463-1: Compressor

1			2				
	Ignition hazard		Frequency of occurrence without application of an additional measure				
	a	b	a	b	c	d	e
No.	Potential ignition source	Description of the basic cause (which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	Reasons for assessment
1	Hot Surfaces (6.2)	Running of comcressor gas compression		#			Increased temperature due to compression/running against closed valve
3	Mechanically generated sparks (6.4)	Contact between rotating and static parts		#			Internally: mixture above upper explosive limit no risk of explosive mixtures Externally: - Pressure side: externally no moving parts - Power side/coupling: moving parts in enclosure with oil filling. Gear is adequately designed for expected torque and load
4	Electrical ignition sources (6.5)	Electrical control units and instrumentation			#		Equipment is in accordance with II 2G IIA T3 or better
5	Static electricity (6.7)	Spark discharges due to non earthed parts		#			Metal parts are connected and earthed (resistance to ground < 1 MO)
		Brush Discharges due to the use non-dissipative coatings (surface resistance exceeding 1 GO			#		There are no non -dissipative coatings in use
6	Adiabatic compression and shock waves (6.13)	Running against/ inbetween closed valves		#			Monitoring of the valve position within PC-System

3			4					
Measures applied to prevent the ignition source becoming effective			Frequency of occurrence incl. measures applied					
a	b	c	a	b	c	d	e	f
Description of the measure	References (standards, technical rules, experimental results)	Technical documentation (evidence including relevant features listed in column 3a)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting equipment category inrespect of this ignition hazard	necessary restrictions
Control of exhaust-gas-temperature and shut down at 230 °C within PC-System (quality: IPL1)	EN 13463-1 Basic methods and requirements EN 13463-6 Control of ignition sources	test-report xxx about thermal test instructions for use			#		2G	T2
Leakages of grease will be detected during routine inspections. Shut down of the compressor via vibration control at the gear/compressor (Gas supply “OFF”). Start-up/shut-down via control-system.	EN 13463-1 Basic methods and requirement EN 13463-8 Liquid immersion	Maintenance according to instructions for use			#		2G	T3
	EN 13463-1 Basic methods and requirements	Equipment list xyz			#		2G	IIA T3
	EN 13463-1 Basic methods and requirements	Earthing according to instructions for use			#		2G	IIB
largest area less than 25 mm²	EN 13463-1 Basic methods and requirements	Parts list yyy			#			
Monitoring of the valve position within PC-System (quality: IPL1)	EN 13463-1 Basic methods and requirements EN 13463-6 Control of ignition sources	test-report xxx about thermal test instructions for use			#		2G	T3
Resulting equipment category including all existing ignition hazards:							2G	IIA T2

The assessment of mechanically generated impact sparks results in one of the following two situations:
Situation 1: When does the ignition source mechanically generated spark -solely by single impacts- need not be considered a potential ignition source independent from the category?
These values are important in two ways. If the values defined in the standard are not exceeded by the operation of the respective equipment, the ignition source "mechanically generated impact sparks" is classified "not a potential ignition source". If there is any other potential ignition related to the equipment, the equipment is under the scope of Directive 94/9/EC, otherwise it is not. The following requirements will be defined in the revised standard:

If the following conditions are met, a mechanically generated spark is classified as not a potential ignition source.

Either

a) the impact velocity is less than 1 m/s and the maximum potential impact energy is less than 500 J and
   1) Aluminum, titanium and magnesium in combination with ferritic steel is not used, or
   2) Aluminum is only to be used in combination with stainless steel (≥16,5 % Cr), if the steel cannot corrode and no iron oxide and/or rusty particles can be deposited on the surface (appropriate reference to the properties of the stainless steel shall be given in the technical documentation and instructions for use), or
   3) Hard steel shall not be used in combination with hard steel, or
   4) Hard steel shall not used where it can impact in granite, or
   5) Aluminum is only to be used in combination with aluminum if no iron oxide and/or rusty particles can be deposited on the surface.

or

b) where a combination of non-sparking materials is used the impact velocity is less than or equal to 15 m/s and the maximum potential energy is less than 60 J for gas/vapor-atmospheres or less than 125 J for dust atmospheres.

Situation 2: When do ignition sources generated solely by single impacts, depending on the category, exceeding these values need not to be considered as an effective ignition sources?

The energy values documented in this standard are dependant on the equipment category and explosion group. They are provided for manufacturers who want to reach a certain equipment category for an intended explosive atmosphere. If these values are not exceeded the equipment fulfills the requirements for the intended equipment category according to the equipment related ignition source mechanical generated sparks.

The limits of mechanically generated sparks are based on published values as well as on extensive tests executed by BAM (2005)/8/.

Additionally, the chapter about mechanically generated sparks will also include statements about grinding sparks resulting from the recently finished MechEx-Project /4/.

3.6. ELECTRICAL IGNITION SOURCES

The electrical ignition sources were included in this standard with their links to the relevant IEC-standards of IEC EN 60079ff /5/. Thus, the interfaces to the standards on the field of electrical equipment were defined as the basis for unified standards.

3.7. REVISED STRUCTURE AND DOCUMENTATION

In addition to the fixed chapters 1 to 3 the revised structure of EN 13463-1, consists of the following main parts:

- Equipment groups and categories, explosion groups (Chapter 4)
- Description of ignition hazard assessment procedure (Chapter 5)
- Assessment of possible ignition sources according to EN 1127-1 including their relevance for the specific equipment (Chapter 6)
- Additional aspects (e.g. dust deposits and other material in the gaps of moving parts, openings of enclosures, non metallic parts of the equipment, removable parts, materials used for cementing, light transmitting parts (Chapter 7)
- Tests Procedures (determination of the maximum surface temperature, mechanical (impact) tests, non-metallic parts) (Chapter 8)
- Documentation (Chapter 9)
- Annexes, Bibliography

The chapter 9, "Documentation", was extended. Now it differentiates in between the technical documentation which has to be archived by the manufacturer and the one which is given to the user. Furthermore it gives guidance to the manufacturers of non-electrical equipment of equipment group II category 2 regarding the documentation given and stored at the Notified Body.

4. SPECIAL CASE: MECHANICAL EQUIPMENT WITHIN PROCESS PLANTS

4.1. IGNITION HAZARD ASSESSMENT FOR MECHANICAL EQUIPMENT WITHIN PROCESS PLANTS ("PROCESS EQUIPMENT")

EN 13463-1 (2001) states that the manufacturer of equipment has to perform an ignition hazard assessment for all possible applications and define measures to prevent ignition sources from becoming effective. The mechanical equipment within the interior of process plants ("process-equipment") is often not used permanently but only during certain well defined phases of the process. During those phases the occurrence of explosive mixtures can deviate from the overall occurrence of explosive mixtures of the complete process, which often would require category-1-equipment. If the occurrence of the explosive mixture depends on the process phase, an optimized/tailor-made ignition hazard assessment requires the knowledge of detailed process information, which is only available from the user's side.

Often, the manufacturer of fast running process equipment (e.g. mixers with rotor-stators or choppers) is asked to design process-equipment for interiors in which explosive

dust/air mixtures are either present for long periods or on a frequent basis. In that case (i.e. "category-1-equipment"), the manufacturer has to evaluate all possible applications in a potentially explosive atmosphere and rare malfunctions leading to effective ignition source and this without knowing the process. On the other hand, the user has detailed knowledge of the process and can perform a customized risk assessment for the phases of the process when the equipment is actually in use. This is done by choosing standard-, category-3 or -2-equipment (no ignition source in normal operation or even in the case of malfunction), assessing the presence of explosive mixtures during the phase of operation and defining the necessary measures for prevention of ignition sources during that phase. A basis for the user's risk assessment can be the ignition hazard assessment of the manufacturer of category-3 or -2-equipment which needs to be reassessed. On top of this, if necessary, the user defines special measures for explosion protection in his risk assessment. The documentation of this additional (i.e. the user's) ignition hazard assessment is part of the explosion protection document (-> Directive 1999/92/EC, Annex II B /7/).The procedure is shown in Table 4.

5. SUMMARY/NEXT STEPS

The revised EN 13463-1 is strongly influenced and improved by the feedback of users since publication. The standard now more adequately describes the step-wise performance of a risk assessment, makes reference to all possible ignition sources, provides additional information on the evaluation of mechanical sparks and gives a revised guideline for accompanying documentation. Despite these informative changes, there are still applications in which the standard does not provide adequate direction. These include mechanical equipment used in the interior of process plants ("process-equipment") where the risk assessment often cannot be performed without more advanced knowledge of the user.

Table 4. Procurement of equipment intended for use in explosive atmospheres

	Electrical equipment	Non-electrical-("mechanical") equipment-process-equipment
Interior of process-plants	Category according to the presence of explosive mixtures "in terms of a zone"	Category independent of process- and operation (i.e. category 2 or 3) + risk assessment by the user (acc. to Directive 1999/92/EC, Annex II B /7/)
Exterior of process-plants	Category according to zone	Category according to zone

Remark: The use of equipment which deviates from the manufacturer's instruction for use must be reassessed in the risk assessment of the user. (acc. to Directive 1999/92/EC, Annex II B or its implementation into national regulations)/7/

The revised EN 13463-1 provides an excellent starting point for the revision of all other standards in the series.

6. LITERATURE

/1/ Directive 94/9/EC of the European Parliament and the Council of 23. March 1994 on the on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres

/2/ EN 13463-1 : 2001: Non-electrical equipment for potentially explosive atmospheres – Part 1: Basic method and requirements

/3/ EN 1127-1:1997: Explosive Atmospheres Explosion Prevention and Protection – Part 1: Basic concepts and Methodology"

/4/ Hawksworth, S., Rogers, R., Proust, C., Beyer, M., Schenk, S., Gummer, J. and Raveau, D.: Ignition of explosive atmospheres by mechanical equipment, Symposium Series No. 150, Crown Copyright 2004

/5/ IEC EN 60079-0 : 2006: Explosive Atmosphere – Part 0: Equipment – General Requirements (Final Draft)

/6/ Brehm, K.: Alles neu im Explosionsschutz? (i.e. "Everything New in Explosion Protection", Technische Überwachung Band 45 (2004) Nr. 11/12 – Nov./Dez.

/7/ Directive 1999/92/EC of the European Parliament and Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from ex-plosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

/8/ BAM Research Report on mechanical generated sparks (2007)