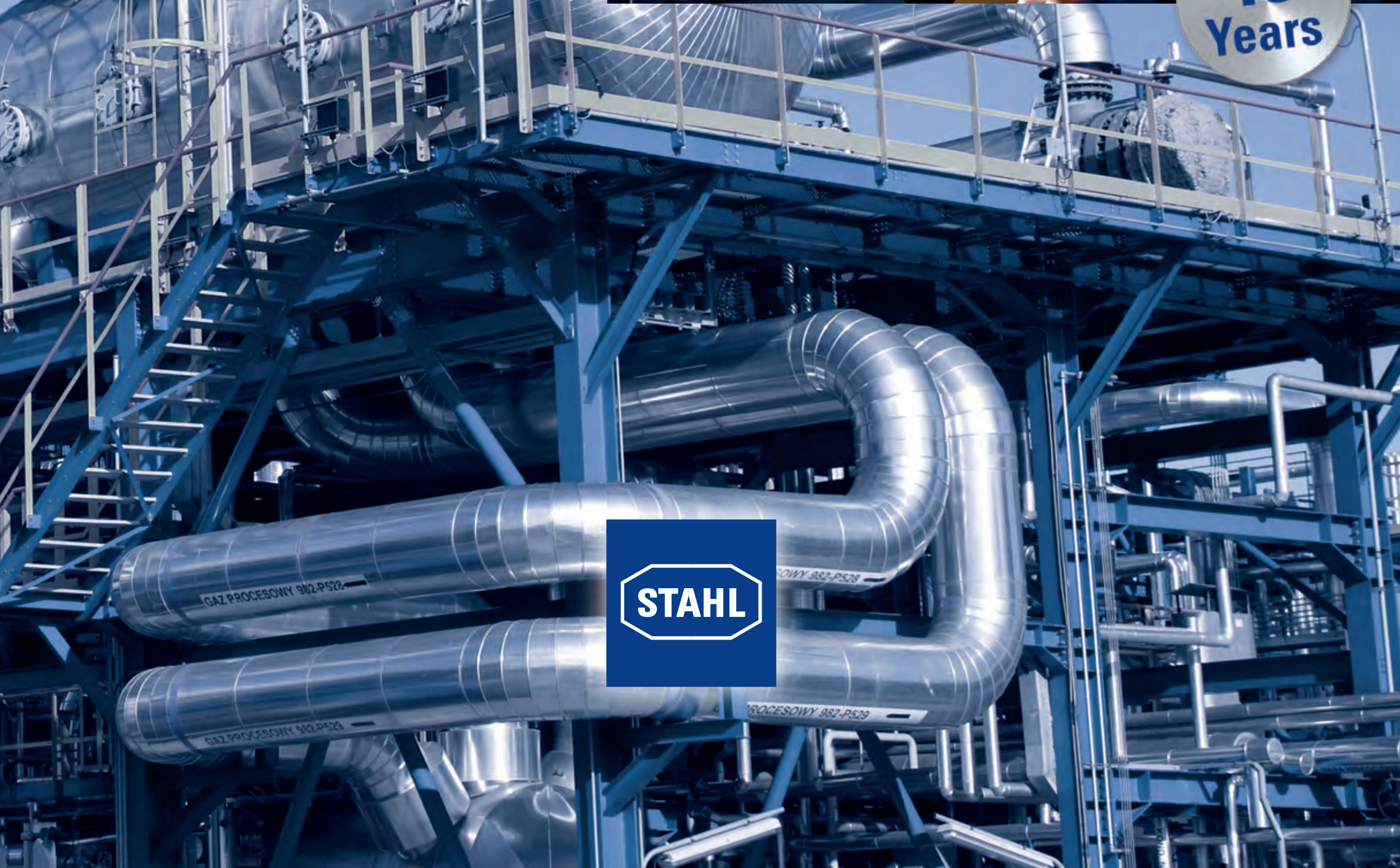
Ex-MAGAZINE **2014**

EXPLOSION PROTECTION – FROM EXPERTS FOR EXPERTS



40 Years

R. STAHL is the world's leading supplier of customer-specific electrical system solutions in explosion protection. The basis for this success is the competence to form systems by integrating different technologies – besides an extensive range of innovative products. The customers benefit from the company's broad know-how in automation technology and the profound knowledge in the field switchgear and luminaires for hazardous environments.

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EDITORIAL
2014

Dear Readers,

our Ex-Magazine turns 40! With the present issue we want to celebrate this anniversary in an appropriate manner. Our article on the development of explosion protection illustrates the extensive and impressive change in technology and regulation during the past four decades. At the beginning there were individual solutions for each individual state. Every country had its own rules and demanded its own inspections and certificates. This was a true bureaucratic nightmare for manufacturers and users which operate internationally. Nowadays, within the European Union we have fully harmonized rules for the placing on the market of explosion protected equipment. The standardization of explosion protection takes place at IEC simultaneously for nearly the whole world market. Most of the countries adopt these standards very easily and integrate them directly into their national technical rules. By now, 33 countries more or less directly convert the IECEx certificates and test reports into national certificates. The IECEx-system is a certification scheme that, for the first time ever, does not only cover new products but the whole life cycle.

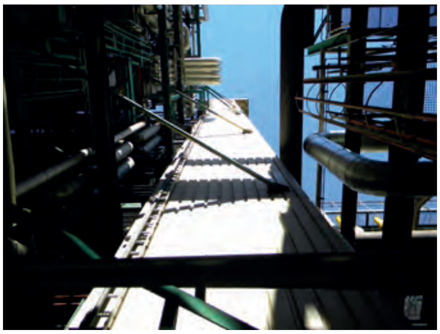
Considering the number of accidents in hazardous areas caused by a lack of competence and incorrect planning, installation and maintenance this offer is long overdue.

In the world of technology, explosion protection is just a small exotic aspect. However, if we consider the potential risks to health and life of thousands of local residents and employees in process plants, it is easy to recognise the importance of a regular exchange of knowledge between experts and users of explosion protected safety technology. Our Ex-Magazine has dedicated itself to this task for 40 years. And its editorial team will do its best to continue this success story for many years to come.

Finally, let us say a few words of thanks: We would like to thank our hard-working colleagues in the editorial department. Certainly, there has been a continuous change of employees during the four decades. But the enthusiasm, talent for improvisation and persistence of the editorial staff members have stayed the same. We would also like to thank hundreds of authors who have contributed their articles and, thus, awoken the interest of our readers again and again. Finally, we would like to thank you, dear readers, our customers who have remained loyal to us for many years and encouraged us constantly to continue our work. With this in mind, we are looking forward to the coming forty years!

Your Editorial team

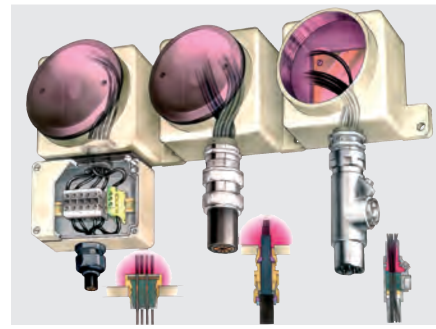
INHALT



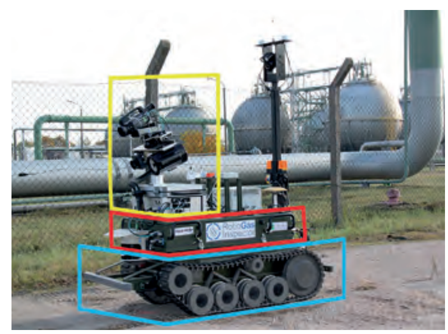
PAGE 26
Modernisation of a full-ex elevator unit in a refinery

PAGE 40
"Power-i" = Intrinsic Safety 2.0?

PAGE 46
The "new" ATEX Directive 2014/34/EG



PAGE 55
Controlling and Distribution Panels



PAGE 91
Robogas$^{\text{Inspector}}$ research project

PAGE 98
US Standard development and the IEC standards

EX-NEWS
INFORMATION ON EXPLOSION PROTECTION

BY THORSTEN ARNHOLD (EDITORIAL BOARD)

IEC TC 31 EQUIPMENT FOR EXPLOSIVE ATMOSPHERES

TC 31 met in Windsor and London (UK) in March 2013, in New Delhi (India) in November 2013 and in Braunschweig/Germany in March 2014.
During this event, the following workings groups met:

WORKING GROUP (WG) 32 NEW DEFINITIONS OF THE CLEARANCE AND CREEPAGE DISTANCES

After a first internal working document had been drawn up and discussed in the working group, the next task was set by TC31, which consisted of drawing up an informal document for distribution to the national committees. This was then sent in January 2013. The response to the document by the national committees was mostly negative. It is feared that the proposed values would cause great uncertainty. It has been suggested that some of these results be included in the relevant standards and that work on this document should be discontinued. The first concrete results to be included in Annex H of the draft of the 5th edition of the IEC 60079-7: Increased safety were two tables containing alternative values for clearance and creepage distances under controlled ambient conditions.

At the meeting in Braunschweig on 24 March 2014, it was found that specifications for clearance and creepage distances are not only contained in the IEC series of standards 60664, but possibly also in other standards. Before proceeding further the following decisions first have to be made in order to ensure that the correct basic standard is used as a basis:

1. TC 109 "Insulation co-ordination for low-voltage equipment" has invited other TCs to a meeting, in which the extension of the scope of the IEC 60664 series is to be applied also to more than 1000 V.
2. Within the TC 109, there are currently discussions as to whether work on IEC 60664-1 or 60664-5 should be continued. WG 32 plans to meet in The Hague during the scheduled IECEx meeting, in order to integrate the decisions made by then into the work of WG 32.

Depending on these decisions, the suggestions by WG 32 will then be revised.

WG 42 (FORMERLY AD-HOC WORKING GROUP (AHG) 33): SAFETY DEVICES RELATED TO EXPLOSION RISK

A first working paper was distributed to the national committees in the spring of 2013. More than 120 comments were received as response. It became obvious that there are still a series of basic misunderstandings. Thus, it is often assumed that the use of safety devices does not require certification. This is not the case. It must be made clear that not only the safety device but also the equipment under control (EUC), for example, a motor, must be certified, since the safety device usually cannot control all critical states on its own.

Furthermore, there is a need of coordination with the MT 60079-14. At the end of 2013, the document was again circulated. Once again, there were more than 100 comments, which were processed at the WG 42 meeting in Braunschweig in March 2014. The scope was adjusted accordingly. This should have eliminated all misunderstandings. Once again, it was made clear that the combination comprising EUC and safety device must be certified for the intended use.

It is planned to process the comments received once again in October 2014 and then establish a project team from the WG 42, in order to draw up the first version of the standard.

AHG 34
VERY LOW AMBIENT TEMPERATURES

The new WG 39 titled: "Adverse service conditions" under the convener Dr. A. Zalogin (Russia) had its constitutive meeting in London in March 2013.

Given the extent of the work to be planned, the decision was made first to focus on applications at low temperatures. All references to non-IEC standards were removed from the working paper. The aim is to include in the relevant standards of the types of protection specific requirements of the equipment at extremely low temperatures, in order to avoid the formation of another cross-sectional standard. The members of the working group still have opposing views as to the orientation and extent of the definitions to be made. For their implementation in practice, it is absolutely necessary to separate functional requirements strictly from pure Ex protection requirements (and eliminate them from the discussion).

AHG 37
ELECTROCHEMICAL CELLS AND BATTERIES IN EQUIPMENT FOR EXPLOSIVE ATMOSPHERES

At the meeting of the AHG 37 in London in March 2013, for the first time representatives from battery manufacturers were present. Standardized requirements for the relevant chapter in IEC 60079-7: Increased safety were developed. This standard was selected, because it is the next one of the main standards to be republished. Following this, the requirements for the degree of protection intrinsic safety are to be developed.

WG 40
LUMINAIRES

By decision of TC31, the AHG was incorporated in WG 40 and assigned the following job: "To review and develop requirements for luminaires for explosive atmospheres". This permanently establishes this working group, in order to incorporate the technical progress in lighting technology in explosion protection with as little delay as possible. The first work of the WG focused on contributing work to the new edition of the IEC 60079-7: Increased safety. Thus, for example, the requirements for enclosed halogen luminaires have been supplemented and incorporated in the selection table. Furthermore, the safety requirements of the LEDs for use in luminaires of this type of protection have been specified in detail.

One current job of WG 40 is to work on the next edition of the IEC 60079-0.

Another pending job is checking the requirements of the luminaires of IEC 60079-15.

AHG 41
HIGH VOLTAGE

This AHG was newly established in Oslo. Dr. F. Lienesch (PTB, Germany) was appointed as the convener. A first working paper was drawn up and discussed internally.

TC 31 CHAIRMAN´S ADVISORY GROUP (CAG) MEETING IN WINDSOR

Mark Koppler (DNV) was elected as the new Vice Chair of TC 31.

The IEC 60079-27 (FISCO) standard has been withdrawn, since its contents have been integrated into Part 25: Intrinsically safe systems. The time period for voting by the national committees has been left at 5 months.

In addition to Mr Jim Munro, who according to IEC regulations may no longer lead this group, Dr. Ulrich Johannsmeyer (PTB, Germany), Chairman of the Subcommittee SC 31G "Intrinsically safe apparatus" and Thore Anderson (NEK, Norway), Chairman of the Subcommittee SC 31J "Classification of hazardous areas and installation requirements", were bid farewell. Neither can stand for another term of office.

Since August 2014 Marc Coppler (USA) is the new Chairman of TC 31. He is the successor of Jim Munro (AU) who chaired TC 31 for many years.

IEC 60079-0
GENERAL REQUIREMENTS

Following the rejection by the FDS of the 7th edition of the standard forced by the majority of the national committees, it was downgraded to the CDV status. In two meetings of the maintenance team, the required corrections were made, and the new CDV was distributed for comments. Comments were received by TC 31 by the end of 2013.

IEC 60079-1
FLAMEPROOF ENCAPSULATION

Following the rejection by the FDS of the 7th edition of the standard forced by the majority of the national committees, it was downgraded to the CDV status. In two meetings of the maintenance team, the required corrections were made, and the new CDV was distributed for comments. Comments were received by TC 31 by the end of 2013.

Now a further basic controversy seems to have develop: The English delegation is against additional tests on flameproof joints in enclosures in the event that leaks are detected in the regular type test following the heat storage according to IEC 60079-0. The fear is that these additional tests will result in testing products until they are deemed safe. Although no agreement could be reached on this topic, the FDIS will be distributed at the beginning of 2014.

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IEC 60079-2
PRESSURIZED ENCLOSURE

The FDIS of the 6th edition of the IEC 60079-2 will be published in 2014. The main novelties compared with the 5th edition of the standard are as follows:

_ The requirements of dust protection applications have been included,
_ New definitions for px, py, pz,
_ Additional battery requirements,
_ Additional requirements of pressure-encapsulated systems,
_ Modified test requirements for fail-safe containments,
_ Modified test requirements for limiting the internal pressure in the enclosure,
_ An additional second source for protective gas supply.

Experts have criticized the following weaknesses:

_ The requirements of enclosures contained in section 5.9. are considered insufficient.
_ According to section 7.11, if excess pressure fails, signaling by means of a signal lamp is also possible. The decision is up to the operator.

IEC 60079-5
POWDER FILLING

The FDIS of the 4th edition was completed in November 2013. Its publication is planned for the end of 2014 jointly with the IEC 60079-6.

IEC 60079-6
LIQUID IMMERSION

The CDV of the 4th edition was distributed in the spring of 2013. The comments received were processed at the meeting in Braunschweig. Its publication is planned for the end of 2014 jointly with the IEC 60079-5.

IEC 60079-7
INCREASED SAFETY

The CDV was published in March 2014. It contains the following substantial changes:

_ Introduction of the equipment protection levels (EPL) eb and ec,
_ The requirements of the IEC 60079-15 for na are moved to Part 7
_ New requirements of inverter operation adjusted to the relevant EPL,
_ Definition that U-enclosures may only be marked on the inside.
_ Thermal requirements of solid electrical insulating materials
_ Annex H: Possibility of reduced clearance and creepage distances in eb and ec under special conditions
_ New requirements for the power dissipation of the cathodes of lamps supplied with power by electronic ballasts (EOL)

The comments received were discussed during two meetings in Windsor in 2013 and in New Delhi and incorporated in the CDV. The work of WG 32, AHG 37 and WG 40 was incorporated in the draft. A table containing modifications connected to the implementation of e in eb and of nA in ec was added.

The processing of the CD'V is scheduled to take place in Northbrook in November 2014.

SC 31 G INTRINSIC SAFETY

IEC 60079-11: INTRINSIC SAFETY

The MT is working on a collection of topics for the 7th edition, which was continued in Windsor in March 2013 and in Braunschweig in March/April 2014. The German proposal of restructuring the text of the standard, with the aim to display the requirements more clearly was adopted by majority vote and will form the basis of further revision.

IEC 60079-25
INTRINSICALLY SAFE SYSTEMS

Currently topics are collected for the 3rd edition. The stability date has been set to 2015.

SC 31 G WG4

The working group of Subcommittee SC31G has been working since Seattle on the modification to the spark test device. In particular, the cadmium disk should be replaced, and an extension of the test options should be achieved. This work is likewise continued in Windsor.

IEC-TS 60079-39
ELECTRONICALLY CONTROLLED SPARK DURATION LIMIT (POWER I)

A first draft of the new Technical Specification (TS) was distributed within the working group at the end of 2012 and discussed in Windsor in March 2013. At the end of 2013, the 1st CD version was published and discussed in Braunschweig in March. The finished TS is scheduled to be published by the end of 2014.

IEC 60079-28
RISK OF IGNITION BY OPTICAL RADIATION

The CDV of the second edition was distributed at the end of 2013. The comments received were discussed in Braunschweig in March 2014.

The scope of the standard was stated in more detail and a few light sources were accepted.

The publication of the FDIS is expected for the end of 2014.

IEC 60079-18 EQUIPMENT PROTECTION BY ENCAPSULATION "m"

The CDV of the 4th edition was published in March 2014.
It contains two significant modifications compared with the predecessor standard:

- The requirements for encapsulated batteries have been adjusted and supplemented.
- For "ma" devices with EPL "Da", the surface temperature must be tested in the mounting position specified by the manufacturer and under a dust layer of at least 200 mm. This makes it stricter compared with the relevant article in IEC 60079-0.

The comments received were processed at the meeting in Braunschweig, and the publication of the FDIS is scheduled for the beginning of 2015.

IEC 60079-26 EQUIPMENT WITH EUIPMENT PROTECTION LEVEL (EPL) Ga

The FDIS of the 3rd edition was distributed at the beginning of 2014. There have been no significant changes compared with the predecessor edition.

IEC 60079-31 PROTECTION BY ENCLOSURE

The 2nd edition of the standard was published in November 2013. The following changes were made compared with the predecessor standard.

- The safety tolerance for the maximum surface temperature was reduced from 20 °K to 10 °K.
- The excess pressure test of ta equipment was made easier.

The new specification for the variation of the steady-state temperature in the temperature test for "ta" of no more than 1K/24h can only be implemented technically at great expenditure.

WG 28: DUSTS

This working group supports and tests the requirements for dusts in connection with TC31 standards.

Current tasks: This group evaluated the suitability of the flameproof enclosure for dust Ex protection.

Another item is the work on dust Ex protection during the revision of IEC 60079-0.

IEC 60079-30-1 ELECTRICAL RESISTANCE TRACE HEATING – GENERAL AND TESTING REQUIREMENTS IEC 60079-30-2 ELECTRICAL RESISTANCE HEAT TRACING – APPLICATION GUIDE

The second edition of this series of standards is in the late draft stage. It is a common standard project by IEC and the North American IEEE. IEC and CENELEC cannot accept that it contains normative requirements relating to the North American division system.

The test requirements for mechanical strength have been significantly increased.

IEC 60079-32-1 AND IEC 6007932-2 ELECTROSTATIC HAZARDS

Part 1 has the status of a technical specification (TS) and contains the basics. Part 2 describes test methods and the CDV status. The latter was distributed at the end of 2013 for comments. DTS 60079-32-1 contains a few contradictions compared with the new edition of FDIS IEC 60079-0:2012, the TS containing in particular several stricter regulations compared with the previous practice. Specifically, these are the values from Table 2: "Allowed isolated capacitance in Zones with explosive atmosphere", which do not coincide with the values from Table 9 from FDIS IEC 60079-0: "Maximum capacitance of unearthed metal parts" and the requirement from CDV IEC 60079-32-1 prescribing a minimum layer thickness of 10 mm against propagating brush discharges for non-conducting coatings on metal surfaces. The current IEC 60079-0 only requires 8 mm as before.

Some requirements from Part 2 of the draft of the standard go clearly beyond the previous requirements and would result in completely new product requirements. On this topic, some discussions with the national committees are still to be expected.

IEC 60079-33 EQUIPMENT PROTECTION BY SPECIAL PROTECTION "s"

The first draft of the standard was published in 2013. It has emerged that there are major discrepancies between the standard and the draft of an operational document (OD) of the IECEx with respect to the organization membership and qualification requirements of the independent verifier. It is planned to clear this up in the next meeting of the maintenance team in Braunschweig in April 2014, and in the meeting of the IECEx Working Group 01 in Dubai in May 2014. The intention is to maintain a close collaboration between MT 60079-33 and the IECEx.

IEC 60079-40 PROCESS SEALING

The 2nd CD will be published in the spring of 2014. The document receives the status of a technical specification (TS).

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TC31 SC31 J CLASSIFICATION OF HAZARDOUS AREAS AND INSTALLATION REQUIREMENTS

IEC 60019-10-1: CLASSIFICATION OF AREAS – EXPLOSIVE GAS ATMOSPHERES

The 2nd CD of the 2nd edition was distributed in May 2013. This time, 370 comments were received from the national committees (for the 1st CD, there were 300). This unusually high number underlines the sensitivity of the topic.

Findings from the Buncefield incident (explosion accident in England in 2005) have led to the appearance of the new terms "catastrophe" and "rare fault". The trend to use mathematical models for zone classification continues. Using example collections, which have been proven in practice for a long time, is, however, still possible.

It also contains the requirements of employees who perform a zone classification.

Furthermore, there are intentions to also include elements of functional safety. This would mean, for example, that a certain SIL classification would be prescribed for safety functions, thus ensuring correct operation of the technical ventilation measures.

IEC 60079-10-2: CLASSIFICATION OF AREAS – COMBUSTIBLE DUST ATMOSPHERES

A CDV was published in November 2013. The Stability Date will be in 2019.

IEC 60079-14: ELECTRICAL INSTALLATIONS FOR POTENTIALLY EXPLOSIVE ATMOSPHERES

The fifth edition of the standard was published in November 2013. The structure of the standard was slightly changed compared with the predecessor edition and now looks like this:

- General requirements
- Erection requirements for certain types of equipment
- Installation requirement as a function of the types of protection

Surprisingly, the selection scheme of the 4th edition for determining the right cable entries for flameproof enclosures was again removed from the standard. This also eliminates the requirement of using "Sealed Cable Entries" for IIC enclosures of more than 2 litres in volume.

In exchange, now a minimum cable length of 3 metres is specified, in order to prevent through-ignition through the cable interior. This was preceded by a survey among operators, who in their majority had opposed encapsulated cable entries.

IEC 60079-17: INSPECTION AND MAINTENANCE OF ELECTRICAL INSTALLATIONS

The 5th edition of the standard was published in November 2013.

The equipment protection levels (EPL) were introduced, and the dust explosion protection was integrated. This standard, too, describes the requirements of qualification and experience of the experts who are entrusted with inspection and maintenance tasks.

The definitions for the initial inspections of the complete installation in new systems prior to their commissioning are now contained in IEC 60079 Part 14.

Another new requirement in section 4.3.1.1 "Verification of unmarked equipment" is that in the event of insufficient marking the information required for performing a correct inspection must be made available later on (e.g. by affixing a unique identification number to the device).

Moreover, new inspection requirements for transportable equipment are included.

This edition also contains for the first time an informative annex containing guidelines for inspecting motors (Annex D), which will certainly be very helpful to many operators.

For the next edition of Parts 14 and 17, it is intended to combine the two standards and also include the aspects of mechanical explosion protection and of Group I (mining).

Given the present size of the two standards and the diversity and complexity of mechanical equipment, it remains to be seen how understandable and practice-oriented the new standard will turn out to be.

IEC 60079-19: EQUIPMENT REPAIR, OVERHAUL AND RECLAMATION

The work on the 4th edition was started in 2013. The aim is to issue a new standard in 2015.

SC 31 M

The subcommittee SC31 M works closely together with the relevant committee at ISO and is in charge of drawing up standards for non-electrical explosion protection.

As successor of Dr. H. Bothe (Germany), Dr. M. Beyer (Germany) was appointed Chairman of SC 31 M from 2013.

IEC 60079-20-1: MATERIAL CHARACTERISTICS FOR GAS AND VAPOUR CLASSIFICATION

The stability date of the standard is 2014. Under the leadership of the convener, Dr. M. Thedens (Germany), the MT was commissioned with the preparation of a new edition of the standard, and a questionnaire was sent to the national committees.

IEC 60079-20-2: MATERIAL CHARACTERISTICS – COMBUSTIBLE DUSTS TEST METHODS

Following the resignation of the previous convener, Dave Wechsler (USA), D.W. Ankele (USA) will become the Chairman of the MT. A new edition of the CD is in preparation.

It was decided to maintain the existing numbering for both standards, as they are cited in many other standards. (all other standards for non-electrical types of protection have the range of numbers 800XX.).

ISO/IEC 80079-34: APPLICATION OF QUALITY SYSTEMS FOR ELECTRICAL AND NON-ELECTRICAL EQUIPMENT

After the first edition of the standard was published in April 2011, the next edition of the standard is now in preparation. A maintenance team will be formed under the leadership of the convener, Thierry Houeix (France).

ISO/IEC 80079-36: NON-ELECTRICAL EQUIPMENT FOR USE IN EXPLOSIVE ATMOSPHERES – BASIC METHODS AND REQUIREMENTS

After the CDV of the standard was rejected by ISO in the spring of 2013 (it was accepted by IEC), it had to revert back to CV status. The reason for rejection was the proposed marking, as it was feared it could lead to confusion. The agreement now arrived upon consists of using, "bh" for control of ignition sources and "kh" for liquid immersion,and only "h" for mechanical explosion protection, instead of "ch" for constructional explosion protection".

This reflects the fact that mechanical explosion protection is strongly related to the particular device, which gives the operating instructions greater importance than in the case of electrical equipment.

A new vote for CDV is expected in the beginning of 2014. If the results are positive , the publication of the standard can be expected in the beginning of 2015.

The standard is very closely related to the basic standard IEC 60079-0: "General requirements". A very helpful list of references for the individual sections of the IEC 60079-0 can be found under Scope.

ISO 80079-37: NON-ELECTRICAL EQUIPMENT INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERES

The CDV of the first edition was published in the summer of 2012. The convener of the project team is K. Brehm (Germany). This standard describes the three types of protection constructional safety "ch", control of ignition sources "bh" and liquid immersion "kh".

IECEX-SYSTEM

The meeting of the IECEx Management Committee (Ex MC) took place in Fortaleza, Brazil, in October 2013. The following topics are worth mentioning:

_ Conformity Assessment Board (CAB) topics: Here, in particular new financial targets of CAB should be mentioned. Starting next year, it is planned to have indirect services, which are currently still invoiced at IEC, allocated with IECEx. Moreover, the reserve, which currently absorbs the surpluses, is to be increased from two to three years. The reason given for this is the better financial safeguarding of economic and other risks. Both could lead to a clear change in the financial situation of IECEx. The ExMC has requested a more detailed explanation of these demands by the CAB.
_ Prof. Thorsten Arnhold, Germany, was elected to be the new IECEx Chairman. He took office on 1 January 2014. The term of office is 3 years.
_ Although the German proposal of applying the general reference of certificates (CoCs) to the operating instructions from the proposed supplement of IECEx 02 only those parts of the operating instructions that are relevant for explosion protection was approved by the majority, it was also clearly rejected by the US, so it was decided to delegate this topic again to WG 01.
_ The German proposal of eliminating the discrepancies between IEC 60079-33 and the corresponding OD (ExMC/866/CD) with respect to the organization membership and technical qualification of the independent verifier (IV) was adopted. The new document shall be adjusted and released through the normal circulation procedures.
_ A proposal was submitted to convert WG 10 to a new committee similar to Ex-PCC. This was supported due to the extended scope of the service facility schemes.
_ The report by the Chairman of Ex-PCC showed that work on the question database continues and that currently suitable software for managing the questions is being selected. Ralf Wigg is resigning as chairman. His successor will be John Allen (UK).
_ The German proposal of specifying the required competences and qualification of the assessors in detail was adopted.

Stand: 15. April 2014

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[CHAIRMAN IECEX SYSTEM / VP TECHNOLOGY, R. STAHL, WALDENBURG/GERMANY]

ABBREVIATIONS

EPL
Equipment protection level

DC
Document for Comments
Survey at the beginning of a new draft

CD
Committee Draft
1. step: publication of the standard´s draft

CDV
Committee Draft for Voting
2. step: first vote on the standard´s draft

FDIS
Final Draft International Standard
3. step: final vote on the standard´s draft

40 YEARS OF EXPLOSION PROTECTION MIRRORED IN THE EX-MAGAZINE

BY WOLF DILL, HELMUT SCHACKE, PETER VÖLKER

Introduction

Many readers are already familiar with the German language Ex-Magazine which has been received with interest on a world wide basis.

This success indicated the demand for a similar publication in the English language to report on all aspects of explosion protection in hazardous atmospheres.

Installation, commissioning and servicing are given special attention together with new applications. Special reports on the formation of the new international IEC regulations and the European CENELEC proposals have also been included.

Articles from top international Ex-experts will be published giving world wide views and opinions on the deeply specialised field of explosion protection.

We trust that you will find this magazine both informative and of interest and would be more than pleased to receive your views and comments which you find applicable.

Dipl. Ing. Werner Stahl
Managing Director
R. STAHL K.G.

Obering. Fritz Weißer
Works Director
Switchgear Works

Ex-Magazine No 1 • April 1975

4

The safety of process plants has been improved continuously during the last 40 years in Europe. For example the chemical industry is considered nowadays one of the safest sectors with a very low number of accidents. Safety is the task and challenge for all involved parties, in particular for the users and employees, equipment manufacturers, authorities, certification bodies, legislators. This also applies comprehensively to explosion protection as an integral part of the overall safety concept whereas the successful prevention of explosions in the companies depends on the expertise of the management and employees on site.

From the beginning it was the declared intention of the publisher R. STAHL to establish the "Ex-Magazine" as the primary safety-related information source for the field of explosion protection. In the first edition dating back to June 1974, the former R. STAHL managing director Werner Stahl and R. STAHL director Fritz Weisser summarized the target objective of the Ex Magazine.

The target group addressed by the Ex-Magazine has expanded significantly in the meantime, but those statements still apply today.

The development and implementation of the safety-related fundamentals and the regulatory environment are reflected in the scientific papers of the numerous contributing authors. New results from the research institutions, news from standardization, reports on problem solutions in the industrial practice and application of improved protection concepts to new products, information from testing laboratories and certification bodies, regulatory authorities and other organizations taking part in accident prevention allow the readers of the Ex-Magazine to keep their professional expertise and the expertise of their colleagues up-to-date. In the following we are going to address some important developments and achievements of the past 40 years in explosion protection the way they are reflected in the contents of the specialist articles. However, due to the amount of information , we rather refrain from explicitly specifying the source references of each corresponding article. Naturally, the Ex-Magazine focused and focuses now mainly on the topics of technology, testing and application of electric devices and systems in explosion protection. Nevertheless, both more general and other specific aspects for the operation of "Ex Plants" had and still have their place, such as formulation of questions on the operational workflow and working out of explosion protection concepts, from the area of "non-electric" and "design-based" explosion protection, etc. However, these aspects can only be alluded to briefly in this article.

DYNAMIC DEVELOPMENT IN THE TECHNOLOGY, ECONOMY AND REGULATORY ACTIVITIES

When comparing today's situation with the situation 40 years ago, it becomes obvious that the developments of the technology, economy and regulatory activities have advanced very dynamically.

In 1974, there were no mobile phones, e-mails, Internet or PCs. It was only five years before that, Apollo 11 had landed on the moon. The technological development of the last 40 years can, therefore, be referred to as extremely rapid and this applies not only to the area of communication and automation. All technology sectors have been influenced decisively by the inventions and innovations. The development of technical and legal regulations went hand in hand with the rapid technology development trying to keep pace with. At the same time – and related thereto – we have experienced and are still experiencing partially correlating economic, political and social change.

The world looks different nowadays. Economic relocations of focuses have taken place. Entire industries have changed, some new industries have appeared, some industries have grown, others have declined or even vanished. There have been relocations within the global economic system as well. For example, the once flourishing black coal mining industry has reduced its importance in Germany continuously and does not play any significant economic role anymore. Some 200,000 people were directly employed in this industry in 1974; at its peak 600,000 people worked in Germany in the black coal mining industry.

One of the most important industry sectors is still the pharmaceutical-chemical industry which has established itself very solidly in Germany. And precisely this industry has a special relationship to explosion protection.

INITIAL SITUATION 1974

At that time explosion protection had not been regulated exhaustively at the legal level (laws/regulations/technical rules) in Germany. Regulations referred to material-, system- and device-specific aspects or had been "hidden" among general safety requirements. The former included in particular the regulation on combustible liquids (VbF, original version dating back to 1960) and the explosion protection regulations (German-Federal-Land-specific) as well as mining regulations.

However, the German Social Accident Insurance Institutions (also institutional legislators) had already issued binding regulations for the entire field of explosion protection ("Explosionsschutz -Richtlinien, EX RL", today: "Explosionsschutz-Regeln"), which later became a model for the legal regulations in Europe for operation of "Ex Plants" as well as for many European standards on non-electrical explosion protection.

Thus, further development of explosion protection remained mostly in the hands of the users (process industry) and manufacturers of electric equipment, machines and systems. In the field of electrics, explosion protection had been regulated by the standards of the corresponding standardization organizations such as VDE, CENELEC and IEC.

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1972
Calculator from Hewlett Packard with scientific functions, HP 35

1974
Intel presents the first 8-Bit-Processor 8080

1973
Foundation of CENELEC

1972
Flameproof Pendant Light fitting 400 W

1973
Explosion protected control equipment for panel mounting series 8004

1974
Ex-Zeitschrift Nr. 1

1972 | 1973 | 1974

HARMONIZATION OF THE STANDARDS 1967 – 1977

The electrotechnical standards are characterised by high continuity.

The applicable standard in Germany in 1974 was VDE 0170/0171, the 1944 version of which had been changed only slightly by amendments in 1957 and 1961, even if the technology itself had become more modern. The type of protection "Intrinsic safety (Ex)i / (Sch)i" was introduced in 1965. Deviations from the standard were checked by both German certification bodies PTB (German Physical and Technical Federal Institute in Braunschweig) and BVS (German Mining Test Facility in Dortmund) and certified as special protection "s". Based on the certificates, the district government or regional mining authorities issued the approvals according to the local regulations (on the basis of the ExVO). Comparable regulations also existed in all other countries in Europe and in the world, but only on the basis of the corresponding national standards and laws. Marketing of very high-quality and safe German products on the international market was a time- and resource-consuming task for the export-oriented manufacturers.

In 1967, IEC 79 was issued for the type of protection "Flameproof enclosure"; then IEC 79-0 and other types of protection. There was no obligation to apply it at that time.

IEC publication 79-10 issued in 1972 served as a pilot project because, for the first time, it had the uniform zone classification. During the wording of zone definitions, each term was intensively discussed and haggled over.

The work at IEC was running in parallel to the first European "harmonization" of the national standards. EN 50014-50019 (only for Ex I and EX II /Zone 1) were established in a laborious process between 1967 and 1977 by Cenelcom (later: CENELEC). These standards contained technical concepts whose origin could be clearly traced back to the French, British or German standards. While for example in Germany the cable entries were usually led into connection boxes with type of protection "e", in Great Britain they were normally flameproof and also contained isolating switches. In France certain electric cables could also be led with special cable entries directly into the flameproof contactor rooms. The synthesis of these variants in the EN standards led partially to technical solutions whose safety level did not always comply with the originally intended one.

MARKET OPENING BY MEANS OF EEC DIRECTIVES 1977 – 1979

The alignment of the European equipment standards for explosion-protected electrical equipment was supported by the first EEC directives for the optional opening of the EEC market for products which complied with the "harmonized" European standards. Harmonization was the explicit quotation of the standards in an EEC directive.

Directive 76/117/EEC provided the legal framework. The member countries were not allowed to impede the sale of products if an "approved body" had issued a "certificate of conformity" on the compliance with the harmonized standards. The concrete application was facilitated by the Directive 79/196/EEC with the first

1975
Docking of Sojus 19
and Apollo 18

1975
European Directive
76/117/EEC

1975
Residual Current
Protective Device

1975

1976
100 years R. STAHL
Founder
Rafael Stahl

1976

1977
Apple II Personal Computer
with keyboard

1977
Standard series EN 50014 to
50020 accepted by CENELEC

1977
First explosion protected
LED pilot lights
(Patent for R. STAHL)

1977

list of harmonized standards. The Hexagon-Ex ⟨Ex⟩ had to be used as a "distinctive community mark" on equipment and certificate.

COMPREHENSIVE RE-ORGANIZATION OF THE GERMAN LEGISLATION FOR THE EX PROTECTION 1980

Both EEC directives from 1977 and 1979 were integrated in 1980 into the German legal system with a comprehensive re-organization of explosion protection in Germany by the regulation on electrical installations in areas with potentially explosive atmospheres ("ElexV").
Both type examination certificates of the German certification bodies PTB and BVS and conformity certificates from the approved bodies (INIEX/BE, DEMKO/DK, CERCHAR and LCIE/FR, BASEEFA/GB and CESI/IT) replaced the approvals according to national law of the German Federal States (Lands).

PTB and BVS were nominated as approved bodies ("notified") by the diplomatic note of the permanent representative of Federal Republic of Germany at EEC.

The ElexV also included the zone definitions and references to technical codes of practice such as the guidelines for explosion protection "EX-RL" as mentioned before.
In addition to the zone definitions, there was an agreement between the Federal Minister of Labour and both German certification bodies: PTB took over the certificates for Zone 0, BVS - certificates for Zone 10 (currently known as Zone 20). Both bodies committed themselves to avoid issuing any certificates for the Zones 2 and 11 (today: Zone 22).
Custom-made equipment could be checked and certified according to ElexV by specially qualified and approved experts of the users and manufacturers. Thus, these experts had virtually the status of a notified body, but only for the German market.

ESTABLISHING THE INTERNAL MARKET 1980 – 1990

In the cross-border trade, explosion-protected electrical equipment at the beginning was subject to a lot of friction, and there were many attempts to protect the national market . Many controversial discussions relating to the acceptance of certified equipment took place in the HOTL (Heads of Testing Laboratories) working group of the certification bodies. This working group was organised by the EC Commission. With 8 members, the group was quite manageable: BE: INIEX (Belgium), PTB and BVS (Germany); DEMKO (Denmark), CERCHAR and LCIE (France); BASEEFA (Great Britain); CESI (Italy). With the later expansion of the EEC, LOM (Spain), Arsenal and TÜV Vienna (Austria), VTT (Finland) and SP (Sweden) were added,, while the entry into force of the Mining directive 82/130/EEC also added, the British body HSE(M). The meetings were held on a rotating basis at the facilities of the individual members, this facilitated building up of the mutual trust and adjustment of the testing procedures. Already in 1982, the group performed a proficiency test on the reference explosion pressure determination on a flameproof motor.

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1978

1978
Safety barriers according EN 50020 and NFPA 493 (for USA)

1979

1979
Rubik presents the magic cube

1979
European Directive 79/196/EEC

1979
Foundation of first R. STAHL subsidiary in the USA

1980/81

1980
ElexV – German Ordinance for Electrical Installations in potentially explosive atmospheres

1980
Explosion protected electric rope hoist

THE HEXAGON EX – INTERNATIONALLY RENOWNED LOGO FOR GOOD EUROPEAN EX PROTECTION

Overall, HOTL has made many positive contributions to the unification of the rules of the game. After max. 10 years, the European system of market opening for uniformly tested and labelled devices was a success story. The Ex has become the logo of the European explosion protection and the key to the market entry even outside the EEC.

To reduce bureaucratic obstacles, HOTL introduced the component certificate for the Ex components such as terminals, cable entries, empty enclosure. It did not have any official status, but it worked and was added to Directive 94/9/EC. The HOTL members mutually agreed to accept these certificates.

A testing and certification procedure provided by the directive in case of deviation from harmonized standards ("Inspection Certificate") got under way very late, by which time the HOTL group had developed a simplified procedure for the application of non-harmonized ENs.

TRANSITIONAL TIME FROM OPTIONAL HARMONIZATION TO THE COMPLETION OF THE SINGLE EUROPEAN MARKET

The system of standard harmonization by means of individual EEC directives though functioning had been too slow in view of the fast and multiple changes of the EN standards. To implement the EC initiatives for "Completing the internal market" and for the "New approach", this system was replaced by Directive 94/9/EC with its reference to a list of standards in the Official Journal of the EU.

1982
THE B-GENERATION OF EN – PLASTICS BECOMES PRESENTABLE IN EX PROTECTION

For the first generation of EN 50014-50020, the technology of mechanical components was oriented towards metallic materials. The testing criteria for plastic materials had to eliminate any existing concerns. The spectrum of material tests was widely extended. Only application showed that certain material characteristics were often not available and had to be determined during elaborate test series. The requirements for prevention of dangerous electrostatic charges formed another significant obstacle.

These changes of EN 50014-020 were harmonized in 1984 as the so-called "B generation" (for group I: 1988), the letter B being added to the digit sequence of the certificate.

1986
DUST EXPLOSION PROTECTION: NATIONAL PRODUCT STANDARD

While the VDE standard for the apparatus of Zone 0 remained just a draft, VDE 0170/0171 Part 13 for devices of Zone 10 was published in 1986.

For Zone 11, VDE 0165 contained enough criteria to select suitable equipment from products for normal industrial applications.

1982
Commodore C64 computer enters the market

1982
European Directive 82/130/EEC (mining)

1982
ICS 1000 Modular system for process automation

1982

1983
Motorola DynaTAC 8000X, first mobile phone approved by FCC

1983
CES-plug and socket system with rotating switch – explosion protected and according CEE-Standard

1983

1984
First E-Mail in Germany

1984
Adaptation of European Directive 79/196/EEC

1985
Safety Circuit Breaker

1984/85

1988
ENCAPSULATION STANDARDIZED AS FURTHER TYPE OF PROTECTION

Before EN 50028 was published, encapsulated devices and components had been certified in Germany as special protection "s" on the basis of internal testing rules of the certification bodies. Even with EN 50028 as a synthesis of the test methods from the certification bodies in Europe, a test phase was necessary to gain experience especially with encapsulation materials.

1988
(ALMOST) THE END OF VDE 0170/0171:1.69

During integration of EN 50014-020 into the VDE- standards in 1978, the 1st of May 1988 was defined as the date up to which the parallel application of VDE 0170/0171/1.69 was still allowed. This transitional period of 10 years seemed to be sufficient, but in the end it was not enough. Shortly before the end of this period, the German DKE committee K 241 introduced a "life-supporting" measure for the equipment designed according to the national standards.

The A102 amendment for Part 1 of VDE 0170/0171:5.78 (=EN 50014) cancelled the end of the 10-year transitional period partially, with the effect from the 1st of May 1988:

For the equipment still not covered by the harmonized standards, PTB and BVS were able to issue further national Ex s certificates. For equipment approved before 01.05.1988 or type-examination tested equipment of Group I, BVS could certify further design modifications. Further applicability of VDE 0170:1.69 for mining was supported by a corresponding change of the Mining Regulation on Approval of Electrical Equipment. The most important definition for the users of explosion protected devices was the following statement of the standard:

"Transition to the new standards has been performed in terms of the European harmonization; it does not imply a change of the safety level."

It prevented a mandatory retrofitting of the installations in operation due to alleged rising of safety level by more recent standards.

1989
GERMAN UNIFICATION WITH REPLACEMENT OF THE TGL STANDARDS

After the German unification, the network of regulations and standards existing in the Federal Republic of Germany was imposed on the new “Laender" (Federal States). Only transitional rules remained for the previous TGL standards (“Technischen Normen, Guetevorschriften und Lieferbedingungen”) of the German Democratic Republic.

The Freiberg testing center – part of the Institute for Mining Safety – was privatised with temporary federal funding and is now known as IBExU.

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1989
Fall of the Berlin Wall

1990
German Reunification

1986
VDE 0170/0171 Electrical equipment for Zone 10

VDE

1986
ICS MUX: First intrinsically safe fieldbus system for hazardous locations on the ACHEMA fair

1989
EXLUX 6000: Start of the innovative lighting system for hazardous locations

1990
Ex e bi-pin lamp holder

1986-88

1989

1990

1989
EN 50021 FOR DEVICES OF ZONE 2

For Germany, the installation standard VDE 0165 was sufficient. It specified the criteria for the selection of Zone-2 equipment from "normal" industrial appliances which are "non-sparking in normal operation". However, at European level a product standard seemed to be absolutely necessary.Already in 1975 the Chairman of TC31 H. G. Riddlestone warned that "on occasion, requirements for apparatus for Zone 2 become more onerous than those for Zone 1 equipment." During preparation of EN 50021:1988, the requirements went significantly beyond those usual for VDE 0165. EN 50021 was not harmonized because the EEC Directive did not cover the apparatus of Zone 2. During revision by the IEC, concepts from the North American system with its "Division 2" classification were adopted into IEC 60079-15.

1994
ATEX AND THE ACCOMPLISHMENT OF THE SINGLE EUROPEAN MARKET

The Directive 94/9/EC drafted according to the "New approach" brought a multitude of upheavals whose implementation entailed significant efforts and costs for the manufacturers and users. Against serious doubts, the non-electrical devices and protective systems were included in the scope. Further serious changes were:

- Establishment of equipment categories for all zones
  However, there were strong reservations against establishment of an equipment category 0 by analogy with Zone 0 ("Zero? C'est rien!").
- Three equipment categories for dust explosion protection
  For the proven "two-zone" system for dust (Germany: 10 and 11; GB: Y and Z; North America: Division 1 and 2), the standardization committee had developed a three-zone system for dust mirroring the three Zones for gas. This has already been reflected through three equipment categories in spite of the fact that the three dust zones became mandatory in Europe only with the Directive 1999/92/EC. The threefold division of the equipment categories was adopted in 2007 by the IEC as the "Equipment Protection Levels" in IEC 60079-0.
- Adoption of the entire spectrum of equipment relevant for explosion-protected, such as protective systems (e.g. explosion pressure relief, explosion suppression), gas detection instruments, safety devices and combustion engines.
- The adoption of safety devices the safe function of which , for example had to ensure that no sources of ignition occur at a monitored equipment during normal operation and in case of faults, took place at a time of discussion on the adoption of quantifiable safety levels for the correspondingly evaluated risk classes and its standardization.

1992
Invention of blue LED in Japan

1991
INTRINSPAK: Safety barrier with exchangeable fuse

1992
ICS PAK: Isolators

1993
Heidrun: Big fieldbus project in the Norwegian Oil Industry

1991

1992

1993

In particular, the users of large industrial plants with safety-critical processes experienced a difficult time. The safety technology developed on the basis of long-term experience often did not allow easy and successful assessment by means of the instruments such as SIL (IEC 61508). The safety equipment relevant for explosion protection was also standardized only after intensive consultations, in separate ENs for electrical and non-electrical equipment.

– Involvement of the notified bodies for the supervision of the quality management for the product manufacturing. Manufacturers and QA certifiers had to get used to this ATEX-specific overlay to the existing QA system according to ISO 9000.

Today, one can say that the transition from optional harmonization to the accomplished Single European Market has been a success, even though there are some side effects which are not all about safety.

For example, by now there are approximately 66 notified bodies in the EU, each of them having been accredited (if at all) and notified according to different criteria. Evaluation of the professional expertise of certification bodies is the responsibility of the member states. Improvement is expected from the so-called "New regulatory framework", which led to the adoption of the new "ATEX Directive" 2014/34/EU in 2014, it is to be applied starting from 2016.

OPERATIONAL EXPLOSION PROTECTION 1999 – 2003 "USER" ATEX AND INTRODUCTION OF A HARMONIZED MINIMUM LEVEL IN OPERATIONAL EXPLOSION PROTECTION

Along with the elimination of trade barriers through the internal market in the economic sphere (it included the ATEX Directive 94/9/EC with its safety requirements for "merchandise"!), the European Union has aimed at reaching a minimum level in the social fields for all member states.

Unlike the regulations for the internal market, the individual states can go beyond their specifications in their national requirements, but they are not allowed to fall below the limits stipulated by the EU.

This applies in full to the explosion protection as part of occupational health and safety.. The Directive 1999/92/EC on the "Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres" ("User" ATEX) was

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1994
Eurotunnel under the Channel is opened

1995
Microsoft publishing Windows 95

1994
New ATEX Directive 94/9/EG

1995
USA: Change of NEC, Article 505 (Code Change): Gases and Vapours

1996
1. Meeting of Management Committee of IECEx in London

German ordinance for explosion protection (11. GSGV)

STAHL

1994
ConSig:
Control Devices

1995
New Circuit Breaker

1996
EXICOM Terminals for hazardous locations

1994

1995

1996

adopted in 1999. This directive and the associated non-binding guide of the EU commission have to a great extent the same characteristics as the EX-RL of the German Social Accident Insurance Institutions as mentioned before. One of the most important features in it is the EU-wide definition of the zones. In terms of area classification, it introduced 3 zones not only for gas but also for dust explosion hazards as it had been already discussed earlier in the standardization circles.In 2004 the IEC adopted this model in IEC 61241-10.

In Germany, this EU directive was implemented in the national law by the Ordinance on Industrial Safety and Health (Betriebssicherheitsverordnung, BetrSichV) and to a smaller extent by the Ordinance on Hazardous Materials (Gefahrstoffverordnung, GefahrStV). This also included a paradigm shift: Within previous German legal regulations, the requirements for the equipment had been interwoven with the requirements for the operation of (electric) systems in hazardous areas, now a strict separation was implemented: For explosion protection, the Ordinance for Explosion Protection (Explosionsschutzverordnung, ExVO) as the implementation of the ATEX Directive 94/9/EC was decisive for the equipment starting from 2003, whereas for the operation this decisive role was taken by the BetrSichV with the GefahrStV, also from 2003. In the course of this development, the annulment of previous legal regulations such as ElexV and VbF became necessary.Direct reference to the standards was no longer provided in the legal regulations. Important standards obtained their mandatory character from the EU Commission by way of mandated "harmonization" at the European standardization institutions CEN and CENELEC.

Explosion protection of high quality is based on correct equipment and technology as well as on correct operation - that's not a new insight! The European directives and their corresponding national legal implementations could not "re-invent" explosion protection. However, it has brought something new: All parties concerned had to deal intensively with the issues of explosion protection.

- It has drawn the attention to the aspects which have been less noticed in the past, for example the aspects of dust explosion protection, suitability of non-electric equipment for explosion protection or electrostatics as source of ignition.
- A comprehensible representation of the followed explosion protection concept and the corresponding taken measures became mandatory ("Explosion protection document").
  A small but also important detail was now mandatory use of the warning sign at all access points to a hazardous area.
- Since then, the so-called "Ex- Plant" as a whole is subject to regular inspections by appointed expert persons or institutions. (In this way Germany went beyond the European minimum requirements.)
- Role distribution and its understanding by the manufacturers, users, authorities and testing institutions had to be reconsidered and redefined.

1997
Mars Pathfinder landing successfully on the Mars

1997
EN 127-1 is adopted by CEN

1997
R. STAHL going public

1997

1998
Cameras and camera systems for hazardous locations

1998

1999
Start of the Euro as booking money

1999
European Directive 1999/92/EC

1999
IS1 Remote I/O technology by R. STAHL

1999

All of this has, no doubt, contributed to raising the awareness of safety issues not only in large companies but in particular in small and medium-sized companies and, thus, to enhancing the explosion protection in general.

SINCE 2006 TECHNICAL RULES FOR INDUSTRIAL SAFETY

In Germany, the entry into force of BetrSichV made it necessary to substantiate this overall general regulation and facilitate its application in practice. This has been achieved by the government issuing new technical rules for operational safety (Technische Regeln für Betriebssicherheit, TRBS). Important sources of information for the explosion protection are, among other things, the TRBS 2152 with different parts of it and TRBS 2153.

TRBS 2152 Part 5 is currently in the last drafting phase. This TRBS takes account of the latest developments and findings for the assessment and application of process control technology in the explosion protection.

1965 – 2014 TYPE OF PROTECTION INTRINSIC SAFETY – CONTINUOUS EXTENSION AND ADAPTATION TO THE TECHNICAL PROGRESS IN THE FIELD OF ELECTRONICS

While in 1974 many types of protection such as flameproof enclosure were considered to be extensively researched and underwent only slight adjustments in the standardization, the type of protection intrinsic safety was subject to a continuous change process from the beginning on, which has often represented a challenge not only for the manufacturers.

Even if there had been tests and certifications of equipment which could not initiate an explosion due to sparks and hot spots, intrinsic safety as the type of protection was standardized in Germany only in 1965, regarded more as a guideline. There were only the types of protection (Ex)i and (Sch)i with single fault safety and a safety factor.

EN 50020 was the first to introduce in 1977 the categories "ia" and "ib", with a footnote indicating that "ia" was suitable for Zone 0.

A constant challenge for all involved parties was and still remains the maximum transmittable power with intrinsically safe electric circuits. The users required ever longer lines for monitoring of large systems and for providing electric power to as many appliances as possible. Even for lighting purposes intrinsic safety was applied as a type of protection at an early stage. Two concepts existed for raising the power limit:

- Disconnection of the supply circuit before the interruption or short-circuit spark becomes ignition capable. This approach was published already in 1975 by Halama at the 2nd IEE conference "Electrical Safety in Hazardous Environments". The application of this concept was approved usually for category "ib" only. According to IEC 60079-11:2011 controllable semiconductors can be used for "ia" as safety shunts or, in series, for power limitation, but they cannot be used for current limitation.

A separate standard (IEC 60079-39 "Power i") is currently being drafted for a sophisticated concept of this type.

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2000
New building for
R. STAHL headquarter
in Waldenburg

2000

2001
125 years R. STAHL

2001

2002
Start of the Euro as cash

2002
European Directive
1999/92/EC – BetrSichV

2002
Cage Clamp enters
hazardous locations

2002/03

1997 – 2014
ATEX STANDARDS FOR NON-ELECTRICAL DEVICES, PROTECTIVE SYSTEMS AND MATERIAL DATA

- Supply with high-frequency electric circuits whose ignition threshold values are generally higher than with direct current. Investigations of the frequency-dependent ignition threshold values were performed at PTB already before 1981, BVS took over after 1982. The corresponding limiting values were implemented in the VDE 0848 standard. After that PTB resumed working to focus on this topic.

Primarily due to highly motivated working group members and perfect strategic management in CEN-TC 305 and its subgroups, almost the entire safety-related know-how of non-electrical explosion protection contained in e.g. EX-RL, VDI directives and investigation reports was transferred to the CEN standards. The beginning was made by the EN 1127 with the fundamentals in 1997. Actually the Official Journal of the EU lists 63 EN standards for a wide diversity of protection concepts, protective systems and substance characteristics determination.

The most important of these CEN standards will soon be published as ISO or ISO/IEC standards with worldwide applicability and, thus, can find their place in the IEC certification system. A holistic concept of explosion protection standardization ensures that ISO standards can also be created by the sub-committee 31M of IEC TC31.

A special aspect of technology transfer can be seen in some CEN standards which are only relevant for the mining industry: The specialist knowledge collected here in Germany and Europe on the firedamp protection underground has been adopted in these standards and can still be used even if the mining industry is a phase-out branch here.

2004
SolConeX:
New series of plugs
and sockets

2004

2005
Change of NEC 2005
Article 506: Dust, three Zones

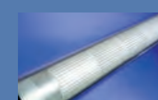
2005
Cable Glands 8160

2005

2006
First hydrogen driven
Citybusses in Berlin

2006
Technical rules for operational
Safety TRBS 2152

2006
LED light fittings
for hazardous
locations



2006-08

1994 – 2014
TWENTY YEARS OF IECEX SYSTEM

At the 5th IEE conference on explosion protection Andy Owler presented its report on the planned IEC certification system for the electrical devices for hazardous areas. The first ideas for this arose from the success of the European system with the Ex which has become worldwide the logo for high-quality explosion protection from Europe.

The aim was to create something similar on a global scale. Internationally established users (e.g. from the chemical and petrochemical industry) prefer to use the same plant technology everywhere, and manufacturers dislike going through separate certification procedures in each export country.

Therefore, the starting conditions for the IEC-Ex system (first, "IECEx scheme", analogous to the CB scheme for low-voltage equipment) have been very good and a successful development can be expected.

By now, 31 countries are taking part with a total of 45 certification bodies. Due to legal matters, the certificates usually cannot be applied directly as an "approval" in the individual countries, but have to be accepted by a national or regional IECEx certification body; however, this does not change anything about the uniform safety-related standards.

IECEx certificates are given particular importance by the recognition of the IECEx system as a model for legal rules of explosion protection by the UNECE (United Nations Economic Commission for Europe). IECEx: "Not a passport yet, but already a pass permit.", this is how the new Chairman of IEC-Ex Thorsten Arnhold (R. STAHL) summarized it.

EXPLOSION PROTECTION
IN NORTH AMERICA

In North America, explosion protection has developed historically and with regard to the standards differently from Europe and the rest of the world; this refers in particular to the installation technology and classification of the hazardous areas. The Ex Magazine discussed the American explosion protection for the first time in 1979.

Since then it has also become a recurrent subject of the Ex Magazine.

An important milestone in the approximation of the NEC (National Electrical Code) of the USA and the IEC standards for explosion protection was the modification of NEC in the year 1996: The paragraph 505 was adopted into the standard NFPA70. This paragraph allowed for the classification of gas explosion hazardous areas and for the definition of equipment requirements according to the zone system and enabled approval according to the IEC-adapted US standard (AEx). Up to that time, only classification into Class and Division had been used.

➔

2010
Apple presenting iPad – first commercial tablet computer

2009
Technical rules for operational Safety TRBS 2153

2009
Innovative fieldbus technology for hazardous locations: Fieldbus barrier

2010
Modern LED Technology: Pendant Light fittings for Zone 1

2011
CUBEx: Ex-System solutions with compact enclosure technology

2009 | 2010 | 2011

Adoption of three dust zones in the NEC followed with its 2005 version.

In Canada this approximation to IEC has progressed much further than in the USA. In Canada, most systems are nowadays classified according to the zone system and cable installation instead of lines in metal pipes (conduits) is widely used in new systems.

Due to increasing internationalization of the user industry and manufacturers of explosion protected products, harmonization is in the best interest of all parties involved. However, some traditional American manufacturers of explosion protected products see their future turnover at risk.

Leading manufacturers have nowadays products in their portfolio which can be used both in the USA and Canada and in the rest of the world, i.e. globally applicable products. It still requires multiple certification today, but it gives the internationally operating plant engineers and equipment manufacturers the chance to offer the same basic technical design worldwide without significant national modifications.

The progress of this harmonization becomes apparent by the participation of the North American experts and institutions in the IEC standardization, the IECEx system, as well as by the latest developments as regards the acceptance of IEC technology in the area of oil and gas production (offshore and onshore). This is commented on in a separate article in this Ex Magazine.

2014 TO 20.. WORLDWIDE HARMONIZATION IN EXPLOSION PROTECTION

Actually, there are only two fields which stand in the way of worldwide harmonization of explosion protection. First of all, the different nature of the North American standards, especially in the USA, and, secondly, the national and regional legal regulations for the formal conformity certification of the products. The solution of the NEC/IEC problem can only be achieved by gradual adaptation of the standards. This will take many years. The solution of the conformity assessment procedure requires legislative amendment of the corresponding legislature in the countries and regions. In Europe this is only possible by way of the EU Commission. The road to making the IEC system consistently applicable worldwide is still long, but it is worth the effort to pursue it and to continue working on both main problems from all sides, standardization organizations, legislatures, WTO, the UN and the EU, etc.

2012
Wireless interface technology for hazardous locations: Wireless Hart Gateway

2012

2013
Temporary power distribution according IEC and NEC

2013

2014
Nobel Prize for the inventors of the blue LED (Japanese)

2014
New ATEX Directive 2014/34/EU

2014
40 years Ex-Magazine

2014

The story of 40 years of explosion protection described here does not claim to be complete. Nevertheless, an attempt has been made to show significant development milestones, and all developments mentioned have found their way into the contributions and technical articles of the Ex Magazine from a wide range of points of view, supplemented with topics from the regularly organized "Ex Forums" of R. STAHL over several decades.

We wish the Ex Magazine to remain also for the next 40 years THE major professional medium in the area of explosion protection and the communication medium for experts from all involved sectors. The harmonization of the regulations and the achievement of a consistently high safety level worldwide are an important issue. We hope that it will not take another 40 years to reach this goal.

Competence and experience along with the insight on where the limits of expertise are important for maintaining a high safety level and preventing serious explosion accidents.

The continuous passing on of knowledge and updating of available and newly gained specialist knowledge are the guarantees for preserving and improving the safety level.

We call on all parties involved to continue working on it.

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MODERNISATION OF A FULL-EX ELEVATOR UNIT IN A REFINERY

BY REINHARD STAUFNER AND TOBIAS POPP

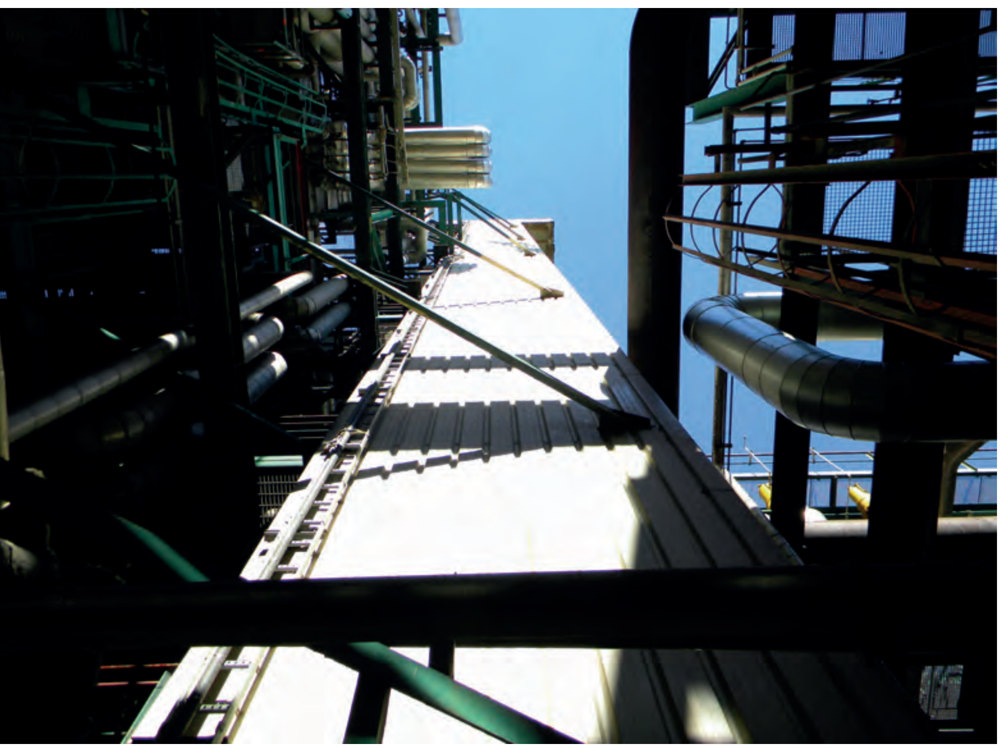

FIGURE 1
External view of elevator unit

The ThyssenKrupp Aufzugswerke GmbH is headquartered in Neuhausen/Germany (near Stuttgart Airport). The Neuhausen elevator plant is the only facility in Germany with start-to-finish production of all components and with its 1,000 employees and a production area of 48,000 sqm it is also the largest of its type in Europe.

This is where the competences in the fields of engineering and manufacturing of elevator systems and components are bundled, where innovations are developed and tested and existing components are continuously being optimised. All of which involves state-of-the-art processes as well as in-house manufacturing up to approx. 80 % in flexible segments. With a production capacity of 3,500 elevator systems per annum, over 17,500 drives and more than 30,000 elevator doors, the global export rate is 70 %. Controls and drives are one of the core competences of the company. In these fields solutions for worldwide elevator projects are developed and realised in cooperation with the corresponding country subsidiaries of ThyssenKrupp Elevator AG.

ThyssenKrupp Liften Ascenseurs n.v.-s.a. in Belgium, with over 300 employees and approx. 10,500 elevators in the service books, is part of the Business Unit CENE (Central/Eastern/Northern/Europe) which is a subsidiary of ThyssenKrupp Elevator AG.

THE TASK: TOTAL RAFFINADERIJ ANTWERP

Elevator systems are in use everywhere, from housing estates to industrial complexes. This also applies to the refinery in Belgium. The Total Raffinaderij Antwerp operates an elevator which was first commissioned in 1989. The passenger elevator, with a nominal load of 1050 kg, five stops and a vertical rise of 36.02 m, showed first signs of ageing, so that modernisation requirements were reported by the end customer Total Raffinaderij Antwerp to ThyssenKrupp Liften Ascenseurs n.v.-s.a.

A concept which meets the requirements of explosion protection was developed in close cooperation with the ThyssenKrupp elevator plant in Neuhausen. Following intensive discussions between ThyssenKrupp Liften Ascenseurs n.v.-s.a., ThyssenKrupp Aufzugswerke GmbH, R. STAHL and the Total refinery, Total Raffinaderij Antwerp ordered a solution package which mainly consisted of control, drive and door technology. The required modernisation referred to an elevator in a potentially explosive area and with a small and narrow drive space above the elevator shaft. The following figure illustrates the drive space in its original condition and the resulting challenges for this project.

FIGURE 2A shows the outdated door drive, **FIGURE 2B** the operating and display elements, and **FIGURE 2C** the drive space from the inside, in specific the unit's controls.

The entire plant is located in Zone 2 according to ATEX. Zone 2 are locations where hazardous explosive atmosphere as a mixture of air and flammable gases, vapours, or mists is normally not present or only occasionally under normal operating conditions. This fact had already to be taken into account during the quotation phase and in specific during the construction phase. Due to the outdated assemblies the following were to be modernised in detail:

- elevator control
- operating and display elements in the elevator cabin
- operating and display elements at access points
- drive
- elevator car door
- shaft doors

Numerous solutions were discussed between ThyssenKrupp Aufzugswerke, the end customer Total Raffinaderij Antwerp and R. STAHL, not only to ensure explosion protection but also to address the extremely limited space available in the drive chamber.

Possible approaches discussed by the team included extending the drive chamber with a steel carrier design, a redesign of the existing Ex de controls or a new control room in container design with steel struts at approx. 10 metres above road level.

After balancing all the pros and cons of the various Ex control concepts and the economic framework of the operator, the parties finally agreed on an electro-technical design using Ex pz (pressurised enclosure). Here, the load and automation sections were realised via two main control cabinets (R. STAHL Series 8625). Two additional ATEX approved air conditioning units were installed as active cooling of the switching cabinet was specifically required for the frequency converter with recovery unit (ThyssenKrupp CPI50R) due to the required driving power of 11 kW. The cabinets were operated via an Ex de release assembly (R. STAHL Series 8265) and are functionally linked. The control package was completed by an Ex de UPS (uninterruptible power supply) system (R. STAHL UPS) for emergency lighting and a voice link.

This solution variant was applied for the first time in modernisation by ThyssenKrupp Aufzugswerke. Furthermore, the clutch of the old drive was adapted and a new Siemens Ex motor installed to the existing drive.

The following were replaced outside the drive chamber:

- 5 shaft doors of type T3S1 in Ex design via one-to-one replacement
- 1 elevator car door of type T3K1 in Ex design
- Door frames of elevator car door, door leaves and portal in stainless steel, grain 220

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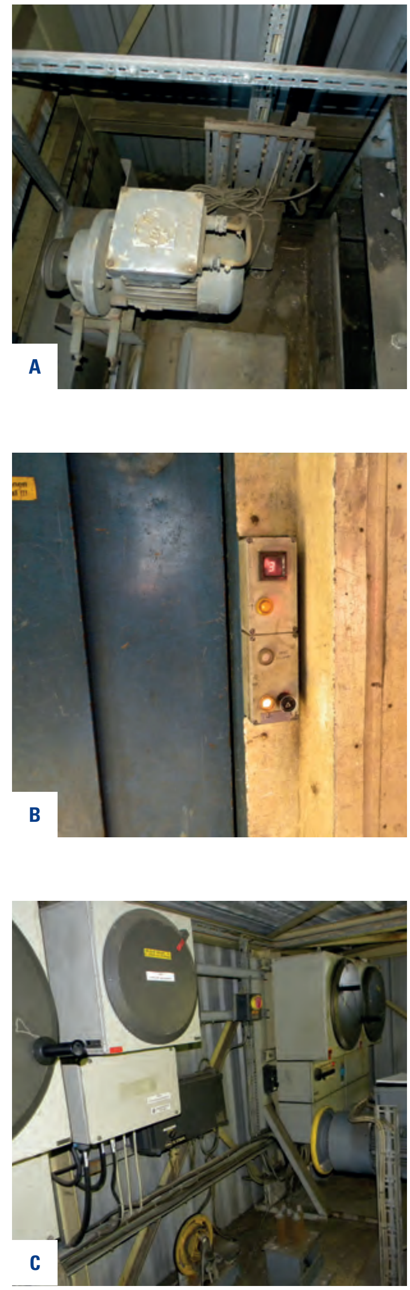


FIGURE 2
Elevator in its original condition (complete view)

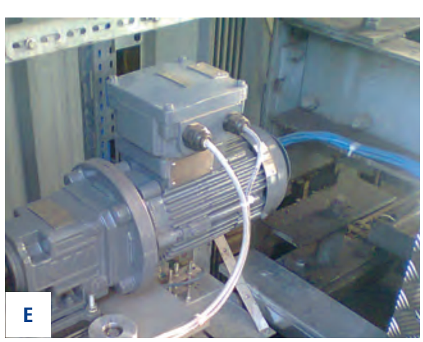
FIGURE 3
Following modernisation


A


B


C


D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In addition, a door frame was designed for the elevator car to install the new T3K1 elevator car door to the old elevator car. The Ex door drive was set slightly higher on this door frame and installed as special version.

The following figure shows the elevator unit at the end customer Total Raffinaderij Antwerp following modernisation.

FIGURE 3A shows the unchanged drive chamber from the outside, **FIGURE 3B** the motor in Ex design, **FIGURE 3C** a new operating station, **FIGURE 3D** one of the new Ex pz control cabinets and **FIGURE 3E** the door drive.

ThyssenKrupp Aufzugswerke are acknowledged experts in elevator controls and elevator drives. In most cases elevator modernisation consists of customised solutions arrived at in close dialogue between customers and suppliers. Many years of cooperation between ThyssenKrupp Aufzugswerke and R. STAHL resulted in developing the perfect solution for the end customer's project. For a safe and comfortable ride in elevators.

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SECOND REGIONAL IECEX CONFERENCE 2014 IN KUALA LUMPUR/MALAYSIA

BY THORSTEN ARNHOLD

FIGURE 1
IECEx-Conference 2014 in Kuala Lumpur/Malaysia

On February 19 and 20, 2014, the Second Regional Conference of the IECEx System took place at the Convention Centre in the capital city of Malaysia, Kuala Lumpur. With more than 250 participants from more than 20 countries, predominantly South-east Asia, this event was able to build on the huge success of the first conference, which took place in Dubai in 2012.

The great importance the IECEx system enjoys in this thriving region was emphasized by the fact that the Deputy Minister for Science, Technology and Innovation Dr. Abu Bakar Bin Mohamad Diah welcomed the participants, organizers and speakers in person. In his very entertaining speech, the high-ranking politician emphasized the great importance of the process industry for Malaysia. In particular, the extraction and processing of oil and natural gas plays an outstanding role for the economy of the country. Since health and safety regulations at the workplace are also given high priority, there is great interest in IEC standardization in the area of explosion protection and in the IECEx system.

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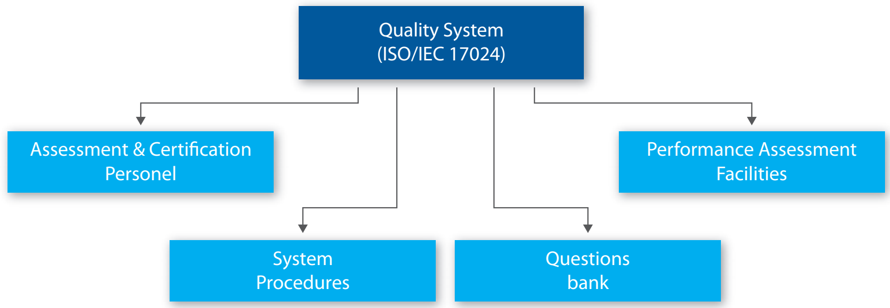

FIGURE 2
Overview of the IECEx system

This statement was corroborated by Mr Mohamad Faudzi Mohd. Yasir, the President of the National Committee of the IECEx, in his introductory talk.

The aim of the Malaysian government is to prepare the national economy for international competition while opting for technologically demanding topics and for strengthening its innovative power. It is planned to develop Malaysia over the years to come into a leading economic power within the region. It is hoped that this will clearly raise the overall prosperity in the country.

Adopting international standards and active participation in their design is expected on the one hand to satisfy the increased security needs of the population and on the other to enable the participation of domestic companies in international competition.

For hazardous areas, a clear decision was made in favour of direct national implementation of the IEC standards of the 60079 and 80079 series while in the area of conformity assessment the IECEx system was selected. It is hoped that the latter will provide, among other things:

- Lower costs for tests and certification on the part of the manufacturers,
- Shorter product development times,
- International recognition and comparability of the conformity assessment process,
- Easy and secure availability of the certificates via the IECEx online database and
- Globally active confidence in the certified products and services.

As provided by the IECEx statutes, for national implementation of the IECEx structures, a national committee (Management Committee for IECEx Scheme Accreditation – ExMC) was established in April 2009 and recognized by the Malaysian National IEC Committee. All parties and organizations involved (e.g. Ministry of Labour, section Health and Safety, fire brigade and emergency service protection, the Navy Department, certification bodies, industrial associations, a.o.) are members of this committee.

For the years to come, the aim is to make all hazardous areas in the country fully compliant with common standards (IEC standards harmonized with Malaysian right - MS/IEC 60079 ff.) and thus to convert Malaysia into a "Centre of Excellence in the Ex field".

In accordance with this claim, the interest of the conference participants was particularly high in the following talks of the international speakers.

First, the newly elected IECEx chairman, Prof. Thorsten Arnhold, presented an overview of the entire conformity assessment system. He stated that in order to guarantee the safety of a technical product, the complete service life must be considered. This statement applies, of course, in particular to such safety-critical applications as the use in hazardous areas. It is not sufficient to merely consider the development and production of a new product and prove its suitability and safety through tests on prototypes. Other important factors are the proper selection of suitable products, the correct installation, and comprehensive testing of the installed products before their initial start-up. Once the system is running, more or less rigorous environmental and operating conditions act on the installed equipment and lead to wear from day 1. This is why in order to guarantee a sufficiently high safety level, regular tests and maintenance must be carried out and, if repairs are required, they have to be performed properly.

Many investigations into explosion accidents have brought to light that sufficient competence of all employees is a decisive factor in guaranteeing a high safety level in hazardous systems. While all previous national and regional certification systems for explosion-protected equipment have merely dealt with the new product, the IECEx system, following its latest extension last year, covers the complete service life (**FIGURE 2**). Over the last 6 years, further certification schemes for repair workshops and for the expertise and experience of persons employed in Ex areas have been added to the Certified Equipment Scheme already proven over many years. Since 2013 IECEx has also been offering certification of service providers for:

- Equipment selection an planning,
- Installation and initial inspection of the systems and
- Testing and maintenance while the system is in operation.

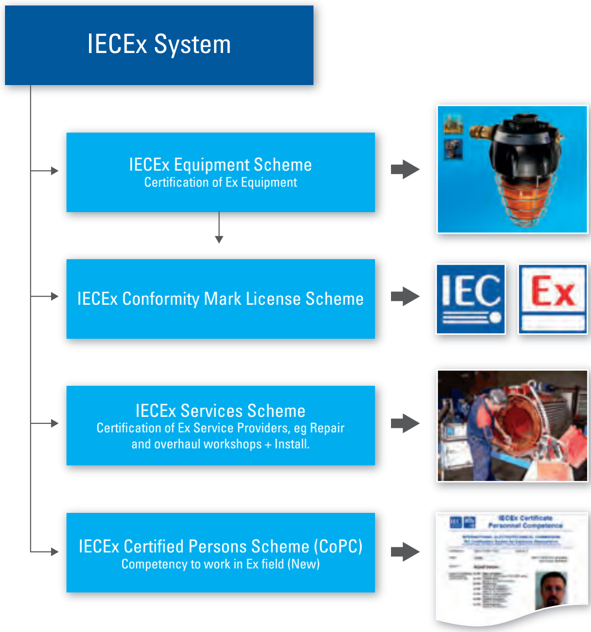

FIGURE 3
Modules of the IECEx Scheme

The basic standards for these certifications are IEC 60079 Part 14, Part 17 and Part 19.

Finally, at the present time, work is underway on a certification scheme for service providers for whom a zone classification on the basis of IEC 60079 Part 10 is to be performed.

This comprehensive consideration of the entire service life and the wide international distribution (31 countries are already members and mutually recognize the test report when issuing national certificates) gives the IECEx system two remarkable unique selling points in the international certification landscape.

Next a further unique selling point was explained by Mark Amos, an employee of the IECEx administration office: the online database for all valid certificates and licences. This database, which is readily available via the IECEx homepage (**WWW.IECEX.COM**), makes it very easy to search for

- Certification bodies and test laboratories
- Manufacturers of approved Ex equipment
- Certified competent professionals for work in hazardous areas
- and suitable certified service providers.

The user has also further options:

- checking the marking of Ex equipment quickly and easily
- consulting details of certificates
- identifying the qualification of professionals
- finding out the installation requirements of Ex equipment.

The search and selection options are quite varied. Thus, certificates can be searched according to the year of issue, the certificate number, the certificate holder (manufacturer, competent person or service provider), company headquarters, according to country, notified bodies, and different combinations of the criteria mentioned. This makes for a genuinely transparent system, which can be considered a very effective instrument for creating security and confidence.

Avoiding the appearance of faulty certificates or even falsifications is, of course, of great importance. Thus, every user can be certain that a certificate that does not appear in the database is not valid. The online version must always be seen as the valid master and hard copies are merely uncontrolled documents.

To facilitate access to the database even further and guarantee flexibility to the user, since 2013 a mobile app for free download has been available.

In his talk, Mr Basori HJ Selamat explained how his Malaysian test institute SIRIM QAS International has implemented the IECEx system for certification of competent persons. Before, various operator representatives had already addressed the importance of building up expert knowledge of explosion protection in Malaysia. The Malaysian notified body SIRIM was created in 1975 by the merger of the Standard Institute of Malaysia (SIM) and the National Institute for Scientific and Industrial Research (NISIR). Since 1996 the organization has been owned by the Malaysian government and managed by the Ministry of Finance.

The subsidiary organization SIRIM QAS International has been offering certification and test services since 1970. In addition, the organisation has more than 700 employees and more than 9000 certificates. Its activity is not limited to the local market, but includes also customers in all of Asia, Australia and Europe.

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POSITION/JOB/FUNCTION	SUGGESTED UNIT OF COMPETENCE	
Plant Manager	Unit Ex 001	Apply basic principles of protection in explosive atmospheres
Safety Manager	Unit Ex 001 Unit Ex 002	Apply basic principles of protection in explosive atmospheres Perform classification of hazardous areas
Site Supervisor (Elec. or Inst.)	Unit Ex 001 Unit Ex 003 Unix Ex 004 Unit Ex 008	Apply basic principles of protection in explosive atmospheres Install explosion-protected equipment and wiring systems Maintain equipment in explosive atmospheres Perform detailed inspection of electrical installations in or associated with explosive atmospheres
Technician (Elec. or Inst.)	Unit Ex 001 Unit Ex 003 Unit Ex 004 Unit Ex 007	Apply basic principles of protection in explosive atmospheres Install explosion-protected equipment and wiring systems Maintain equipment in explosive atmospheres Perform visual and close inspection of electrical installations in or associated with explosive atmospheres

TABLE 1
Certification of personal competence: Function and Units of Competence

Since March 2011 SIRIM QAS International has been accredited as a certification organization for IECEx 03 – IECEx Certified Service Facility Scheme and since June 2013 it has had the approval IECEx 05 – IECEx Certification of Personnel Competencies (CoPC) Scheme.

FIGURE 3 contains an overview of the key points of the certification system for professional competence in explosion protection at SIRIM.

The guideline for the quality system is ISO/IEC 17024: Conformity assessment - General requirements of the bodies that certify persons. Further important prerequisites that had to be developed and documented have been the procedures of personnel certification. The inspectors were selected and qualified, and a database containing examination questions had to be compiled. Finally workplaces for examining the candidates' practical knowledge were set up. In addition to the already mentioned ISO/IEC 17024, the specification for correct implementation came from the relevant IECEx documents IECEx 05, and OD 501 to OD 504.

The certification of competent professionals for jobs in hazardous areas was started in December 2013, following a preparation time of several months.

The approval, testing and certification procedure takes about two months. After the candidate has submitted his application and his personal written qualification and experience certificates, these documents are checked. If this check returns a positive result, the knowledge and competences are reviewed in writing. This is followed by carrying out practical examination tasks. The entire procedure can take place over several dates within approx. two weeks.

The test result is then counterchecked once again by an independent expert and, if this step also returns a positive result, the certificate will be made available online by the IECEx administration office.

The start of the new certification scheme can be regarded as successful for the certification body, but as mixed for the test individuals: During the first few months, 64 people were examined (predominantly for Ex Unit 001). Of these, 18 (which corresponds to 28%) did not pass the exam! This can be seen as an indicator for the necessity of such an assessment scheme. After all, even the unsuccessful individuals were professionals who used to work in Ex areas and had been co-responsible for safety without having sufficient expert knowledge! A good indication is the classification of the recommended competences as a function of the person's responsibility in the system (**TABLE 1**).

To summarize, the importance of the CoPC scheme was related to the following essential aspects:

- It provides operators with independent and strong evidence that the certified persons have the knowledge and skills to apply the relevant IEC standards correctly and to execute the safety-critical jobs in Ex areas correctly.
- It assists the operators in strengthening the safety awareness among the employees, suppliers and external service providers, and
- It helps preserve safety factors of the complete installed technology in Ex areas, since the operating and maintenance personnel have the required understanding and competences.

The IECEx Certified Service Facility Scheme was discussed by John S. Allen. For many years, he has been working for a large repair company in the U.K. and, additionally, been an active member of IECEx. Since 2013 he has chaired the IECEx committee for the certification of competent persons (ExPCC).

In his speech, he too, first discussed the necessity of a qualified and independent certificate which certifies that repair workshops are capable of performing proper maintenance on Ex equipment and, in doing so, comply with IEC 60079 Part 19.

This standard first of all clearly states that the operator of explosion-protected equipment is responsible for selecting a suitable repair workshop. Every responsible person on the part of the operators must therefore first ask the question whether he is at all capable of selecting the right service provider or whether he has the required number of equipment, professionals, repair and testing technology, documentation, etc., for carrying out such repairs himself.
On the part of the repair workshops, they must prove and demonstrate that they are indeed capable of performing repairs in such a way that following the repair, the equipment fulfils the corresponding requirements of the type of protection standards. This also requires the abovementioned prerequisites.

Of course, you could also dismiss the entire problematic by saying that in case of doubt, it would be best not to repair at all but to replace faulty products right away with new products or to have the repair work performed by the manufacturer. From a cost-effective point of view, however, the latter is only rarely worthwhile due to expensive customized products such as motors, transformers, control units, pumps and compressors. Nor is it in most cases possible to have the part repaired by the manufacturer, as many manufacturers are not prepared for repair processes of this type because no repair organization is provided in their value-added system. Frequently manufacturers are also located too far away to make an expensive transport of the defective equipment to and from the manufacturer worthwhile.

Often, the only remaining alternative is to have the repair done by an independent repair workshop nearby. This is where the IECEx Certification Scheme for service providers (Service Facilities) comes into play.

The basis for the certification of repair workshops is a set of valid IECEx documents:

- IECEx 01
  IECEx Basic Rules
- IECEx 03-05
  IECEx Certified Service Facility Scheme Rules W– Repair
- OD 313-5
  Certified Service Facility Assessment Procedures – Repair
- OD 314-5
  Quality Management system Requirements – Repair
- OD 315-5
  IECEx Service Facility Scheme Additional Requirements – Repair

Certified repair workshops must meet the following prerequisites:

- Documented quality management systems according to OD315-5,
- regulated and documented repair processes,
- effective monitoring of this process,
- effective systems for monitoring subcontractors,
- effective systems for selection and monitoring of measuring and testing equipment with traceability to international standards,
- suitable premises, equipment and availability of machines for carrying out the repair and, last but not least,
- suitable personnel having the required competences for proper execution of the repairs.

An additional requirement of IEC60079 Part 19 is that at least one executive is named and effective as responsible person for proper execution of the repair. To this end, this employee must not only have the required competences but also the required powers.

During the two-day conference, a large number of other speeches about a wide range of standardization and certification topics were given. Aspects of practical implementation of the standards for zone classification and for installation and maintenance were also addressed.

During the conference breaks and in the final panel discussion, many topics were addressed. Overall the keen interest of all participants showed the great importance the IEC standards on explosion protection and the IECEx system have in Southeast Asia.

For the organizers and speakers, this has been a confirmation of their efforts to spread the international certification system.

This is why the next IECEx conference is already in the planning stage: It will be held from 22 to 23 April 2015 in Gdansk/Poland and will be aimed at interested operators, manufacturers and notified bodies, in particular from Eastern Europe and Scandinavia.

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FUNCTIONAL SAFETY OF ELECTRICAL INSTALLATIONS IN INDUSTRIAL PLANTS

BY OTTO WALCH

Trouble-free and safe operation of industrial systems is of great importance, not only for the safety of the systems and of the personnel, but also for the economic success of a company. Adverse effects on operation can be manifold, for example:

- **Malfunctions or failures in a process control system**
- **Power failure**
- **Overheating of machine bearings**
- **Dangerous rise of temperature in a container**
- **Failure of an emergency off switch**

To avoid any consequential damage, the term "Functional safety" was introduced in electrical engineering.

Functional safety is subject to a probability consideration for each individual device or for a complete loop, as errors cannot be determined in advance. They depend not only on the quality of the devices and systems, but also on the conditions of use, on operating conditions and on environmental conditions. This is why, based on the large number of details to be observed for complying with functional safety, application-specific guidelines and standards have been drawn up, the most important are listed in the following:

DIN EN 61508
Functional safety of electrical/electronic/programmable electronic safety-related systems; Part 1-7

DIN EN 61511
Functional safety – Safety Instrumented Systems for the process industry sector; Parts 1-3

DIN EN ISO 13849
Safety of machinery – Safety-related parts of control systems; Parts 1-3

DIN EN 62061
Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems

DIN EN 50495
Safety devices required for the safe functioning of equipment with respect to explosion risks

In addition to the standards listed here, there are also further standards and essays on the topic "Use of safety equipment". As examples, guidelines for the use of safety equipment in vehicles, in nuclear power plants or in railway applications are mentioned.

SAFETY INTEGRITY LEVEL	PROBABILITY OF FAILURE ON DEMAND PER YEAR PFD	PROBABILITY OF A DANGEROUS FAILURE PER HOUR (H 1) PFH	RISK REDUCTION BY A FACTOR OF
SIL 4	$>= 10^{-5}$	$\geq 10^{-9}$ to $< 10^{-8}$	100.000 to 10.000
SIL 3	. $>=10^{-4}$ to $< 10^{-3}$	$\geq 10^{-8}$ to $< 10^{-7}$	10.000 to 1.000
SIL 2	$>=10^{-3}$ to $< 10^{-2}$	$\geq 10^{-7}$ to $< 10^{-6}$	1.000 to 100
SIL 1	$>=10^{-2}$ to $< 10^{-1}$	$\geq 10^{-6}$ to $< 10^{-5}$	100 to 10

TABELLE 1
Classification of the SIL values according to probability and frequency of dangerous failures

DIN EN 61508

This standard is a basic standard for safety considerations. This is where the SIL classification comes from. SIL stands for Safety Integrity Level.

This standard defines the SIL value and subdivides it into four levels. The determination of the SIL value specified here applies to the complete safety system. This is why for the determination of the SIL the data for all components of the safety loop is composed of must be available.

Examples for increasing functional safety include redundant components or circuits and limit switches that respond in case of malfunctions.

The standard 61511 applies in particular to the users of safety systems in the process industry.

Since this essay discusses mainly the determination of the SIL value, the standard DIN EN 61511 will only be mentioned briefly. An important factor is that, in addition to systematic and random faults, the fault tolerance must also be considered, for which measures have been specified as to how the safety equipment must be designed and used. These measures must always be taken simultaneously.

The term "Proven in Use" will also be discussed. This term is defined in the standard DIN EN 61508. For many components used in safety applications, the specification of DIN EN 61508 was not yet known or had not been observed when these components were developed. Nor were the values required for the SIL calculation known. To be able to use these components despite this, another standard, DIN EN 61511, allows for this option, and the operator must take responsibility accordingly. The NAMUR (Normen-Ausschuss Mess- und Regelungstechnik, Committee for Standardization in Measurement and Control Technology) recommendation NE 130, in which these specifications of DIN EN 61511 have been incorporated in detail, should be mentioned in this context.

The safety equipment is classified (evaluation of SIL value) according to **TABLE 1**.

As a differentiating factor for which value is to be used, the demand rate is used. In Low Demand Mode (demand for safety equipment maximum once a year), the PFD value must be used, but in High Demand or Continuous Mode the PFH value must be used. For the classification to determine the SIL value of a safety device the following tables have to be considered as well. To do so, the safety device must be first classified as type A or type B. The definition for type A states that the malfunction must be defined for all components used. Safety devices for which the malfunction has not been defined as type A (**TABLE 2**) or whose function depends on software must be declared as type B (**TABLE 3**). The corresponding table must then be used depending on this definition.

The term Safe Failure Fraction (SFF) is a value that shows how many of the failures, relative to the total number of failures, are to be considered safe failures.

$$SFF = 1 - \frac{\text{undetected, dangerous failures}}{\text{all failures}}$$

Example: at an SFF ≥ 99 % more than 99 % of the failures must be declared as safe failures and, vice versa, a maximum of 1 % of all failures may be undiscovered dangerous.

The Hardware Fault Tolerance (HFT), also known as redundancy, indicates how many safety functions are in use simultaneously. Example: if two safety functions are in use simultaneously (HFT = 1), the safety function is still guaranteed if one of the two fails.

This standard provides two options of determining safety characteristic values for a safety device. One is development using the complete service life of the safety device. The other option is to determine the values according to an FMEDA (Failure Modes, Effects and Diagnostic Analysis) for already existing products used in safety applications.

The service life of a safety device starts with the concept and ends, via the hazard assessment, the determination of the safety requirements, the development, the implementation, and the operation of the safety systems, with the decommissioning.

This shows that this standard applies predominantly to the manufacturers of safety systems or their components.

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SAFE FAILURE FRACTION (SFF)	HARDWARE FAULT TOLERANCE (HFT)		
	0	1	2
< 60%	SIL 1	SIL 2	SIL 3
60% -< 90%	SIL 2	SIL 3	SIL 4
90% -< 99%	SIL 3	SIL 4	SIL 4
≥ 99%	SIL 3	SIL 4	SIL 4

TABLE 2
SIL values as a function of SFF and HFT for type A

SAFE FAILURE FRACTION (SFF)	HARDWARE FAULT TOLERANCE		
	0	1	2
< 60%	Not permitted	SIL 1	SIL 2
60% -< 90%	SIL 1	SIL 2	SIL 3
90% -< 99%	SIL 2	SIL 3	SIL 4
≥ 99%	SIL 3	SIL 4	SIL 4

TABLE 3
SIL values as a function of SFF and HFT for type B

Furthermore, the following values of the safety circuit must be defined:
_ clear safety function
_ safe status of the system (Fail-Safe)
_ dangerous status of the system (Fail Dangerous)

An example of the Fail-Safe status is switching off the electrical energy of an explosion-protected electrical apparatus, which in case of failure would result in an increased surface temperature.

An example of the Fail Dangerous status is when a level monitoring unit does not switch off the medium supply in case of failure, resulting in overfilling of the container to be monitored.
All other values listed in the standard will not be considered in this document.

DIN EN 62061

This standard applies to the machine industry. Here, too, the SIL value is used in the same way as in the standard series DIN EN 61508.

The service life in this standard is defined in the same way as in DIN EN 61508, but in this standard it ends with the modification of the components used. In DIN EN 61508 everything, including the decommissioning of the safety equipment, is regarded as service life.

This standard discusses in detail which SIL value must be used for the application in question. This specification is based on risk assessment. It determines which SIL value the safety equipment must fulfil as a function of the "extent of the damage" and "probability of the damage to occur".

The extent of the damage, also referred to as severity of the damage, is subdivided into the following 4 levels:

1 – reversible
2 – reversible by medical treatment
3 – hardly reversible or easily irreversible
4 – very severe or irreversible (death, …)

The class of probability or the probability of the damage to occur is the sum of the following 3 individual levels:
_ Avoidance (P) having the values 1-5 (how can the damage be avoided)
_ Probability (W) having the values 1-5 (with which probability will the fault occur) and
_ Frequency / duration having the values 2-5 (how often or for how long will the fault occur) which can adopt a value of between 4 and 15.

These values can then be used to determine the required SIL value from **TABLE 4**.

➔

SEVERITY	CLASS 3 TO 4	5 TO 7	8 TO 10	11 TO 13	14 TO 15
4	SIL2	SIL 2	SIL 2	SIL 3	SIL 3
3	.	Other measures	SIL 1	SIL 2	SIL 3
2			Other measures	SIL 1	SIL 2
1				Other measures	SIL 1

TABLE 4
SIL values determined via risk assessment

PL	SIL
a	no SIL Wert
b	SIL 1
c	SIL 2
d	SIL 3
e	SIL 4

TABLE 5
Comparison of SIL and PL

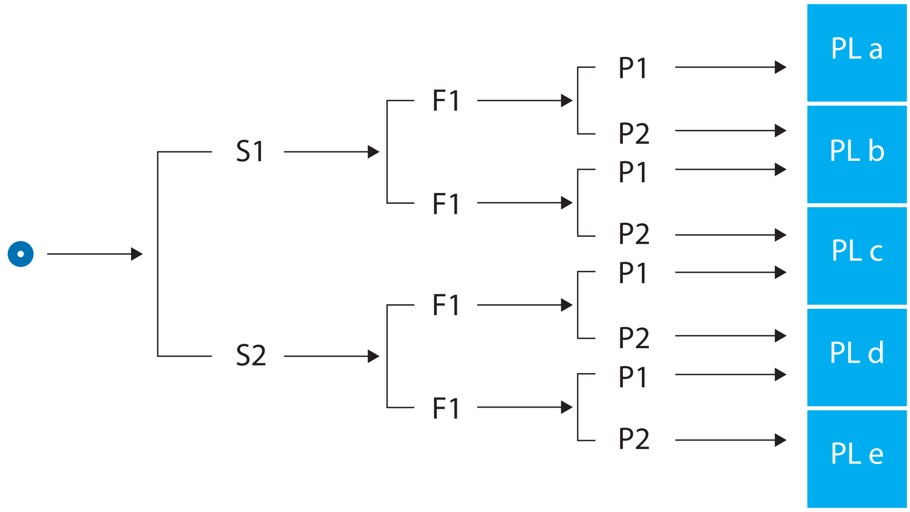

FIGURE 1
Risk graph for determining the PL value

DIN EN ISO 13849

This standard also applies to the machine industry. The main difference to DIN EN 61508 is that instead of the SIL value the Performance Level (PL), which is divided into 5 levels, is used.
In this standard, the relationship between the Performance Level (PL) and Safety Integrity Level (SIL) is listed in tabular form.

TABLE 5 shows that the Performance Level c can correspond to a SIL 2 value (or also vice versa). However, in order to be able to apply this table, all specifications of the other standard must be taken into consideration. Provided that the existing values were determined in compliance with the standard, when SIL is converted into PL, the requirements of DIN EN 13849 and, when PL is converted into SIL, those of DIN EN 61508 must be additionally met.

This standard defines the risk graph and its use. To determine the required PL for the application using this risk graph (**FIGURE 1**), the following values must be predefined.

S: Severity of the injury:
S1 = light, reversible injuries
S2 = serious injury, death
F: Frequency or duration of exposure to the hazard
F1 = rarely to less frequently and/or less frequently or time of exposure to the hazard is short,
F2 = frequently to permanently and/or time of exposure to the hazard is long
P: Possibility to avoid the hazard or limit the damage
P1 = possible under certain conditions
P2 = hardly possible

All these values must then be entered in the risk graph, in order to determine the required PL value.

Both the risk graph and the risk assessment described in the standard DIN EN 62061 must be performed by the user of the safety device.

DIN EN 50495

In this standard, the two different safety considerations, the calculation via the probability (functional safety), and the predefined failure consideration for explosion protection are applied. The scope of this standard is to use safety monitoring designed in accordance with functional safety to monitor a potential ignition source, for example at the bearing of a machine, and thus to have the complete application certified for use in the corresponding Zone. The term Zone is defined in the standard DIN EN 60079-0 and states how high the risk of the existing explosive atmosphere is. In Zone 0, the explosive atmosphere can be present continuously or for long periods, but in Zone 2 only rarely and for a short period. This standard is not a new type of protection (see DIN EN 60079-0). It is intended to be used for monitoring an ignition source that cannot be monitored using the traditional types of protection by means of a safety monitoring unit using the corresponding specifications.
The exact requirements are listed in **TABLE 6.**
To give an example: An Ex device has been certified for Zone 2, but safety is only guaranteed for use in this zone. To meet the requirements of certification for Zone 1, safety must also be guaranteed under defined failure conditions. Monitoring the behaviour under failure conditions can be achieved by means of a safety device which has a fault tolerance of 0 and a SIL value of 1.

HAZARDOUS AREA	ZONE 0			ZONE 1		ZONE 2
EUC Fault tolerance	2	1	0	1	0	0
Safety device Fault tolerance SIL-Value	- -	0 SIL 1	1 SIL 2	- -	0 SIL 1	- -
Combined system Category	1			2		3

TABLE 6
Requirements of safety devices according to the SIL qualification or according to the category of the equipment in accordance with the explosion protection regulations

The complete combination Equipment Under Control (EUC) and the safety device must meet the Ex requirements of the desired category and be certified by a Notified Body.

At present, this standard is only valid as an European Standard. There is currently work underway to make this standard an IEC standard.

CONCLUSION

The present essay shows that functional safety plays an important role in safe and trouble-free operation of industrial systems.
In this context for Hazardous Locations there must be full compliance with the relevant equipment and installation standards and regulations (in Europe the ATEX directive).

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NE130 (NAMUR)
"Prior use"-Devices for Safety Instrumented Systems and simplified SIL Calculation

"Power-i" = INTRINSIC SAFETY 2.0?

BY ANDRÉ FRITSCH AND MANFRED KAISER

FIGURE 1
Is Power-i the new, more powerful intrinsic safety of the future?

The type of protection "Intrinsic Safety" has been rapidly established since its development at the beginning of the 20th century. Today this type of protection has become standard in most process automation systems and is frequently used due to its advantages such as "live working" (hot work) or live switch-on/switch-off (hot swap). However, almost as old as "Intrinsic Safety" is the desire to have more energy available than "Intrinsic Safety" can deliver. The type of protection "Intrinsic Safety" is based on the concept of energy limitation, meaning that energy or power, current and voltage are limited, even under faulty conditions, to values that cannot result in the ignition of an explosive atmosphere. The still admissible, that is, intrinsically safe, power under these conditions typically has a maximum of 2-3 watts. This is quite sufficient for many applications in process automation, but some application users and manufacturers would like to have more power available.

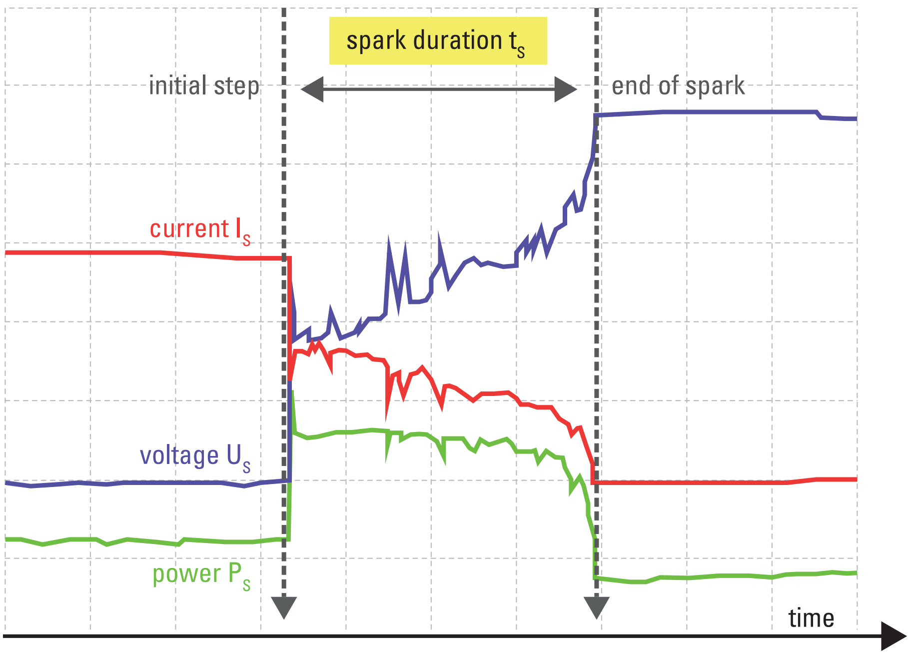

FIGURE 2
Typical example of the break spark curve with a linearly limited current source (Graphic: B1 from TS60079-39)

This is why manufacturers have always worked on raising "Intrinsic Safety" to higher levels and making more power available for special applications (e.g. STAHL Ex i power supply). Since the beginning of the 21st century, several working groups under the leadership of the PTB (German Federal Technical Institute) have been working on such concepts at Braunschweig/Germany. One possible way to achieve this was designed and published in 2003 under the name of c-i-s, an acronym for "continuous interruption supply". Apart from the PTB, various manufacturers, including R. STAHL, were involved in this concept. The functioning principle of c-i-s is such that short circuiting the electrical output power during an exactly defined cyclic time interval guarantees the type of protection intrinsic safety. This is based on the finding that an ignition spark requires a certain time for a few µs to be able to build up a sufficient amount of ignition energy. This cyclic supply allows quasi-intrinsically-safe powers of up to 20 watts to be achieved at supply voltages of up to 100 V. Unfortunately, this cyclic supply concept is the precise reason why c-i-s has never made it to a marketable product. The cyclic DC voltage results in a high interference emission and in EMC problems, leading to impaired data transmission on the lines [2].

The basic idea of c-i-s served later on as a basis for another concept, which today is known both under the trade name DART (Dynamic Arc Recognition und Termination) and under "Power-i". First introduced under the heading "Dynamically acting intrinsically safe circuits", but then renamed to "Dynamically acting electrical circuits", due to the clear differences from the traditional "Intrinsic Safety", the PTB and Pepperl + Fuchs developed the original concept further in a joint research project [3]. Instead of switching off the energy cyclically as in the case of c-i-s, the new concept is based on the timely detection of the formation of an ignition spark and of a very quick switch-off of the energy-supplying components. Whereas Pepperl + Fuchs had the resulting circuit technology patented under the trade name of DART "Dynamic Arc Recognition and Termination" and assigns licences for this, PTB established a new working group for integrating the technology into standardization at IEC level, which is an unavoidable and important process for worldwide acceptance. The working title still in existence today is "Power-i".

In contrast to the known "Intrinsic Safety" according to IEC 60079-11, in which the source allows a continuous, limited release of energy, Power-i uses a dynamic concept. The difference can be illustrated very well by looking at the physical relationships between energy and power: to ignite an explosive mixture, energy is required in different amounts depending on the gas/air mixture. Energy (W) is formed or by the power (P) supplied over the time (t) as a formula: $W = P \bullet t$. Whereas the traditional intrinsic safety limits the power P or voltage and current ($P = U \bullet I$) by means of appropriate safeguarding elements, such as Zener diodes and resistors, to such an extent that no ignition occurs even at continuously available power, Power-i reduces the time factor t and thus the energy that can be released via a spark. So much for the physical theory, how does this work in practice? It is known, among other things, from working on c-i-s that opening an electric circuit will result in an abrupt increase in voltage accompanied by the corresponding lowering of the current. The voltage of this initial step depends on the material combination of the contact materials and is, for example, approx. 10 V for the materials tungsten and cadmium used in the spark test apparatus. However, this voltage does not contribute to the release of energy by the spark., The energy is only released after the voltage above the spark increases continuously up to the maximum possi-

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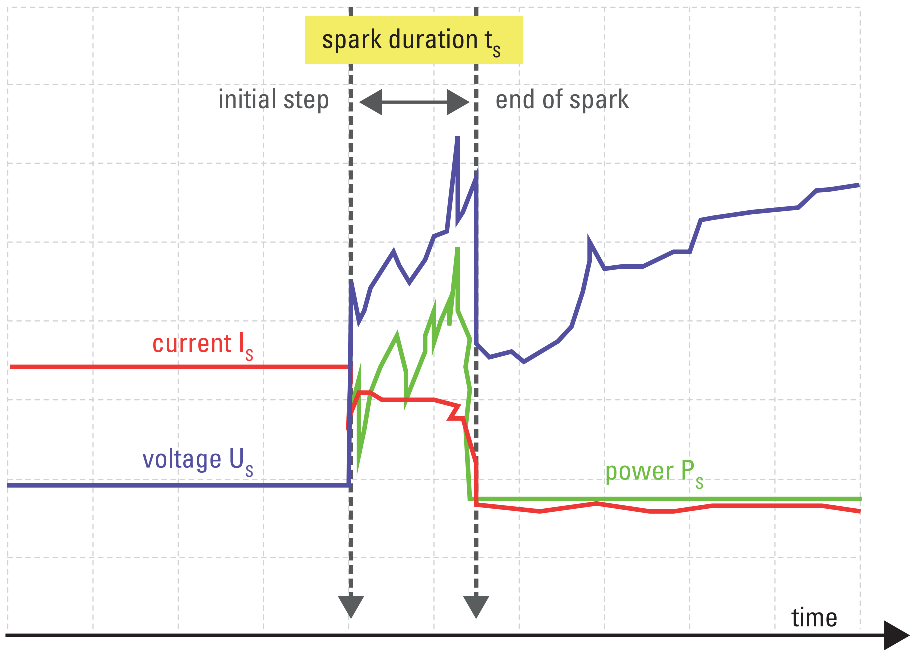

FIGURE 3
Example of a typical break spark curve, limited by a Power-i source (Graphic: B2 from TS60079-39)

ble open-circuit voltage at a rise speed of ≤ 1 V/µs, whereas the current continues to decrease until the spark finally is quenched . This is why the energy that builds up will exceed the critical limit value, at which the gas mixture can be ignited, only after the time period referred to as "initial phase" has expired.

This already shows the basic requirements for Power-i: first the initial spark formation must be reliably detected, without "confusing" it, for example, with a level change of the useful signal or with interference signals from the environment. While the initial phase is still going on, that is, before reaching the critical released amount of energy, the energy source must be switched off or limited to "normal" Ex i values according to IEC 60079-11, as long as the fault state continues. This takes place within a time period of 2 to 10 µs.

Naturally, you have to keep in mind that depending on the structure of the electrical circuit, it is quite possible that several energy sources are present. Energy stored in the connecting cable are unavoidable, which is why basically differential capacitances and inductances have to be expected. If the load(s) connected also can store energy, it must, of course, also be taken into account. Thus, similar to the known proof "Intrinsic Safety", the following system components must be considered in a Power-i circuit: the Power-i source, all loads and the connecting cable. The concept described above clearly shows that the proof for a Power-i circuit can become much more complex than the usual proof of "Intrinsic Safety" and that in particular the cable plays a significantly larger part in the calculation – an important topic in standardization work. The protection level achievable with Power-i is the same as the device protection level b (EPL b – Equipment Protection Level) or Category 2 and is thus suitable for devices and electrical circuits in Zone 1 or 2. For the rather infrequent applications in Zone 0, that is, for EPL or Category 1, the traditional intrinsic safety "ia" can still be used. Unfortunately, this restriction has an adverse effect on its use in the USA. In Division 1 according to NEC 500 (NEC National Electrical Code), only ia-suitable protection concepts can presently be used.

Do we need all of this? Is the conventional "Intrinsic Safety" not sufficiently complex as it is? Basically, Power-i allows the known advantages of intrinsic safety, that is, for example, replacement of the field devices operated in an explosive atmosphere to be combined with clearly higher supply voltages. Thus, depending on the implementation of the Power-i concept, for example, up to 50 W can be achieved with a supply of 40 V DC and a cable length of 100 m for gas group IIB (e.g. ethylene). Since the cable length is a critical factor in the design of the Power-i circuit, the available Power-is reduced to approx. 12 W if, for example, a 1000-m line is required, which is still much more than in traditional "Intrinsic Safety". Basically, even larger distances could be covered, but this has to be analyzed in the future in more detail and is currently not a part of this investigation.

Apart from technical feasibility, international standardization must also be taken into account. No type of protection could be established internationally, if it is not treated accordingly in an IEC or EN standard. This is why the "Power-i" working group under the leadership of the PTB and with the participation of various manufacturing companies, including R. STAHL, was established, in order to incorporate the concept in an international standard. A full treatment of the complex Power-i topic and consistent standardization at IEC level is extremely time-consuming. This is why the decision was made first to limit the discussion to a few clearly defined applications on the basis of an IEC Technical Specification (IEC-TS). The resulting IEC-TS 60079-39 standard "Explosive atmospheres - Part 39: Intrinsically Safe Systems with electronically controlled spark duration limitation" is

TYPE OF EXPLOSIVE ATMOSPHERE	ZONE	DURATION OF THE PRESENCE OF AN EXPLOSIVE ATMOSPHERE	EQUIPMENT CATEGORY	EQUIPMENT PROTECTION LEVEL EPL
Gases, vapours, mists	0	constantly, over a long period, permanently	1G	Ga
	1	occasionally	2G	Gb
	2	rarely	3G	Gc
Dusts	20	constantly, over a long period, permanently	1D	Da
	21	occasionally	2D	Db
	22	rarely	3D	Dc

TABLE 1
Zone division and assignment of devices according to their category or their equipment protection level EPL

then to be incorporated in suitable IEC and EN standards. Based on present knowledge, the publication of the IEC-TS 60079-39 can be expected in July 2015. In addition to the description of the basic explosion protection concept and the definition of the special device requirements, the document will also contain suitable installation guidelines and the varification procedure already mentioned above for the connection of Power-i devices. Since Power-i circuits must satisfy the same basic requirements with respect to limitation of voltage, current and galvanic isolation as conventional intrinsically safe circuits, Power-i circuits must be treated in the same way as conventional intrinsically safe circuits. This means that the current national installation regulations, for example, according to IEC 60079-14, in particular chapter 12, must be followed.

Power-i for the connection of the connected field devices via a cable is done through the so-called "Assessment Factors (AF)" and the "Response Time", which for Power-i devices must be determined and certified by the manufacturer using the method described in TS 60079-39. To simplify the assessment of connections of Power-i devices from different manufacturers, TS 60079-39 has introduced the division of devices into voltage and current classes, for which it specifies the permissible combinations for the system response time as a function of the gas group and of the requested protection level. In this case, Power-i devices must also be labelled as such and and their assessment factors and response times (for Power-i sources) must be given. However, due to the fact that the cables has a significant effect on the Power-i circuit, it must be analyzed in more detail. It is easy to understand that this begins with the required larger copper cross-sections for the higher current intensities, in order to minimize voltage drops and avoid impermissible heating of the cable (observe temperature class!) Moreover, the achievable cable lengths would be drastically limited if in the cable analysis, as is customary in traditional "Intrinsic Safety", "worst-case" cable parameters (according to IEC 60079-14, chapter 12.2.2.2: maximum assumable cable parameters 200 pF/m and 1 µH/m) is taken into account. This is a method frequently used in practice when technical data of the cables or installations containing different cable segments and distribution boxes are missing.

The TS specifies a calculation based on cable parameters and, alternatively, a measuring method for determining the parameters "Response Time" and "Assessment Factor" required for the Power-i system analysis. As a measurement of the cable parameters of the installation is near to impossible in practice, the only remaining practical option is to use the calculation method, for which, however, the cable parameters L', C' and R' must be known.

In the absence of the TS 60079-39, a further obstacle is the evaluation method for obtaining an EC Type Examination Certificate from the Notified Bodies. Neither the available ignition limiting curves from IEC 60079-11 Annex A nor software tools, such as the ISpark developed by PTB or the traditional spark test apparatus, are suitable for detecting a Power-i circuit. Nevertheless, even today a solution with EC Type Examination Certificate according to ATEX and an IEC Approval derived from Power-i is already available in the form of the Pepperl + Fuchs DART fieldbus. The system certificate according to DIN EN 60079-25 "Explosive atmospheres – Part 25: Intrinsically safe systems" serves as the basis and allows for safe use in a precisely specified and closed fieldbus system containing the components listed in the certificate. However, the specifications and classifications in the Power-i TS that are being drawn up still differ from the existing DART solution in certain aspects, and are noticeable in DART, for example, through the absence of the assessment factors and response times.

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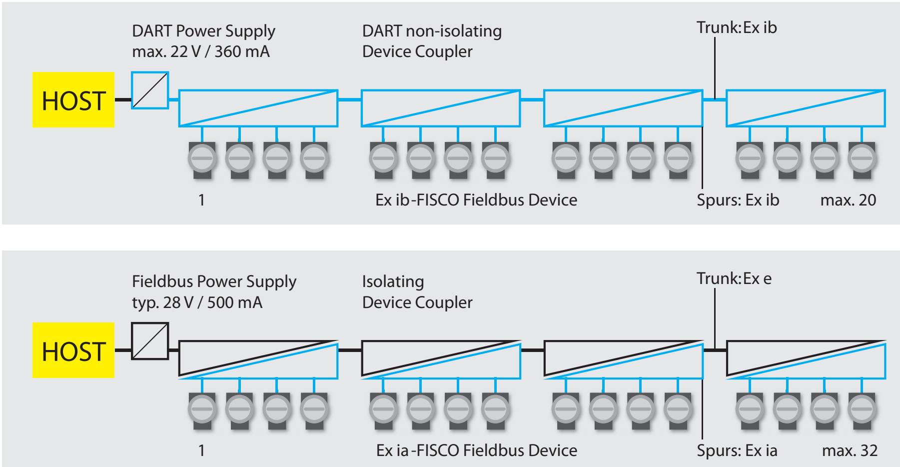

FIGURE 5
Comparison of fieldbus installations with DART and the High Power Trunk

This concludes the theory and the current progress of work in standardization. What about the applicability of Power-i in practice and what are the new and extended options when applying the concept? At a first glance, it is most welcome to "finally" have more power available for intrinsically safe applications. What comes to mind then are the more complex field devices with increased energy demand, which previously had been made suitable by other types of protection, such as "flameproof encapsulation Ex d" for Zone 1. Examples include solenoid valves, flowmeters, analytical apparatuses, but also motors, signal transducers, operator terminals, etc. For intrinsically safe fieldbuses such as the PROFIBUS PA or Foundation fieldbus H1, a higher supply power seems to make sense, in order to be able to operate more users per segment.

However, it must be kept in mind that a higher supply power or the associated current has an effect on equipment and cabling. More power in the field device results in higher power dissipation and thus in more heating. In order to avoid ignition of a hot surface in this case, other protective measures are necessary, such as flameproof encapsulation, which would turn the Power-i application on its head. It must also be taken into account that a higher current results in higher voltage drops on the cable. Thus, any already laid cables of 1 mm² or 1,5 mm² would no longer be sufficient and would have to be replaced with 2,5 mm² or even 4 mm² – a cost factor not to be underestimated. At the present time, manufacturers of field devices apparently see few applications for the Power-i versions of their products. Field devices in which the so-called hot swap plays an important role, for example for regular calibrations, are for the most part already available in the type of protection "Intrinsic Safety" and have proven themselves in use for a long time. Non-intrinsically safe devices can be, if required, disconnected from the circuit without problems using special connectors or disconnecting devices – which can be done at a much lower price than a new development based on Power-i. Thus, it must be feared that the selection of available Power-i field devices will be limited at least over the next few years. Moreover, some users point out that as part of the current energy-saving measures "Intrinsic Safety" as it is in its most "ecological type of protection" will become more important and the development of Power-i will become a counterproductive process. Unfortunately, Power-i does not get more users on fieldbuses, nor does it supply more energy. The fieldbus physics and in particular the performance of the host systems and the requested cycle times limit the devices currently to typically 12 (FF H1) or 24 (PA) devices per segment. Due to the branched structure of fieldbus segments and the cable lengths required in practice of up to 1.000 m, even Power-i cannot supply much more energy. For example, the solution available on the market based on the DART technology presented above provides only 22.5 V at 360 mA, whereas the High Power Trunk concept of intrinsically safe fieldbus devices connected to the non-intrinsically-safe main line via galvanically isolated Ex i couplers [4] typically provides 28 V and 500 mA, not to mention the fact that the users do not even find a second source on the market these days.

Keyword "User" – which advantages and applications does the user see in Power-i? On this topic, manufacturers have already carried out various customer surveys and workshops. Thus, last year R. STAHL carried out a workshop over several days with the participation of end-users and the PTB, in which the Power-i concept was presented and discussed and potential applications were investigated. The numerous discussions and ideas showed that Power-i cannot be considered a replacement technology for "Intrinsic Safety" and that the number of sensible applications is also limited. Although various potential applications were identified, they are either rather rare, that is, probably unattractive for new developments by the manufacturers, or a dream for the future, such as a new 2-wire fieldbus based on Power-i Ethernet. This is aggravated by the fact that a quasi-intrinsically-safe 100-Mbit or even Gigabit Ethernet with its clearly higher bandwidth could be desirable for future networks in process systems, but the high data rate – that is, very rapid voltage fluctuations – rather counteracts the Power-i concept, as shown at the beginning. Whether Power-i is suitable for this or whether it would be better to rely on already available solutions, such as inherently safe fibre-optic cables ("ex op is" according to IEC 60079-28 "Explosive atmospheres - Part 28: Protection of equipment and transmission systems using optical radiation" [5]), remains to be seen.

FIGURE 6
Remote I/O IS1+ with powerful intrinsically safe system structure [6]

To summarize, it can be said that Power-i is an interesting addition to traditional "Intrinsic Safety" , but is unlikely to take over from it in the foreseeable future. The discussions currently held in the Standardization Committee at IEC level do not indicate a quick propagation of the technology, even more so because potential users show a lot of reluctance. At the moment, it looks like a good solution for which we still have to find an advantageous application. However, as part of new automation concepts, such as those discussed at the Industrie 4.0, it is possible that new applications for Power-i can be found. Accordingly, manufacturers need to continue providing the types of protection that are best and most effective for application and user – Power-i will be another option to choose from.

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25 years Remote I/O

THE "NEW" ATEX DIRECTIVE 2014/34/EG

BY FRANK LIENESCH

FIGURE 1
EU buildings in Brussel

The requirements of explosion protected equipment and protective systems have been specified for approx. 20 years by the Directive 94/9/EC, also referred to as the ATEX Directive. The ATEX Directive establishes the basic safety and health requirements for the design and construction of equipment intended for use in potentially explosive atmospheres and the required conformity assessment procedures.

The basic idea behind the ATEX Directive is that of the "New Approach", which regulates free trade within the European Union with the main objective of eliminating trade barriers. The "New Approach" principles have been implemented over the years for various products [1]. This has led, however, to the introduction of different language and process regulations, some of which were adjusted to the products, resulting in inconsistencies during the drawing-up process of the directive.

For unification, the Commission has used the New Legislative Framework (NLF) and the associated (EC) Regulation No. 765/2008 to regulate the definitions, the accreditation of notified bodies and the market surveillance at European level [2]. Since accreditation is an important instrument for checking the competence of Conformity Assessment Bodies, it should also be used for notification purposes. To guarantee effective access to information for market surveillance purposes, the information required for determining all valid legal acts of the Union should be available in a single EU declaration of conformity. This can be an act consisting of relevant individual declarations of conformity.

The New Legislative Framework also includes the (EC) Decision No. 768/2008, which formulates the common legal framework for the marketing of products [3]. The definitions, CE marking and the notified body requirements are regulated accordingly. In Germany the decision was implemented by means of the Product Safety Act (Produktsicherheitsgesetz / ProdSG).

The Alignment Package of the New Legislative Framework was an attempt to adjust nine harmonization regulations to the Decision 768/2008/EC. These also include the ATEX Directive, which was passed by the European Parliament and Council and had received the number 2014/34/EU [4]. For its implementation in Germany, the 11th Amendment to the Product Safety Act will be adjusted in the future.

The new directive is a general revision of the ATEX Guideline. The structure of the revision is to correspond to the structure of the machinery directive. This is why as a first step the existing text must be assigned to the respective articles and appendices, as a result of which the structure can undergo a fundamental change.

The Commission's principle was that this should not result in fundamental technical changes, which is why Annex II was not changed. Nevertheless, the formal changes have had certain effects, which will be outlined below point-by-point.

In chapter I, Article 1, of the directive, under Scope the term "products" is also extended to components intended for installation in equipment and protective systems. This has made necessary certain reformulations, which have to be taken into account when read.

According to Article 2 "Definitions", "making available on the market" means any supply of a product for distribution, consumption or use on the Union market in the course of a commercial activity, whether in return for payment or free of charge. In particular, the term "Use" shows the responsibility for self-production.

Article 3 defines making available on the market and putting into service. Products may be made available on the market and put into service only if, when properly installed and maintained and used in accordance with their intended use, they comply with this Directive.

Chapter 2 regulates the obligations of economic operators. According to Article 6, persons also become manufacturers when they use the products for their own purposes. Article 6 requires the EU declaration of conformity, the affixing of the CE marking and the specific marking of explosion protection for products. This is not forseen for components, but the manufacturer shall draw up a written attestation of conformity. Article 8 describesd the obligations of the importer. He must guarantee that the manufacturer has fulfilled all obligations. The importer must give his name and postal address and is responsible for corrective measures in case of non-conformity. The importer (but also dealer) becomes a manufacturer if the product is traded under his name or if the product is impaired in its conformity.

In Article 13 (Conformity assessment procedures), paragraph 5, the competent authorities may, on a duly justified request, authorise placing on the market and putting into service in the territory of the Member State concerned with the products other than components in respect of which the procedures referred to in paragraphs 1, 2 and 4 have not been applied and the use of which is in the interests of protection.

The EU declaration of conformity according to Article 14 requests for products that are subject to more than one Union act each of which requires an EU declaration of conformity that a single EU declaration of conformity shall be drawn up with respect to all such Union acts. The EU declaration of conformity shall have the model structure set out in Annex X. In particular, the relevant harmonised standards or other technical specifications used for the relevant conformity assessment procedures make a statement on the safety assessment. The EU declaration conformity shall be translated into the languages required by the Member State in which the product is placed or made available on the market.

Chapter 4, Article 21, defines in detail the requirements relating to notified bodies, in order to achieve a harmonisation of the requirements in the Member States. Chapter 5, Articles 34 to 37, deals with the union market surveillance, the control of products entering the Union market and the Union safeguard procedure. Article 37 mentions possible formal non-conformities.

The transitional provisions in chapter 6 establish that certificates issued under Directive 94/9/EC shall be valid under this Directive. Finally, a transitional period of 2 years is established.

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INTERACTION BETWEEN MACHINERY DIRECTIVE AND ATEX DIRECTIVE

BY URSULA AICH AND FRANK LIENESCH

The minimum requirements with regard to explosion protection in production facilities are defined in Directive 1999/92/EC for the EU. They are transposed in Germany in the Ordinance on Hazardous Substances (GefStoffV) and Ordinance on Industrial Safety and Health (BetrSichV) [1, 2]. A general harmonization in production facilities is not intended in the European legislation because the individual Member States want to define the level of protection with regard to this issue themselves. However, there are minimum requirements in certain areas, which can then be extended by the Member States. A German particularity is that work equipment ("Ex installations") is also subject to the requirements as specified in the Ordinance on Industrial Safety and Health with regard to operating installations subject to mandatory inspection. Machinery and equipment subject to European single market legislation, such as Machinery Directive (2006/42/EC) and ATEX Directive (94/9/EC), are used in these installations [1, 3]. While the ATEX Directive requires a notified body to be consulted for equipment used in certain potentially explosive atmospheres, the Machinery Directive normally assumes the individual responsibility of the manufacturer. In addition, complex systems in potentially explosive atmospheres also include mounting on the operator's facilities, which have to be evaluated in terms of safety in the operator's explosion protection document. The separation of the different legal areas is sometimes based on the different opinions of the responsible persons, who often follow pragmatic considerations.

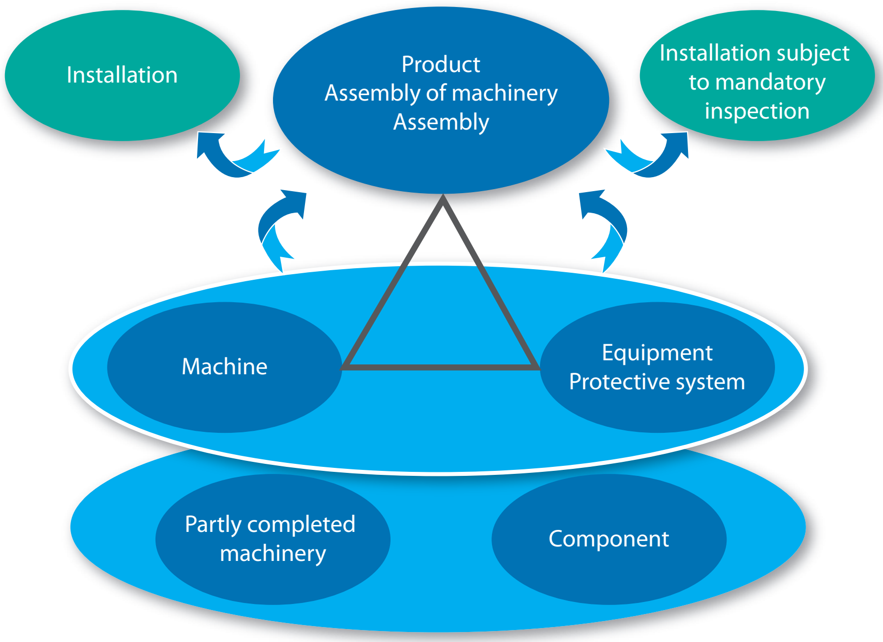

FIGURE 1
Comparison of terms

COMPARISON OF TERMS

The Machinery Directive and the ATEX Directive are subject to the "new approach" and regulate placing products on the market. They are transposed in Germany in the Product Safety Act (ProdSG) and the 9th and 11th Ordinance on Product Safety (ProdSV) [3]. As a basis for discussion, the terms of the scopes of the Directives will be compared in the first step.

Within the context of ATEX Directive, "products" means equipment, protective systems and in the future, after harmonizing the New Legislative Framework (NLF), also components. "Equipment", whether it be electrical or non-electrical, means machines, apparatus or devices which, separately or jointly, are intended for the processing of material and which have their own potential sources of ignition. Therefore, the Directive 94/9/EC only specifies the general extent of equipment. In ATEX guidelines , the term "assembly" is used for "combined equipment". It is not defined in the Directive. An assembly is the combination of pieces of equipment and components by a responsible person (manufacturer) to form a single functional unit. When being placed on the market or during commissioning, it has to be checked by means of an ignition risk assessment of the assembly whether new ignition risks are produced after assembly. As a result, the conformity assessment procedures have then to be carried out for electrical equipment or non-electrical (mechanical) equipment. If no new ignition risks are produced, the assembly may be put on the market without further conformity assessment.

Generally, the manufacturer could launch these pieces of equipment separately, each with its own EC Declaration of Conformity. However, if the manufacturer launches the equipment as an assembly, the formal question of how the Declaration of Conformity of this product will look is raised. At the same time, equipment and assemblies may also be machinery in the context of the Machinery Directive.

In terms of Machinery Directive, however, "products" means machinery and partly completed machinery. When these definitions of the two Directives are contrasted, a similar structure becomes apparent (**FIGURE 1**). Machinery and equipment as well as partly completed machinery and component seem to be formally defined in the same way. For partly completed machinery and components, conformity assessment procedures are still required for the finished product. The result of a combination is, on the one hand, machinery or assemblies of machinery, and on the other hand, equipment or an assembly.

Assemblies of machinery are defined in article 2 of the Machinery Directive (article 2, letter a), fourth indent). An interpretation paper of the German Federal Ministry of Labour and Social Affairs (BMAS) [4] further specifies the definition of "assemblies of machinery" for Germany. The explanation of how machinery or parts of machinery interact in production contexts with safety-related units is good help. Therefore, the term "assemblies of machinery" does not necssarily comprise a complete industrial installation; the installation may also be subdivided into individual assemblies of machinery.

According to the Ordinance on Industrial Safety and Health [2], an installation subject to mandatory inspection in this context is an installation in potentially explosive atmosphere that is or includes equipment, protective systems and safety, controlling and regulating devices in terms of the ATEX Directive.

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EXPLOSION PROTECTION AS DEFINED IN THE MACHINERY DIRECTIVE

Annex I Number 1.5.7. of the Machinery Directive 2006/42/EC regulates hazards due to explosions.

Quotation: "Machinery must be designed and constructed in such a way as to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery. Machinery must comply, as far as the risk of explosion due to its use in a potentially explosive atmosphere is concerned, with the provisions of the specific Community Directives."

This means for manufacturers that they have to take into account both the Machinery Directive and the ATEX Directive. In the "Guide to the application of the Machinery Directive", it is specified that machinery in potentially explosive atmospheres is subject to the ATEX Directive. Therefore, the ATEX Directive does not apply to machinery with an explosive atmosphere in its interior or non-explosive conditions for the complete machinery. Equipment (electrical or non-electrical) incorporated inside the machinery, which complies with the requirements of the ATEX Directive, can be used according to the Guide to application of the Machinery Directive(§ 91). These comments with regard to the Machinery Directive can be understood as meaning that the manufacturer of the machinery may use ATEX equipment manufactured by another company and correctly put on the market without renewing the conformity assessment. Another note is included in § 228. This article requires – in conformity with Directive 94/9/EC and its guidelines - compliance with the ATEX Directive for all equipment in terms of Directive 94/9/EC used within the machine in areas with potentially explosive atmospheres. This includes not only technical but also formal requirements.

The use of electrical ATEX equipment is considered non-problematic because it is already available on the market as a correctly marketed product according to Directive 94/9/EC. In contrast, an evaluation of the non-electrical (mechanical) equipment is sometimes very problematic, e.g. mechanically moved parts inside machines and their ignition risks. This concerns, for example, the interior of cleaning systems with solvents or transport devices in which a potentially explosive atmosphere is continuously present or present for long periods.
Consequently, different procedures in the market can be observed:

Manufacturer 1 determines during risk assessment that a potentially explosive atmosphere will be continuously present or present for long periods inside the installation (Zone 0). Therefore, the manufacturer requests a notified body to check the mechanical equipment built in the installation according to the requirements of Directive 94/9/EC.

Manufacturer 2 has the same initial situation. However, he considers that the inspection by a notified body is not required because the mechanical equipment moves with a circumferential speed of less than 1 m/s and therefore, there is not any potential ignition risk. This saves the cost for inspection by a notified body.
To avoid risk of explosion, the common approach used for explosion protection according to Directive 99/92/EC is explained in the "Guide to the application of the Machinery Directive":

1. Prevention of the formation of explosive atmospheres
2. Avoid ignition sources
3. Mitigation of the detrimental effects of an explosion

In the Machinery Directive, however, the involvement of a notified body in the conformity assessment procedures is not required for areas within machinery where a potentially explosive atmosphere may exist.

CONFORMITY ASSESSMENT PROCEDURES ACCORDING TO ATEX DIRECTIVE

In contrast to the Machinery Directive, the ATEX Directive requires a strictly graded procedure for conformity assessment, which can be derived from the hazard potential. The general division can be explained using equipment of Group II, Category 2G, which is used in Zone 1 (**FIGURE 2**).

The possible requirement of involvement of a notified body is of basic importance for the manufacturer. Electrical equipment of Group II, Category 2G, requires an EC Type Examination Certificate and, additionally, an audit of the manufacturer's QA system by a notified body. In contrast, ATEX Directive requires for non-electrical (mechanical) equipment of Group II, Category 2, filing of the documentation and the module "internal control of production" without notification by a notified body. This procedure generally means lower costs and less time delay for the manufacturer. On the other hand, manufacturers involve a notified body without it being legally required as marketing arguments state a higher safety or alleged legal requirement. In particular for assemblies, one can see a heterogeneous implementation of the ATEX Directive on the market, leading to "unfair" statements by the manufacturers.

The situation for Categories 1G and 1D, used in Zones 0 and 20, is undisputable and requires involvement of a notified body. For Category 3, to be used in Zones 2 and 22, ATEX Directive prohibits involvement of a notified body. However, certification bodies issue certificates in particular for electrical equipment. In this case, they may not act as a notified body and may not issue an EC Type Examination Certificate.

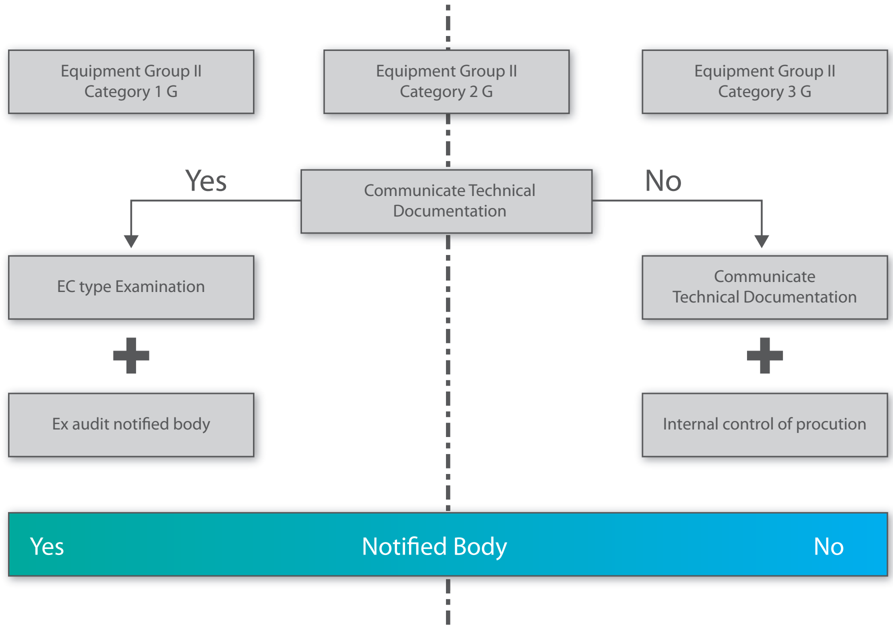

FIGURE 2
Conformity assessment procedures acc. to ATEX Directive for equipment of Group II

STATEMENTS OF THE ATEX GUIDELINES

The ATEX guidelines clarify that products in which a potentially explosive atmosphere may exist are not subject to the scope of the Directive as a whole. However, machinery or equipment that produces a potentially explosive atmosphere externally during operation, are subject to the ATEX Directive. Entry and exit points of the process have to be considered.

Therefore, the ATEX guidelines point out that the Zone classification by the manufacturer is not intended within machinery; instead, the manufacturer has to define the requirements for Ex equipment by means of a risk assessment. Electrical and non-electrical Ex equipment used in the potentially explosive atmosphere within machinery has to comply with the Category requirements of the ATEX Directive: with it, requirements of the Machinery Directive as stated in Annex I Number 1.5.7 are also complied with.
Mounting of conform equipment (this does not include components) on the operator's premises is not subject to the ATEX Directive but has to comply with regulations on installation as specified in Directive 99/92/EC, i.e. Ordinance on Industrial Safety and Health in Germany. The operator is obligated to carry out a risk assessment and is responsible for proper operation. The same combination of equipment can also be put on the market by the manufacturer as an assembly. Mounting by the manufacturer with a mounting certificate issued by the manufacturer is not included in the ATEX Directive nor in product safety legislation. In this case, supplier and customer have to clearly agree who is responsible for the combination of the conform equipment.

We use fictitious examples to clarify this issue:

Example 1

The first example is an enclosed machine with a potentially explosive atmosphere in its interior, which is installed in a non-explosive area. This means, that the ATEX Directive does not apply for the machinery as a whole.

The Machinery Directive specifies that the ATEX Directive does not apply within the machinery but that the built-in equipment has to fulfill the requirements of the Directive. A Zone concept by the manufacturer within machinery is not intended by Directive 99/92/EC; instead, the manufacturer carries out a risk assessment and defines the requirements for the equipment in the interior.

The Ex equipment to be built in can be purchased. Then, the conformity assessment procedures have already been carried out by the supplier. However, if the manufacturer produces the equipment internally, it has to comply with the requirements of the ATEX Directive, i.e. the conformity assessment procedures have to be carried out. The manufacturer's Declaration of Conformity is issued without reference to the ATEX Directive. The operating instructions to be observed with regard to the Ex equipment have to be documented in the manual. There will not be any Ex marking outside the machinery. The equipment built in the machinery has to be marked in conformity with Directive 94/9/EC. Often, this marking is missing for mechanical equipment produced by the manufacturer, while purchased electrical equipment usually is correctly marked.

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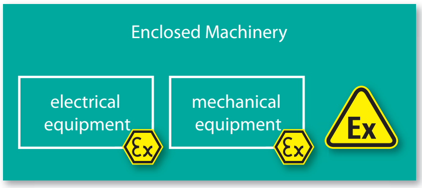

FIGURE 3
Example 1: Enclosed machinery with interior areas with potentially explosive atmosphere

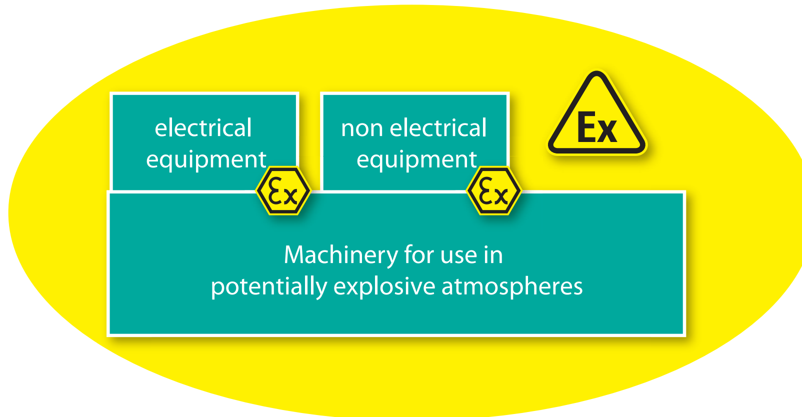

FIGURE 4
Example 2: Machinery for use in potentially explosive atmospheres

Example 2

The second example is an enclosed machine without a potentially explosive atmosphere in its interior, but which is installed in a potentially explosive atmosphere. The Category for the machinery will be specified according to the operator's Zone classification. The manufacturer carries out risk assessment with regard to potential ignition sources; purchases conform equipment or manufacture it themselves. Depending on the equipment used, it has to be specified for the assembly which conformity assessment procedures of the ATEX Directive will be carried out. The machinery is marked with the explosion protection symbol.

The EC Declaration of Conformity covers the ATEX Directive, the Machinery Directive and all other applicable Directives. The manufacturer of the machinery has to specify in the operating instructions the use of its machinery in potentially explosive atmospheres. The focus is always on the possible requirement of involvement of a notified body. For example, the manufacturer of the machinery needs to observe that the conformity assessment procedures are required for electrical components of Category 2 used in electrical equipment.

Example 3

In examples 1 and 2, the procedures are shown for enclosed machinery with areas in which an explosive mixture is present and, on the other hand, for enclosed machinery to be used in potentially explosive atmospheres. A considerably more frequent version is machinery with areas in which a potentially explosive atmosphere is present, which have a connection point to the environment. These connection points are, amongst others, exhaust air systems that extract potentially explosive atmospheres from the inside of the machine or doors/flaps that are required for loading or maintenance of a machine.

Machinery in potentially explosive atmospheres are subject to the ATEX Directive. The ATEX guidelines specify that equipment (i.e. also assemblies) with potentially explosive atmospheres in its interior (e.g. containers) that also produce potentially explosive atmospheres on the outside are subject to Directive 94/9/EC. By means of risk assessment, the manufacturer of the machinery defines the requirements for the equipment, which is purchased or manufactured in-house and for which, consequently, conformity assessment procedures in conformity with ATEX Directive have to be carried out.

The connection point has to be sufficiently defined so that the effects of the potentially explosive atmosphere in the interior to the external environment of the machinery can be evaluated in terms of safety. The operator, as the purchaser of the machinery, must be able to carry out the Zone classification in the environment of the machinery based on the manufacturer's information in the operating instructions and using the safety-relevant examination of its place of installation while considering other ambient conditions. The transition from interior of the machinery to external environment is the context, so that machinery has to comply with the ATEX Directive at the connection points to areas with potentially explosive atmospheres.

Example 4

Assemblies of machinery with potentially explosive atmospheres or work equipment or an installation subject to mandatory inspection may consist of a large number of machinery and partly completed machinery or equipment and components. Therefore, a strictly homogenous approach is not possible, and can already be assumed based on the examples stated. In the context of Machinery Directive and ATEX Directive, the manufacturer is responsible for putting on the market assemblies of machinery or an assembly, while the operator is responsible for mounting an installation subject to mandatory inspection. When mounting work equipment or an installation subject to mandatory inspection, it must always to be considered that the operator will be considered the manufacturer of self-produced machinery. With the upcoming amendment of law, the regulation on self-production will also be clarified in the ATEX Directive.

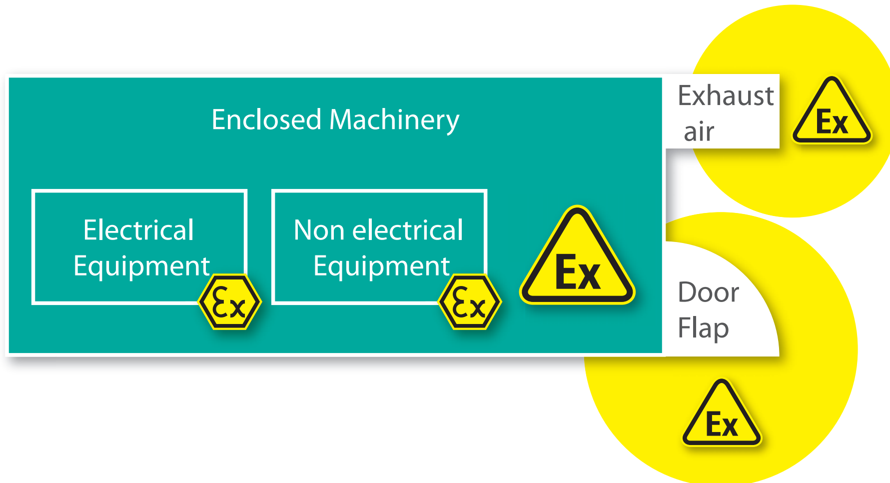

FIGURE 5
Example 3: Machinery for use in potentially explosive atmospheres, which is being produced by connection points to environment

One difficulty when considering assemblies of machinery with potentially explosive atmospheres is delimitation of the machinery interior.

A possible criterion could be non-accessibility for anyone during the process in order to avoid occupational health and safety being an issue for consideration in the interior of the machinery. More complex installations normally cannot delimit the potentially explosive areas by means of enclosures so that there is not any "interior" (with potentially explosive atmospheres) of assemblies of machinery, for which the ATEX Directive may not be applied.

Example 5: Painting plants

In standards, painting plants are considered machinery. In areas in which a potentially explosive atmosphere can be produced during operation, the manufacturer has to select equipment of a suitable category according to the probability and duration of presence of the potentially explosive atmosphere. This means the manufacturer quasi classifies zones but it is not called this officially as Zone classification is dealt with in Directive 1992/92/EC or BetrSichV. The standards include zone classification in informational annexes that the manufacturer can use during assessment.

If, for example, a spray painting robot with application device is operated inside a spray booth, in which a potentially explosive atmosphere occurs rarely and only briefly, this robot has to be put on the market as equipment of Category 3 in terms of Directive 94/9/EC. This also includes marking in conformity with the ATEX Directive.

Example 6: Stirring devices

If stirring devices are used in containers of installations, in which a potentially explosive atmosphere is continuously present or for long periods, the manufacturer of the stirring device has to fulfill the requirements of Category 1. Normally, this makes the operator responsible for the container in which the stirring device will be incorporated. During risk assessment, the manufacturer determines and defines which measures are necessary to avoid ignition sources during operation of the stirring device in the container. In contrast, ignition sources due to the drive and construction of the stirring device are the manufacturer's responsibility.

SUMMARY

An "installation subject to mandatory inspection" according to the German Ordinance on Industrial Safety and Health is defined as an installation in potentially explosive atmospheres that is or includes equipment, protective systems and safety, controlling and regulating devices in terms of Directive 94/9/EC. The installation subject to mandatory inspection may also be machinery in terms of the Machinery Directive, or the machinery is part of the installation subject to mandatory inspection. Machinery with enclosed potentially explosive atmospheres does not fulfil the definition of an installation subject to mandatory inspection; however, the equipment inside the machinery (e.g. the spray painting robot in the painting plant) is also considered an installation subject to mandatory inspection. If the machinery is located in or in conjunction with a potentially explosive atmosphere, the definition of installations subject to mandatory inspection is fulfilled.

The manufacturer is responsible for putting the product on the market. The product may also be an installation or be defined as assemblies of machinery or an assembly. The manufacturer of the installation is responsible for the safety-related condition of the product according to the requirements of the single market when placing it on the market. The operator, as customer, is responsible for complying with the requirements to be observed during operation. Therefore, we recommend that manufacturer and operator already agree on this issue when the order is

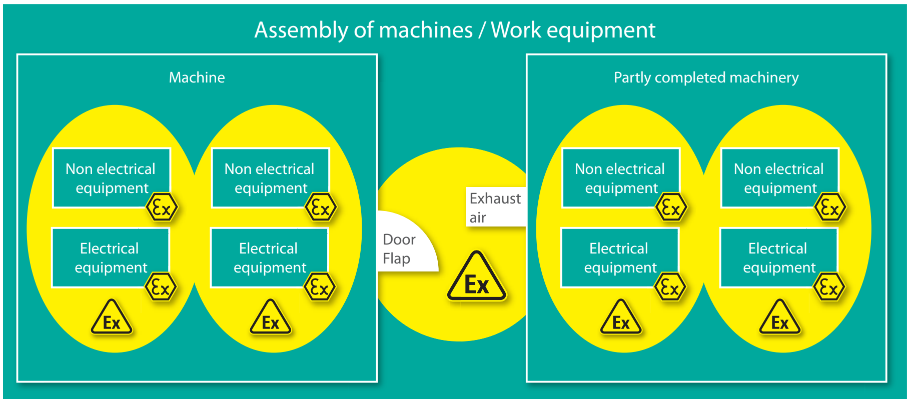

FIGURE 6
Example 4: Assemblies of machinery with potentially explosive atmospheres

being placed. The manufacturer of the installation can assume conformity of individual components with EC Declaration of Conformity purchased from other manufacturers; however, when combined in an installation, their interaction has to be assessed. Parts can be ordered by the manufacturer from other manufacturers (sub-suppliers). By means of private-law agreements, the manufacturer may safeguard themselves against any damage. However, the sole responsibility for the product still falls to the manufacturer.

Partly completed machinery in terms of the Machinery Directive is not considered machinery, and therefore, no CE marking is provided. However, if the partly completed machinery is equipment in terms of the ATEX Directive, CE marking is required. In this case, the manufacturer has to issue an EC Declaration of Conformity in conformity with ATEX Directive and a Declaration of Incorporation for the machinery.

The operator is responsible for the safe operation of an installation subject to mandatory inspection. Under private law, this service can also be provided by a sub-contractor (e.g. design of the installation, mounting, inspection); however, this does not release the operator from his legal responsibility in case of damage.

Mounting installation consisting of several machines is the operator's responsibility. If the operator manufactures a machine or assemblies of machines, he becomes the manufacturer of such and has to comply with the requirements of the Machinery Directive for the "assemblies of machines". Manufacture for in-house use will be included in the scope of the new ATEX Directive by integrating the New Legislative Framework.
Conclusion: The primary objective of legislation is to clarify who is responsible and to ensure a safe operation of the installations. There are different approaches for complying with the requirements. Generally, the manufacturer's and the operator's responsibilities have to be kept apart, while, in combined cases, doubts with regard to responsibility should not arise.

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LITERATURE

[1]
http://ec.europa.eu/enterprise/sectors/mechanical/atex/

[2]
http://www.gesetze-im-internet.de/betrsichv/index.html

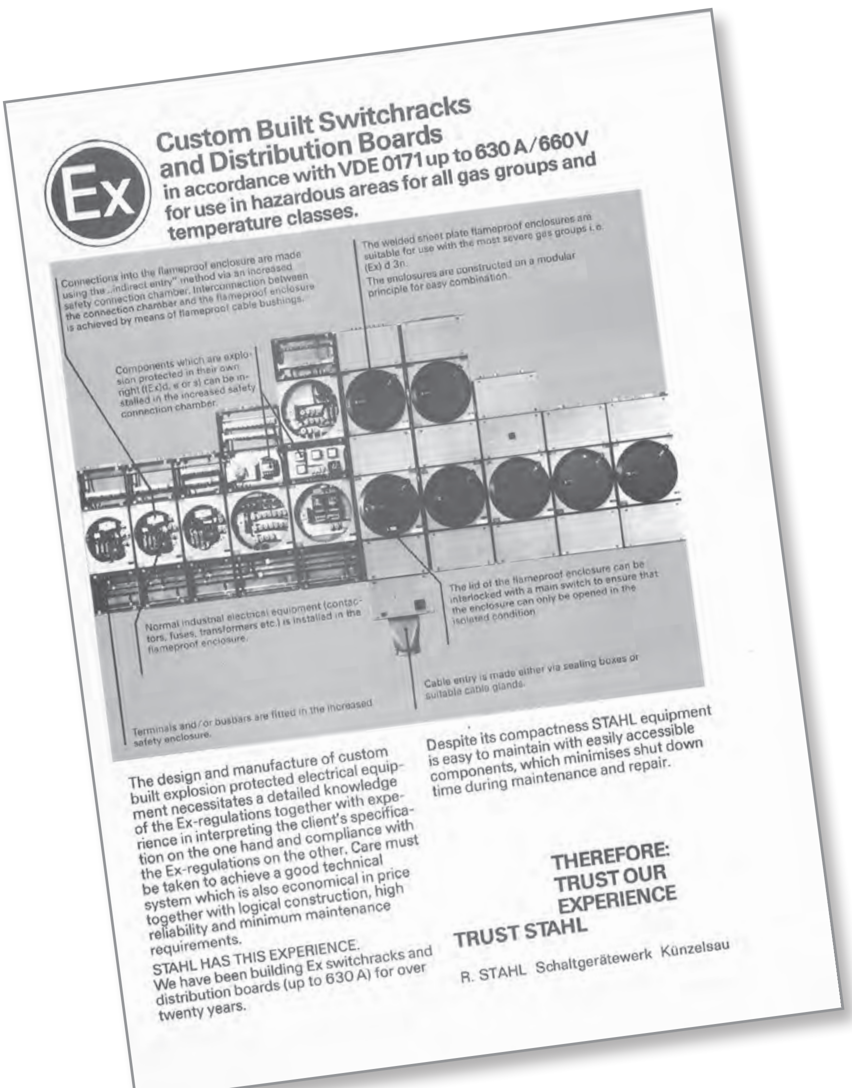
[3]
http://www.gesetze-im-internet.de/prodsg_2011/index.html

[4]
http://www.bmas.de/DE/Themen/Arbeitsschutz/interpretationspapier-gesamtheit-von-maschinen.html

CONTROLLING AND DISTRIBUTION PANELS

FOR HAZARDOUS AREAS AND THE TECHNOLOGY DEVELOPMENT OVER THE LAST 40 YEARS

BY JÜRGEN POIDL



Switching, controlling and power distribution requires safe equipment that is reliable over extended periods of operation. This is of particular importance in hazardous areas to which guidelines and standards apply.
The company R. STAHL started producing explosion-protected control devices and indicator lights for its elevators and hoisting equipment in the twenties of the last century. Control and distribution systems from the production program, even though extensively extended in the meantime, were already the topic in the first issue of the Ex-Magazine that was first published by R. Stahl in 1974. This article describes the further development of this technology and the current state of the art.
Electrical switching operations normally cause switching sparks or arcs. If exceeding a certain amount of energy, these can be an effective source of ignition. The task in developing explosion-proof switchgear is to neutralise these sources of ignition. The main types of protection are flameproof enclosures "Ex d", pressurized enclosures "Ex p" and oil immersion "Ex o", the latter of which is hardly used anymore. In addition to that, further types of protection such as increased safety "Ex e" or encapsulation "Ex m" are applied.
The first and traditional design was the installation of conventional switchgear in a large-sized flameproof encapsulated cast iron enclosure. The flameproof enclosure could withstand an explosion in the inside of the enclosure and prevented hot gases being released into the environment. Due to the flexibility of the possible uses, the type of protection "Ex d" is still one of the most common applications.

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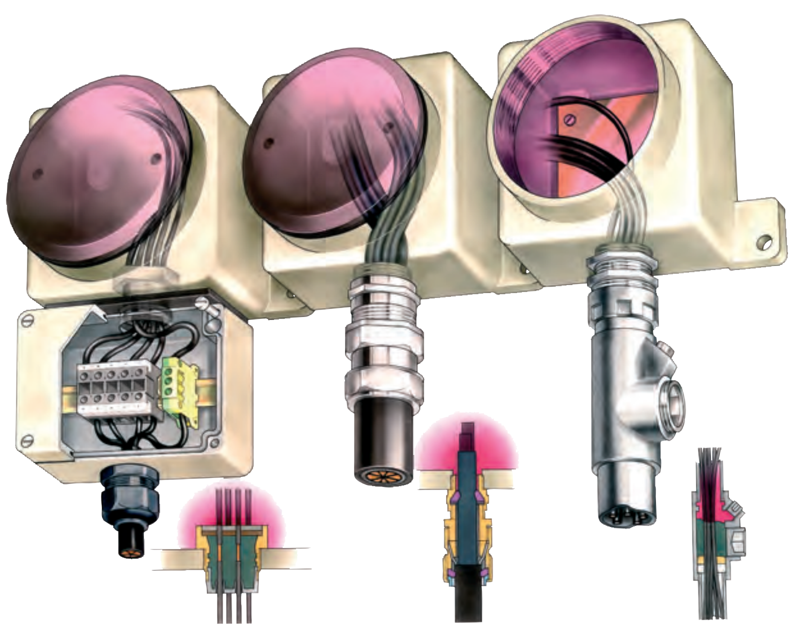

FIGURE 1
Overview enclosure technology

ENCLOSURE TECHNOLOGY

In explosion protection, the available solutions can be classified as to their structural type and the types of protection applied. (**FIGURE 1**).

_ Enclosure technology with direct cable entry
_ Enclosure technology with indirect cable entry
_ Module technology using individually encapsulated modules (**FIGURE 2**)
_ Components with integral solution from the explosion protection and the product function.

A challenge in explosion protection of switchgear combinations was to develop the design solutions for the types of protection. The developed principles are still applied without changes in the approach of the technological safety assessment of the sources of ignition. The criteria for safe installation, commissioning, usage and maintenance of the products are important right from the start.

The standards of the types of protection have established constructive criteria and the relevant tests for demonstrating resistance to the environmental effects and to fatigue phenomena to be expected. The selection of cables and lines for installation in hazardous areas takes place, for example, in accordance with DIN EN 60079-14 (VDE 0165-1 Hazardous areas – Part 14: Engineering, selection and installation of electrical systems.

To insert cables and electric lines, different technical solutions are available. They differ considerably in terms of design, requirements and costs for maintenance and repair and will be explained below.

ENCLOSURE TECHNOLOGY WITH DIRECT CABLE ENTRY

A distinction is made between the installation of cables and the conduit technology. The conduit technology will not be discussed here, since it is mainly used in North America. As opposed to other markets, the cable installation has not established itself there.

The cables and lines used in accordance with the standard leave some questions unanswered. The installers are often unable to cope with the selection of cables. The fit between the cable and the cable entry must be suitable for the type of protection.

Two main solutions are available:
First, cable entry using a sealing ring and, second, cable entry for sealing the individual wires by means of a sealing compound introduced into the cable.

Indirect cable entry, the installation work must be performed with particular care. An error in the execution of the cable entry with a compound or a sealing ring may result in flame transmission when an internal explosion takes place inside the Ex d enclosure.

The remaining items are the maintenance and the associated assessment of the flameproof end of the cable entry. Since cables are not assessed as to their fatigue and the techni-

Cover with threaded gap (FIGURE 3)
The opening of a cover with a thread requires a high force for overcoming the high friction at the peripheral face. The weight of the cover must be taken into account. This is why for large-sized enclosures a hinge is required at the cover, in order minimize the risk of accidents caused by the heavy cover.

Cover with flat gap and cover screws
Depending on the enclosure size, the number of screws at the cover differs. For typical enclosures, fastening screws with M8 - M12 threads are used. The number of cover screws ranges from 6 up to 40 screws. In many cases, enclosures of this type must be opened without using machines. This is a time-consuming activity. Here, too, depending on the cover weight, a hinge must be additionally provided.

Ex e enclosures made of plastic (FIGURE 4)
Opening of 4 to 6 screws for each enclosure, the covers are very light weight and therefore very easy to handle.

Ex e enclosures and cabinets made of stainless steel
Simple handling with only a few quick-action couplings and mounted hinges make the enclosures easy to open and close.

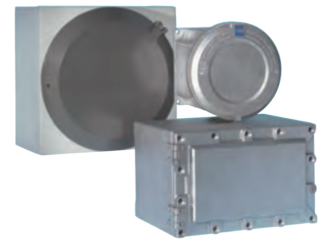

FIGURE 3
Ex d enclosures in aluminium, sheet steel and stainless steel

FIGURE 4
Ex e enclosures in GRP, sheet steel and stainless steel

cal properties of the cables in use and since they can be evaluated in an infrequent visual inspection for optical defects at most, this is where the greatest uncertainty of the safety function exists. For flameproof enclosures, it is essential to maintain the mechanical strength of the enclosure and the flameproof condition during the entire operating period. Here, too, the question on how the cable itself is assessed in practice arises. In the experience of the author, this often leads to consultation talks with customers. They consist of extensive discussions of the facts described in the relevant standards.

An additional basic question arises: How can safety technology work reliably if a certain technical uncertainty must be accepted? Therefore, a different solution was and is required. The goal is to gain more safety thus creating better preconditions for economical operation. This lead to the indirect cable entry technology.

ENCLOSURE TECHNOLOGY WITH INDIRECT CABLE ENTRY

Indirect cable entry, a higher material and mounting expenditure in the electrical equipment production must be expected. However, these additional costs are more than compensated for by reducing the technical imperfections in comparison with direct cable entry. Indirect cable entry is effected with flameproof enclosures that are sealed ex-factory. The electrical connections are established via so-called conductor bushings and are wired to the connection terminals in the connection chamber in Ex e technology. The incoming and outgoing cables are connected to these connection terminals. In these connection chambers, simple cable entries with suitable Ex e approval are used. For the Ex e type of protection, it is sufficient to observe the ingress protection for protecting the built-in components against environmental effects. The minimum requirement has been established as IP54, which provides protection against fatigue and mechanical damage. This reliably encapsulates the sources of ignition, and no essential modifications compared with the usual industrial installation technology must be observed for installation. The assessment during maintenance is simple and straight forward with respect to the cable entry.

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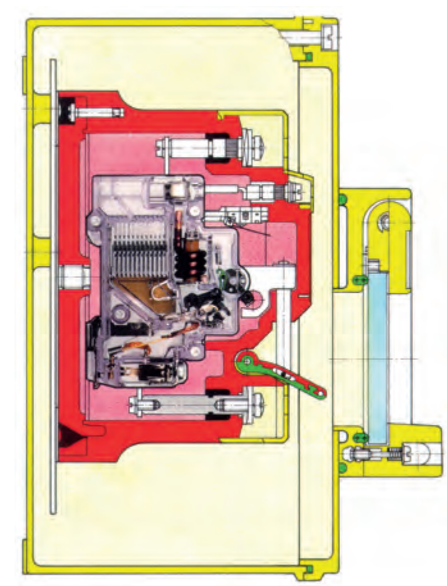

FIGURE 2
Flameproof module in an Ex e enclosure

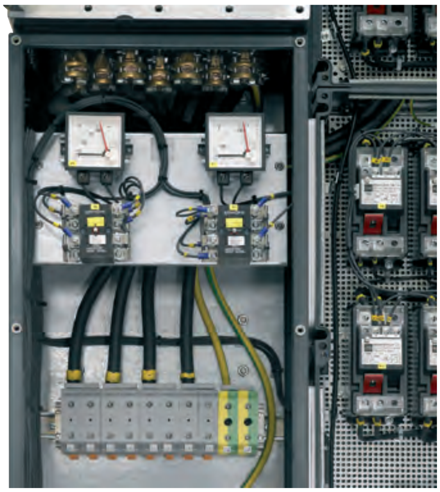

FIGURE 5
Connection to terminal block

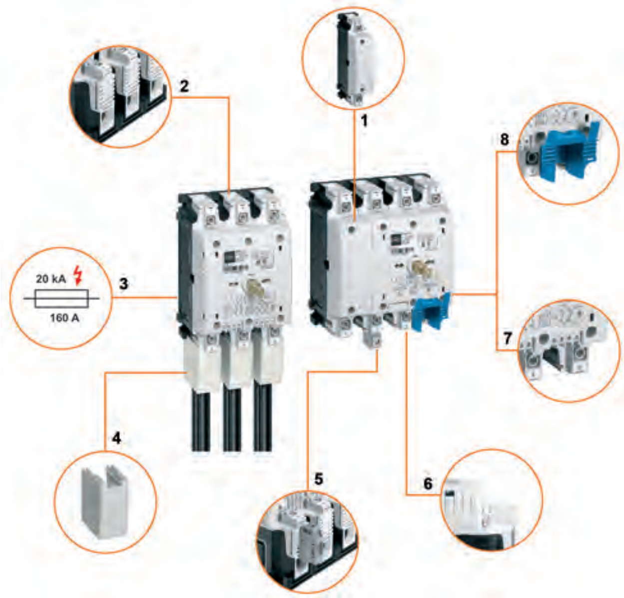

FIGURE 6
Main circuit breaker/load disconnect switch up to 180 A

As an intervention into the flameproof enclosure is not required, simple extensions or modifications of controls are easier with indirect cable entry.

MODULE TECHNOLOGY USING INDIVIDUALLY ENCAPSULATED MODULES

The extension of this idea is to install electrical equipment in separately designed component enclosures of flameproof design. Or even the integral solution of explosion protection and the product function in one design. In some cases, this is referred to as "individual contact encapsulation" for switches and contact elements. As a result, the components are available for assembly and for wiring in the same way as in industrial cabinet manufacturing. The Ex e switch cabinets to be used are equipped with special cable entries approved for Ex e. During assembly and wiring, especially heating and the corresponding creepage distance and clearances of active parts must be taken into account.

Handling, installation and wiring is easy to understand for any skilled person. This helps to avoid mistakes and saves costs during handling. Even system expansions can be incorporated at a later stage. Mechanical reworking of the enclosures can be carried out on site in many cases. The wiring can be easily changed, since all Ex e connection terminals of the components are freely accessible. Device extensions can easily be implemented at available slots and even enclosure extensions can be implemented if certain criteria are fulfilled. This ensures maximum flexibility over the time of use of the equipment.

Using plastics as enclosure material protects against corrosion in an optimal way. The maintenance of the flameproof gap typical of Ex d enclosures can be omitted. The technology has a low weight and thus enables easy handling during installation and assembly.

OPENING THE ENCLOSURES

(see box on page 99)

An important differentiating factor is the opening of the cover. The plastic cover of an Ex e enclosure with 4 or 6 cover screws and a weight of up to 1.5 kg can be easily opened. In comparison to this, there are heavy covers of flameproof enclosures with large metal covers that are closed via threads or flat joints. In Ex e enclosures, simple enclosure combination design of plastic enclosures or a cabinet design is customary. Here the covers are designed with quick-action couplings or cover screws.

EX e ENCLOSURE SYSTEMS MADE OF PLASTIC AND STAINLESS STEEL

The enclosures of Series 8146 (polyester resin) and 8150 (stainless steel) are designed in the type of protection "Increased safety" Ex e. All fitted components have an explosion-protected design in the types of protection "Flameproof encapsulation" Ex d and/or "Increased safety" Ex e. The modular system of both enclosure series allows any combination of these components within their series. The explosion protection of the general arrangement is ensured by installing a sealing frame between the enclosures. (**FIGURE 4**).

FIGURE 7
Circuit breaker in flameproof enclosure

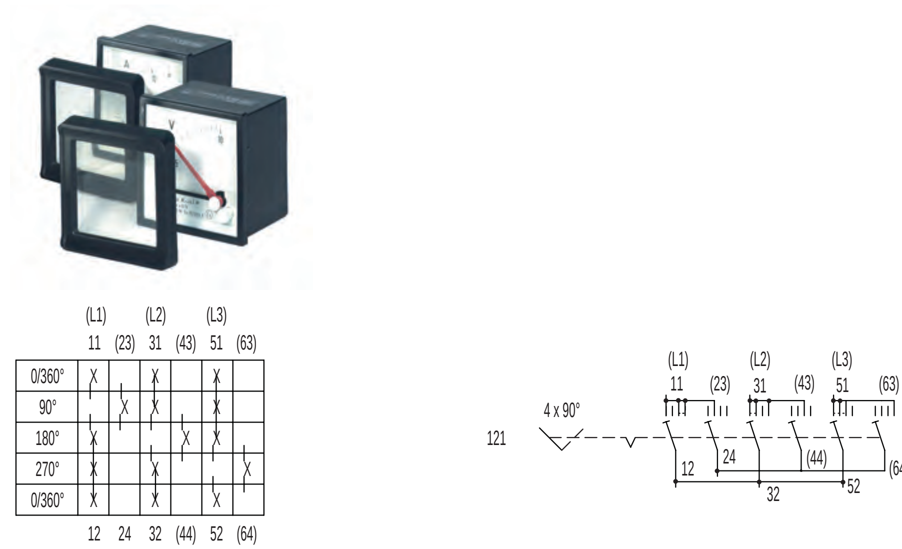

FIGURE 8
Measuring devices with phase changeover switch

EX D ENCLOSURE SYSTEMS

The CUBEx enclosures (Series 8264 made of aluminium or stainless steel), Series 8250 (made of aluminium) and GUBox enclosures (Series 8265 made of aluminium) and Series 8225 (made of sheet steel) are used for the installation of industrial switchgears. Combining them with the corresponding Ex e enclosures can be easily done via matching dimensions in the modular system. The Ex d enclosure technology enables single enclosure solutions and enclosure combinations in pure Ex d technology or in connection with Ex e technology. Typical dimensions for use in power distribution panels are up to 730 mm x 730 mm x 560 mm. (**FIGURE 3**).

AVAILABLE COMPONENTS IN MODULE TECHNOLOGY

Wiring to terminal blocks

For indirect cable entry, the installation cable is connected to terminal blocks outside the flameproof enclosure. The wiring to the flameproof chamber is established by means of factory-assembled cable glands. Thus, the function of the flameproof enclosure does not depend on correct installation or selection of the cable by the fitter, but functions safely and is type-approved by the qualified manufacturer.

On the one hand, the cost-saving effect of this technology is produced by simple and quick cable selection and installation. On the other hand, maintenance of this indirect cable entry by means of defined individual components is easy to do. The flameproof quality of the cable interior and cable sheath has not been proven by means of a type test.
(**FIGURE 5**).

Main switch / load disconnect switch

Solutions of up to 180 A via 8544 and 8549 with terminal blocks or direct wiring to switches

The design of the new flameproof modules integrates Ex e connection terminals (IP 20), which can be marked with separate terminal markings. The cost benefits are the direct result of the compact design and the expandability of the switches. Auxiliary contacts can be configured at a later stage (**FIGURE 6**).

For solutions requiring switches of nominal currents greater than 180 A, flameproof enclosures are used.

Combining "increased safety" enclosure systems with "flameproof enclosure" systems results in additional options for meeting the requirements of power distribution systems.

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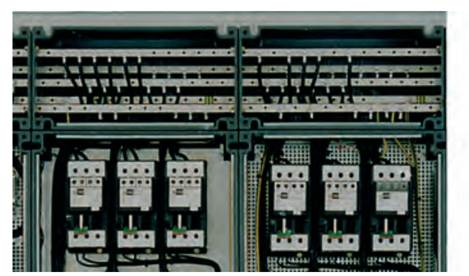

FIGURE 9
Busbars 160A – 630A in an Ex e housing

FIGURE 10
Residual current circuit breaker (RCCB)

FIGURE 11
Fuse elements

FIGURE 12
Circuit breaker for motor protection

Thus, it is possible to install load break switches or circuit breakers of up to 800 A into flameproof enclosures (**FIGURE 7**).

Residual current monitoring relay with summation current transformer

Residual current monitors (RCM) with built-in summation transformers are used for monitoring residual currents. Combining them with circuit breakers or contactors allows the residual current circuits to be switched off upon reaching the switch-off threshold. It is possible to generate a message, which allows errors in the system to be detected at an early stage. The display and switch-off threshold of the units can be freely programmed. This allows preventive maintenance and increases system availability, making the system more economical, as an unscheduled switch-off takes place less frequently. In combination with Ex e power distribution systems, flameproof IIC or IIB enclosures are used for encapsulating these components. In their standard version, incoming or outgoing circuits of up to 100 A can be easily implemented. The response range of the units ranges from 10 mA to 10 A of residual current. (**FIGURE 7**).

Measuring equipment (current transformers / current transformer changeover switches / voltmeter changeover switches)

To measure currents in incoming and outgoing circuits, current transformers are built into flameproof enclosures. The ammeters are built into the Ex e connection chamber or also in flameproof enclosures.

The ammeters and voltmeters are mounted behind windows, thus enabling them to be read from outside. (**FIGURE 8**).

Busbars

The advantage of busbars in Ex e technology is the simple structure of the enclosures, the simple wiring and the clear arrangement of components in the system.

This produces an economical solution, which substantially simplifies the assembly of power distribution systems in Ex e and Ex d technology. (**FIGURE 9**).

Residual current circuit breakers (RCCB)

Residual current circuit breakers protect from dangerous body currents, but have no integrated protection from overload and short circuit. They can be used for pulsating direct currents and alternating currents (**FIGURE 10**).

Residual Current Circuit Breaker with overload protection (RCBO)

The RCBO is the perfect protection against earth fault, overload and short circuit. The RCBO contains a residual current measuring and tripping device as well as the switching MCBs containing the proven design features and triggering characteristics. They replace the previously used single components "Residual current circuit breaker" (RCCB) and "Miniature circuit breaker" (MCB), thus reducing assembly and wiring expenditure.

"Reset" key for alarm signalling contacts

In the accessories, a reset function for alarm signalling contacts is available for some devices. The advantage of this function lies in its practical application to power distribution. The error message is reset by pressing the "Reset" key. This reactivates the monitoring function for the remaining circuits.

When the circuit breaker of a switchgear combination has been tripped, the error is signalled via the alarm signalling contact. The maintenance personnel can be sent to the faulty circuit in a target-oriented manner. In most cases, the user cannot open enclosures under tension, in order to investigate the error. The error is documented, and this part of the system does not have to be switched off, if the circuit is not critical.

FIGURE 13
Module with motor starter

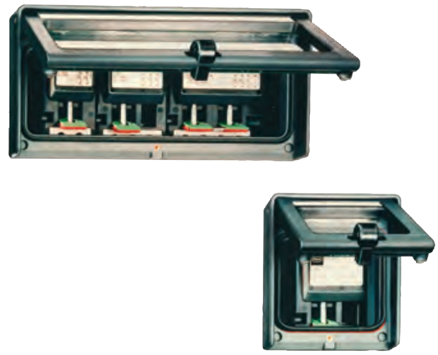

FIGURE 14
Flapped window

FIGURE 15
Rotary drive in the cover of flameproof enclosure

Accessories and features

All design versions of the MCBs, RCCBs and RCBOs can optionally be equipped with auxiliary conctacts. A special version is the fault signal contact, which is only switched when tripping due to an error takes place. The switch lever has a 2-colour design and is additionally used as switching position indicator. The circuit breaker can be individually secured against unintentional switching back on by locking it with a padlock. The connection terminals are designed so as to be finger safe.

Fuse elements

Fuses can be used in Ex e enclosures for protection against overload and short circuit. The fuses cover the nominal current range from 0.2 to 25 A (Neozed) and 2 to 63 A (Diazed) and are particularly suitable in case of high short-circuit currents (**FIGURE 11**).

Motor protection circuit breaker

The motor protection circuit breakers (Series 8523/8) are equipped with a non-adjustable fast short-circuit trip and a thermal overcurrent trip adjustable at the switch (nominal current from 0.1 to 22.5 A). The switches are suitable for protecting motors of types of protection Ex e und Ex d. The circuit breakers are actuated by an actuator, which also displays the switching position. The circuit breaker meets the criteria from IEC 60079-14 and is equipped with phase failure sensitivity accordingly.

The trip-free mechanism ensures a safe function of the overload disconnection even when the actuator is held. When using a shortened rotary actuator, the circuit breaker fulfils the disconnect requirements. It can be used as main switch or EMERGENCY STOP switch if the rotary actuator was selected accordingly. The trip characteristic of the circuit breaker corresponds to the K characteristic. This makes additional line protection unnecessary (**FIGURE 12**).

Modules for motor starters

From the series of modules (Series 8510) (**FIGURE 13**), numerous functions for assembling typical motor starters from contactors, time relays and motor protection relays are available. They are suitable for motor power up to 15 kW. The switchgears for larger motor starters are integrated into flameproof enclosures.

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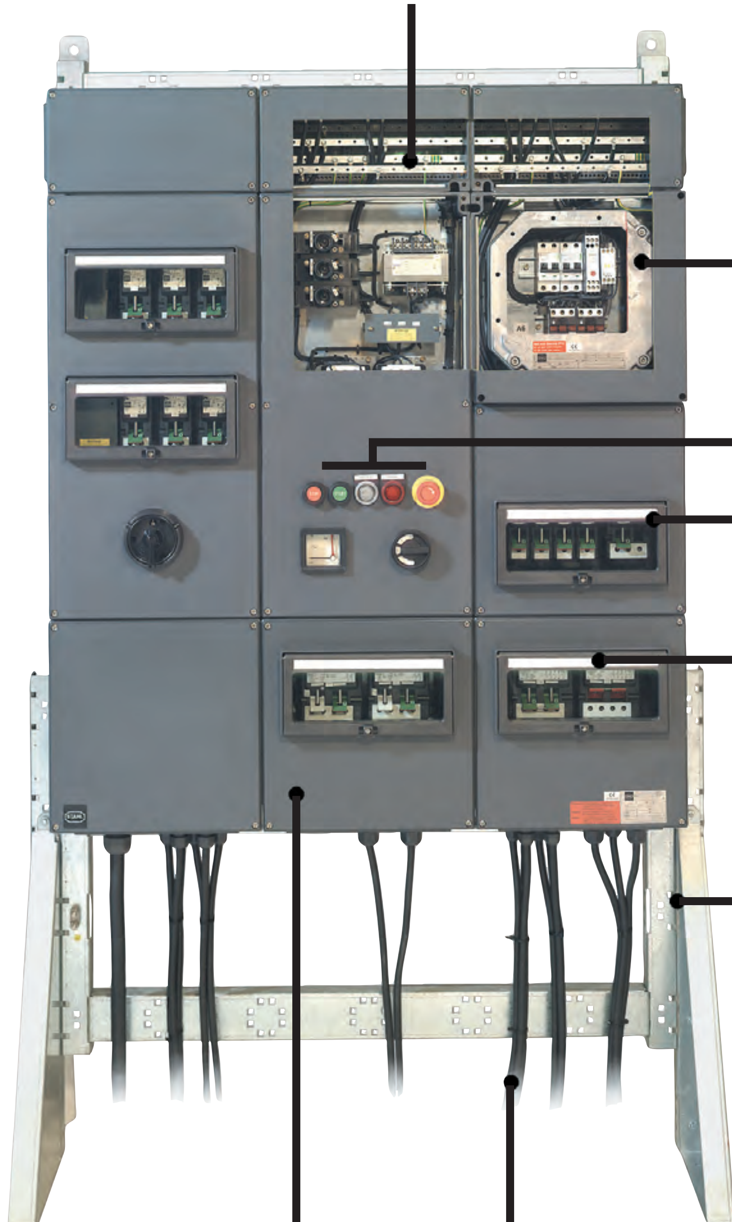
FIGURE 16
Flange socket

FIGURE 17
Specially thermally insulated power distribution for energy saving heating

Busbar system
- for high current power distribution
- maximum 690V and 160 A



Ex d enclosure
- enclosure made out of cast aluminium
- installation of normal industrial equipment

Control and signalling equipment
- switch, indicator lamp
- control and motor switch
- ammeter and voltmeter
- digit display

Window flaps
- actuator for mccb 8562 (Ex de) from outside
- opening of the enclosure lid not necessary
- switching position indicated
- interlockable by padlock

Carrier rack
- suitable for wall mounting
- available with roof and lighting
- modular mounting system
- designed for enclosure series 8146 and 8125

Connecting enclosure
- Cable glands
- Cable connection via terminal blocks

Cable connection accessories
- Cable glands for unarmoured and armoured cables

	ENCLOSURE TECHNOLOGY		MODULE TECHNOLOGY
	DIRECT CABLE ENTRY	INDIRECT CABLE ENTRY	
Internal wiring	--	++	++
Opening the enclosures	-	-	++
Mounting	-	-	++
Installation	--	++	++
System expansion	--	--	++
Maintenance	--	-	++
Weight	-	--	++
Special requirements	++	++	-

TABLE 1
Advantages/disadvantages of the different technologies

Flapped window

An actuator flap installed in the enclosure cover allows the circuit breakers to be switched from outside in live condition, without opening the enclosure cover. The reset button can also be activated with this function. The switching position of the circuit breaker can be seen from the outside through the inspection window . The actuator flap can be locked by means of a padlock. (**FIGURE 14**).

Rotary drive in the cover of flameproof enclosures

Manually actuated switchgears are installed by using actuator switches. Rotary actuators are equipped with locking devices upon request. They actuate the circuit breaker, miniature circuit breakers and load disconnect switches directly through the cover or the enclosure wall. Mains connection switches of any size can be coupled to a positive interlocking cover lock.

For the use of flameproof enclosures that require a rotary drive for the circuit breaker units installed in the cover, the connection to the rotary actuator in the cover is established by means of an axle bushing. (**FIGURE 15**).

Flange socket

For installation in the enclosure wall, a flange socket can be used. This makes it possible to install switch sockets directly in connection with the protection components of a switchgear combination.

POWER DISTRIBUTION SYSTEMS FOR USE AT LOW TEMPERATURES

Special features

In order to avoid condensation and to maintain the temperature of the components, enclosure heating is used and will be switched on by a thermostat before the temperature drops below the rated temperature. The enclosure walls are specially insulated to save heating capacity (**FIGURE 17**).

SUMMARY

Advantages provided by Ex d enclosure technology

Despite the above-mentioned disadvantages resulting from the use of the enclosure technology, the use of Ex d enclosures offers an enormous advantage. For special requirements, the technological design must be flexible. Special requirements can be fulfilled by a flameproof enclosure in most cases. If technical innovations require devices and components for which solutions are not yet available in module technology, customized requirements with regard to component selection can be easily fulfilled.

Special requirements requiring the use of Ex d enclosures:

- Technical innovations
- Particularly high switching powers,
- Higher power dissipations,
- Large connection cross-sections for which no Ex e connection technology is available,
- Rare applications not allowing any Ex d modules.

Is module technology the only solution?

The best solution first of all seems to be module technology. In a technologically neutral evaluation, however, the variety of technical options will always lead to the best customer solution. There are limits to the applicability of Ex e module technology, which can be overcome by the advantages of a flameproof enclosure. Compared to indirect cable entries, if correctly installed by qualified personnel, direct cable entries also provide certain advantages, thus adding substantially to the possible solutions in certain segments of explosion protection.

Therefore, the best solution is to have all possible types of protection available to answer the requirements. The different enclosure technologies need to work together in a perfect combination to solve the specific customer requirements in a safe and economical way.

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LITERATURE

[1]
Explosive atmospheres – Part 14: Electrical installations design, selection and erection (IEC 60079-14:2013); EN 60079-14:2014

[2]
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TEMPERATURE RISE OF FLUORESCENT LAMPS AT THE END OF THEIR SERVICE LIFE

BY KATRIN HERRMANN, ULRICH JOHANNSMEYER, RAINER KULESSA

For explosion protected luminaires of the type of protection Increased Safety "e" and Non-sparking "nA" in which fluorescent lamps according to IEC 60081 are operated with electronic ballasts, a maximum surface temperature must be complied at the lamp also at the end of there service life. In the past, the risk that temperatures above the admissible surface temperature might occur at aged fluorescent lamps was estimated to be sufficiently small, as no experience was available which contradicted this assumption and as the operating devices (ballasts) for fluorescent lamps in explosion protected luminaires corresponded to the state of the art.

The more, however, luminaires with electronic ballast and lamps with two pins (instead of the one-pin fluorescent lamps with conventional ballast used so far) were installed, the more it turned out that higher safety relevant temperatures may occur at the fluorescent lamps.

The experience gained with obviously increased temperatures at fluorescent lamps in luminaires for general lighting led to safety requirements for electronic operating devices in accordance with EN/IEC 61347-2-3.

Thus a safety relevant relation between the surface temperature of the lamp, the power conversion in the electrodes of the fluorescent lamp at the end of its service life and the function of the electronic operating device have to be considered.

These requirements are applicable for all electronic operating devices (ballasts), which are used for the high frequency operation of fluorescent lamps in accordance with IEC 60081 and thus also for electronic operating devices of this kind in explosion protected luminaires.

The applicability of the limit values indicated in EN/IEC 61347-2-3 for the maximum electrode power in order to comply with the temperature limits placed on explosion protected luminaires has been investigated.

From experimental investigations with fluorescent lamps in the explosive mixture, and from temperature measurements carried out at fluorescent lamps, values of the electrode power based on safety technology have been derived to limit the surface temperature of fluorescent lamps in explosion protected luminaires.

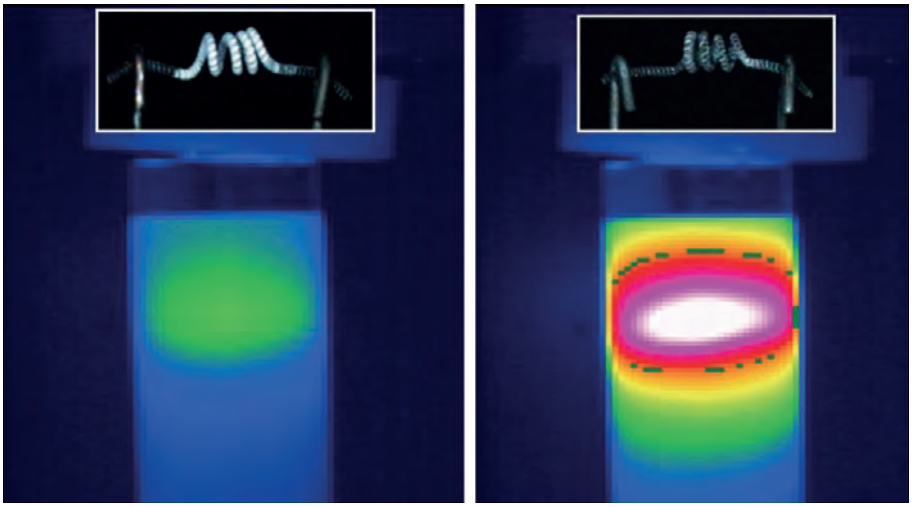

FIGURE 1
New electrode (left) and electrode at the end of the lamp's service life (right), comparison of the surface temperature distributions of the fluorescent lamp

1. INTRODUCTION

1.1 Increased power dissipation in the electrode at the end of the service life of the fluorescent lamp

When the emitter material of the electrode (i.e. filament of the conventional two-pin lamp) is exhausted at the end of the service life of the lamp or loses its emissivity for other reasons, the emission of the electrons is made difficult, which leads to an increased voltage drop at the electrode. The operation of the lamp with a constant current – as the electronic ballast is normally approximately a constant current source – causes a high power loss which strongly heats the glass surface in the area of the electrode. This process is frequently referred to as "end of life (EOL) effect" and manifests itself electrotechnically by the so-called "partial rectifier effect" and a clearly increased power dissipation in the electrode. The surface temperatures occurring at the lamp ends can reach values in the range of the melting temperature of the lamp glass if no further measures are taken.

1.2 Limitation of the surface temperature of fluorescent lamps at the end of their service life with electronic operating devices in luminaires for general lighting

Under rated conditions of the fluorescent lamp, the temperature at the surface, in the centre of the lamp, lies approximately in the range from 75 °C to 120 °C – depending on the lamp type and the thermal operating conditions (and can be higher in the area of the lamps' electrodes). At the end of the service life of the fluorescent lamps, the power dissipation in the electrodes may increase. This causes the temperature of the lamp surface to increase considerably in the area of the electrodes, in particular in the case of fluorescent lamps with a bulb diameter of 16 mm and smaller.

As the lamp temperatures may reach values which are relevant under fire protection aspects, the surface temperature of fluorescent lamps is normatively limited in accordance with the state of the art [6], i.e. the electronic operating device switches the fluorescent lamp off when the power conversion in the electrodes of the lamp reaches defined limit values. For electronic ballasts for fluorescent lamps with a nominal diameter of the glass tube of 12 mm and 16 mm, the switch-off criterion is indicated in the respective standard [6] as a function of the nominal diameter of the bulb.

Thus, the functionality of electronic ballasts for fluorescent lamps in explosion protected luminaires must be aimed at considering the relation between the temperature of the lamp's surface at the end of the lamp's service life and the power dissipation in the electrodes with respect to safety requirements for explosion protected luminaires.

1.3 Limitation of the surface temperature of fluorescent lamps at the end of their service life with electronic operating devices in explosion protected luminaires

1.3.1 Temperature classification of explosion protected luminaires

The test conditions for classifying explosion protected luminaires with fluorescent lamps [7] into temperature classes, as they are normatively laid down, only require a measurement of the surface temperature of the components when the electronic ballast is in operation in the extended input voltage range and under worst-case thermal ambient conditions. Since the temperature measured at the surface of the lamp under such test conditions usually lies below 130 °C, a classification into temperature class T4 has established itself for these luminaires internationally. The maximum permissible surface temperature of 130 °C corresponding to temperature class T4 has to be complied with when operating the luminaire.

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1.3.2 Temperatures at fluorescent lamps at the end of their service life

In this context, the question had to be clarified as to which values, in connection with the requirements laid down in the standard EN 61347-2-3 [6], the surface temperature of fluorescent lamps can reach as a function of the electrode power under worst-case thermal conditions, and at which electrode power the lamp would have to be switched off in order to comply with the temperature limit of 130 °C.

No reference was available to estimate the conditions since the corresponding standard EN/IEC 61347-2-3 [6] does not state a switch-off criterion for electronic ballasts for the type of fluorescent lamps most frequently used in explosion protected luminaires with a bulb diameter of 26 mm.

1.3.2.1 Surface temperature of real-time aged fluorescent lamps

In a first step, the link between the lamp temperature and the electrode power in fluorescent lamps with a nominal diameter of 26 mm had to be determined by means of thermal measurements on 40 real-time aged fluorescent lamps; these lamps were already considerably aged.

The power dissipated in the electrodes of such lamps fluctuates considerably over time (the emitter material was worn out to a large extent). The surface temperature of the lamp in the area of the electrode could therefore not be attributed to the power dissipated in an electrode under thermal steady-state conditions, but only for shorter intervals with relatively low fluctuations of the power dissipation. Yet, the results of the metrological estimation (**FIGURE 2**) allow the following statement: in order to comply with the maximum permissible surface temperature of 130 °C at fluorescent lamps with a bulb diameter of 26 mm, the electrode power has to be limited to a few watts only.

An electrode power of a few watts as a switch-off criterion for an electronic ballast leads to start-up problems in the case of new fluorescent lamps that are not yet burnt in. The power initially dissipated in the electrodes of new fluorescent lamps is different at the two ends and lies in the range of a few watts. New fluorescent lamps thus basically always comply with the switch-off criterion if the latter is set low enough. For that reason, the switch-off criterion (**FIGURE 3**, P^{T4}_{max}) derived for a maximum permissible surface temperature of 130 °C (**FIGURE 3**, T4) can, in practice, not be applied to the electronic ballast.

1.3.2.2 Temperature class and surface temperature

According to clause 5.3.3 of EN/IEC 60079-0, it would be admissible for the maximum surface temperature permitted within the scope of the temperature class to be exceeded on the lamp's surface (**FIGURE 3**, T^0) in Group II luminaires if tests carried out in the corresponding explosive mixture with a safety interval corresponding to the temperature class T4 ensure that this surface does not represent an explosion hazard.

Hereby, the normative surface criterion of 1.000 mm^2 is only applied to that part of the lamp's surface where the temperature is higher than the maximum surface temperature of temperature class T4, i.e. to that part of the lamp's surface which is relevant for explosion-protection purposes and whose temperature could cause an explosive mixture to ignite (**FIGURE 1**).

The use of this safety concept seemed possible as the thermographic determination of the surface temperature during the investigation of the (real-time) aged T8 fluorescent lamps showed that also at higher temperature values, the surface on which the maximum permissible surface temperature for temperature class T4, i.e. 130 °C, is exceeded only amounts to a few cm^2.

Accordingly, the safety concept is based on the possibility to exceed the maximum surface temperature of the temperature class when the surface temperature of the lamp is limited to a value which, considering a safety factor, lies below the experimentally determined ignition temperature (**FIGURE 3**).

1.3.2.3 Surface temperatures of fluorescent lamps

On the basis of the maximum permissible surface temperature T_o, the switch-off criterion (**FIGURE 3**, P^{Tz}_{max}) for the electronic ballast must be determined on the basis of the safety-relevant worst-case heating curve (**FIGURE 3**, K).

In practice, if a ballast with an implemented switch-off criterion (**FIGURE 3**, P^{Tz}_{max}) would be connected to a fluorescent lamp whose heating curve were steeper than that used to determine the switch-off criterion (**FIGURE 3**, K), the ballast would only switch off the lamp when the maximum permissible surface temperature has already been exceeded.

The heating curve K (**FIGURE 3**) is the function of the maximum temperature of the fluorescent lamp's surface (that is relevant for ignition in the area of the electrode) from the additionally dissipated electric power (power increase induced by ageing or within a test).

The surface temperature of the lamp is determined to a large extent by the power dissipated in the electrode.

If the power dissipation is given, it is the spatial and axial orientation of the lamp that determines the surface temperature; there exists an ignition relevant temperature maximum which depends on the orientation of the lamp.

At the same electrode power, lamps with a different bulb diameter have different surface temperatures. Changing the position of the electrode inside the bulb while modifying the power dissipation in the electrode when sweeping the characteristic curve T = f(P) (**FIGURE 3**, K) can influence the curve to the unsafe side (due to thermally caused material tensions of the electrode fixture).

Also the self heating of the lamp, which depends on the power, has an influence on the temperature of the fluorescent lamp's surface. A long-shaped lamp has higher power dissipation, but it can also release more heat into the environment.

When the ambient temperature around the lamp increases, the temperature of the lamp's surface also increases in the area of the electrode. On the other hand side, for numerous types of lamps, an ambient temperature exceeding 30 °C leads to a reduction of the power dissipation in the range of up to 20 % of the nominal power and to a corresponding reduction of the temperature of the lamp's surface in the area of the electrode.

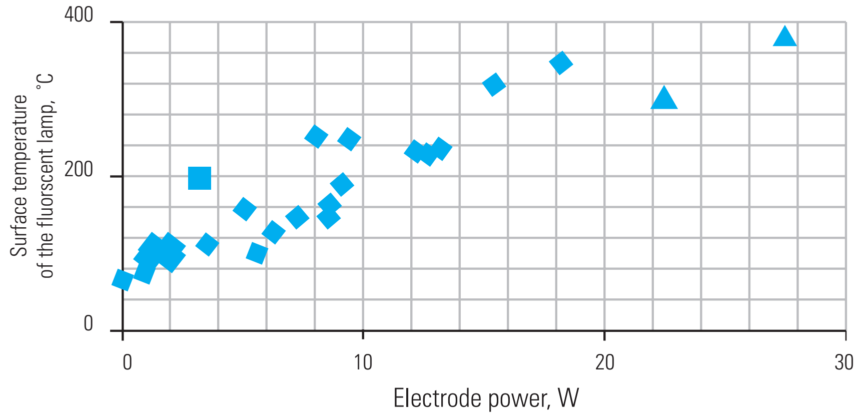

FIGURE 2
Temperature measurements carried out at real-time aged lamps

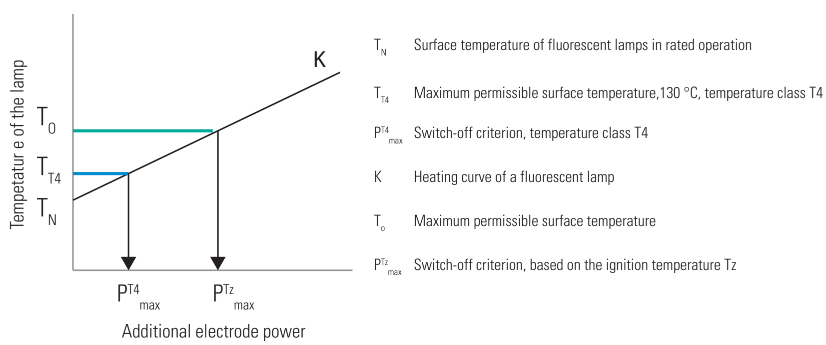

FIGURE 3
Safety concept for explosion protected luminaires, taking the requirements of EN/IEC 61347-2-3 into account

Particularities of the electrode construction due to the manufacturer under otherwise comparable measurement conditions can have an influence on the temperature in the area of the electrode.

From the interference of all these influences results the position and the value of the temperature maximum as well as the temperature distribution of the surface of the fluorescent lamp that is relevant for ignition – i.e. the surface temperature of the fluorescent lamp inside a luminaire in normal operation and under ageing conditions.

The increased power dissipation of the electrode of a lamp aged in real time has been simulated for the metrological investigations by supplying external electrical power into the electrode by means of a DC supply unit. The power fed in has to be kept constant since the thermal steady-state must be attained at the measurement point in order to measure the heating curve at a given electrode power.

At the location of the temperature maximum a thermocouple is positioned to measure the surface temperature.

Fluorescent lamps of the same nominal diameter exhibit different resistance values of the electrode filament. At a higher electrode resistance, this can, for a higher electrode power, require such a high voltage at the lamp pins that transverse discharges at the fixture wires of the electrode inside the lamp make a thermal measurement impossible. In this case, the heating curve of the lamp at higher electrode powers has to be extrapolated from the measured values at a smaller electrode power. Given the number of factors that have an influence on the temperature, and given the necessity of determining the worst-case safety-relevant characteristic curve for a given lamp diameter, an additional uncertainty of the characteristic curve determination occurs, especially with lamps having a diameter of 16 mm and smaller, and this uncertainty is difficult to estimate.

To derive a switch-off criterion for electronic ballasts for fluorescent lamps in explosion protected luminaires according to **FIGURE 3**, taking both the requirements of EN/IEC 61347-2-3 relating to the limitation of the electrode power at the end of the lamp life, and the requirements of EN/IEC 60079-0 concerning the limitation of the maximum permissible surface temperature according to the temperature classification of the luminaire into account, knowledge of at least the following data is required (depending on the nominal diameter of the fluorescent lamp):

- the ignition temperature as a function of the ambient temperature of the fluorescent lamp, and
- the safety-relevant heating curve as a function of the electrode power.

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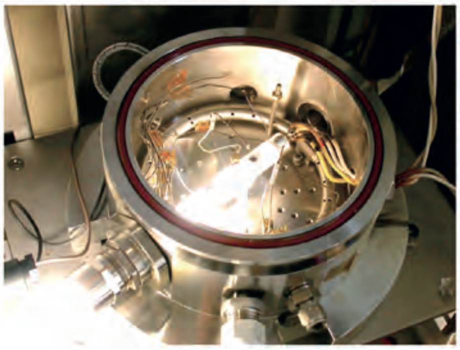

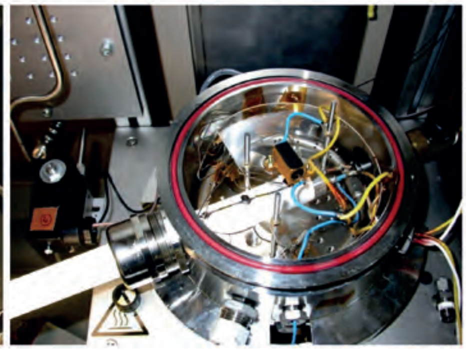

FIGURE 4 LEFT:
Test vessel with T5 lamp
FIGURE 5 RIGHT:
Test vessel with T8 lamp

2. EXPERIMENTAL INVESTIGATIONS

2.1 Ignition temperature of T8 and T5 fluorescent lamps

When the surface temperature of the fluorescent lamp is high enough, it can ignite a surrounding explosive atmosphere. In case of an inhomogeneous temperature distribution at the surface under consideration, the smallest maximum of the surface temperature of the lamp in the area of the electrode is evaluated, at which an ignition of the surrounding explosive atmosphere is just obtained, depending on the temperature of the explosive atmosphere.

2.1.1 Test procedure

The part of the lamp's surface that is defined as relevant from an ignition viewpoint is located in a test vessel consisting of a heatable lower part made of stainless steel (**FIGURES 4 AND 5**) and of a heatable upper part made of glass.

The lamp is positioned horizontally and turned axially towards the temperature maximum at the top. The spacing between the bottom of the test vessel and the lamp and between the lamp and the reflector roughly corresponds to the constructional conditions encountered in luminaires of different manufacturers.

The tests to determine the ignition temperature were carried out both with the exposed lamp (**FIGURE 4**, which corresponds to a wall-mounted luminaire) and with the lamp covered by a reflector (**FIGURE 5**, which corresponds to a ceiling-mounted luminaire).

After the heated, closed test vessel and the lamp in operation have reached thermal steady-state, diethyl ether is sprinkled below the lamp into a recess in the lower part of the test vessel. The procedure when working with an inhomogeneous diethyl ether/air mixture is described in [1], [2], and [3].

A thermocouple near the electrode is located approx. 1 cm above the lamp to measure the speed of the temperature rise in the reaction mixture and to classify the course of the reaction of each test into "ignition" or "non-ignition".

The temperature of the lamp's surface in the area of the electrode is varied from one test sequence to the next by modifying the heating power of the electrode in small steps, from high to lower temperatures as well as from low to higher temperatures until ignition no longer takes place and until ignition takes place again, respectively. The tests are repeated with different quantities of sprinkled diethyl/ether and at different mixture temperatures until the lowest temperature is determined at which ignition can only just be registered, and until the highest temperature is determined where ignition can no longer be detected.

2.1.2 Results from ignition tests with explosive mixtures

The test result "ignition" resp. "non-ignition" is attributed to the coordinates "mixture temperature" and "ignition temperature", respectively.
In **FIGURE 6 AND 7** for a clear presentation only the test results for the case of "ignition" of the explosive mixture are plotted.

The red dotted lines (**FIGURES 6 AND 7**) represent the lowest surface temperatures of the fluorescent lamp according to the temperature of the explosive mixture where an ignition has to be expected.

This line is further taken as a basis for the determination of the maximum permissible surface temperature of the fluorescent lamp used in a luminaire classified T4. The assessment also depends on the ambient temperature (temperature of the explosive mixture during the test) and the method used to take into account the safety factor according to IEC 60079-0 clause 5.3.3 and clause 26.5.3.

The results of the experimental research for fluorescent lamps with a diameter of 26mm (T8-lamps) and for fluorescent lamps with a diameter of 16 mm (T5-lamps) are displayed in **FIGURES 6 AND 7**.

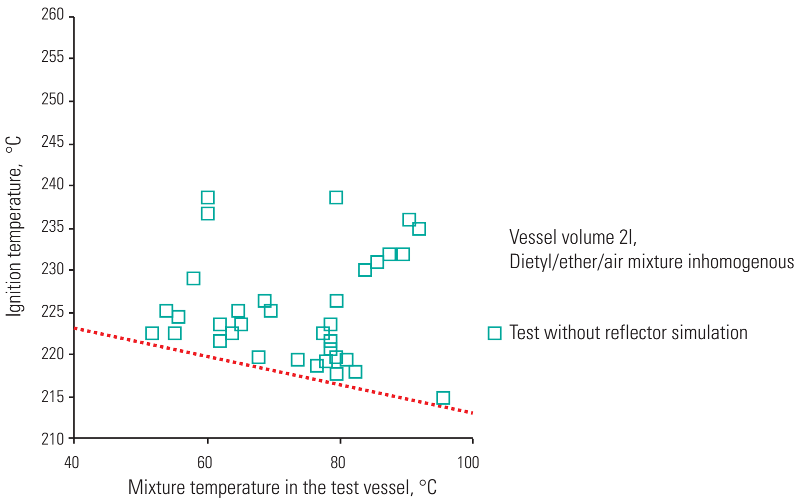

FIGURE 6
Ignition tests with fluorescent lamps with a diameter of the glass tube of 26 mm (T8-lamp), ignition of the mixture

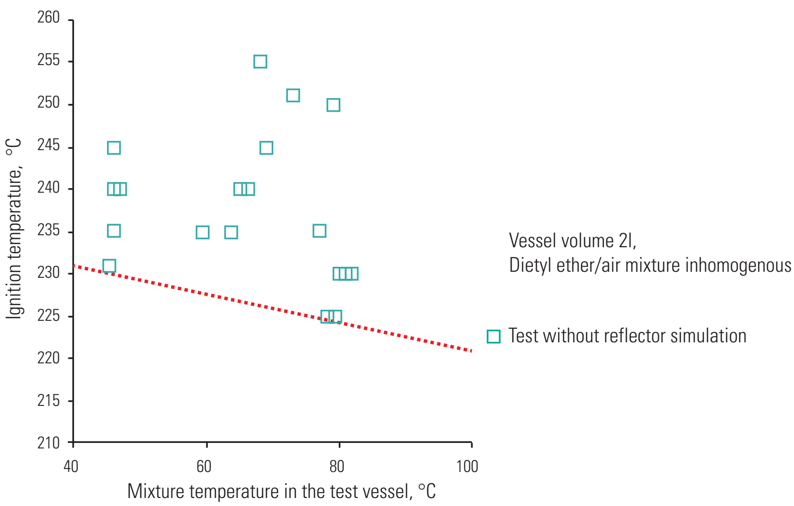

FIGURE 7
Ignition tests with fluorescent lamps with a diameter of the glass tube of 16 mm (T5-lamp), ignition of the mixture

2.1.3 Determination of the maximum permissible surface temperature

The ambient temperature of a luminaire with fluorescent lamps, as normatively defined, shall not exceed 60 °C.

The ambient temperature of the fluorescent lamp inside the explosion protected luminaire is determined by numerous factors. It is (measured at an ambient temperature of the luminaire of 60 °C) – approx. 15 K higher for T8 lamps and approx. 20 K higher for T5 lamps than the maximum ambient temperature of the luminaire.

Inside a luminaire of the type of protection Increased Safety "e" the ingress of explosive atmospheres has to be assumed. Furthermore it has to be considered, which initial temperature the explosive mixture has, depending on the operational conditions of the luminaire. This is part of a risk assessment and in principle two different cases can be regarded:

In the first case the mixture inside the luminaire is already present and has reached a temperature of 75 °C to 80 °C before the lamp surface temperature increases and reaches values which might be ignition capable.

In the second case the lamp has already reached a high temperature due to EOL when the explosive mixture enters (or is sucked in), in this case with a temperature corresponding to the maximum ambient temperature of the luminaire of 60 °C.

As a variant of case 2 it could be assumed that there is a multiple ingress of mixture with a temperature of 60 °C, which heats up inside the luminaire to the ambient temperature of the lamp TG = 75…80 °C, before the lamp reaches ignition critical temperatures.

In any case the safety relevant temperature TG in the range from 60 °C to 80 °C is the starting point for the estimation of the maximum permissible surface temperature To of the lamp (**FIGURE 3**).

2.1.3.1 Safety factor achieved by increase of the temperature of the component under test

If the safety factor (temperature class T4) is not achieved by the test conditions, the projection of the intersection of the vertical line through TG (on the axis "mixture temperature in the test vessel") with the green dotted line to the axis "ignition temperature" determines the lowest ignition temperature T_z. The maximum permissible surface temperature T_0 results from T_z reduced by 25 K safety margin (**FIGURE 8**).

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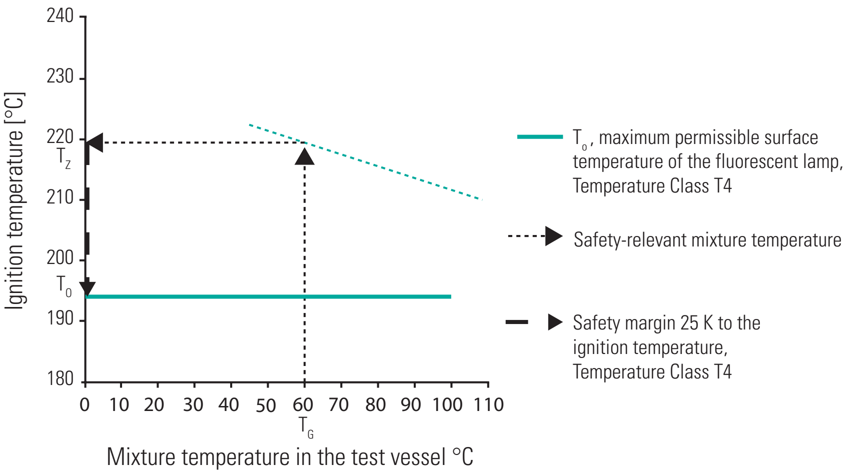

FIGURE 8
Estimation of the maximum permissible surface temperature of T8-lamps, mixture starting with an initial temperature of 60°C

2.1.3.2 Safety factor achieved by increasing the mixture temperature

If the safety factor is taken into account by increasing the ambient temperature of the ignition capable element, a vertical line is drawn through the point T_G + 25 K. The maximum permissible surface temperature T_0 is determined in this case from the projection of the intersection of the vertical line through T_G + 25 K with the green dotted line to the axis "ignition temperature" (**FIGURE 9**).

2.1.3.3 Risk assessment and maximum permissible surface temperature

Taking into account the temperature of the gas mixture surrounding the fluorescent lamp in the instant of a potential ignition and the chosen method to implement the safety factor according to IEC 60079-0 the maximum permissible surface temperature results as follows (**TABLE**):

2.2 Heating curves of fluorescent lamps

2.2.1 Typical heating curves of fluorescent lamps with a bulb diameter of 26 mm (T8 lamp)

A T8 fluorescent lamp with a nominal power of 36 W was positioned with respect to the maximum surface temperature in a thermobox at a defined and regulated ambient temperature and in horizontal and axial orientation, using additional supplied power to the electrode. The thermocouple to measure the surface temperature was positioned at the place where the temperature of the ignition-relevant surface is highest.

The temperature of the lamp's surface at an additional electrode power of 0 W corresponds, in this case, to self heating of the fluorescent lamp at a power dissipation of the electrode that had been burnt-in for approx. 100 hours. The additional electrode power according to **FIGURE 10** corresponds approximately to a power dissipation in the electrode of a fluorescent lamp in operation with additionally fed DC power, which represents the increased power dissipation in the electrode caused by the ageing effect.

The course of the heating curves of the 36 W T8 fluorescent lamp can, based on comparison measurements also with 58 W T8 lamps performed, be considered as typical for fluorescent lamps with a diameter of 26 mm in the range of the electrode power of 6 W to 10 W with regard to the slope of the characteristic curve and with regard to the influence of the ambient temperature.

In the range of the electrode power from 6 W to 9 W (**FIGURE 10**), the characteristic curves increase with a mean value of 29 K/3 W (9.7 K/W). When the ambient temperature of the lamp increases and when the electrode is heated, the surface temperature of the lamp increases by an amount of 8 K when the ambient temperature of the lamp varies by 15 K (0.53 K/K). These factors are used in the following conversions of measurement results.

2.2.2 Variation of the heating curve of fluorescent lamps with a diameter of the glass bulb of 26 mm (T8 lamp)

To go from the typical characteristic curve to the "worst-case" safety-relevant curve, the temperature of the lamp's surface in the area of the electrode was measured at an ambient temperature of 25 °C and an additional electrode power of 8 W on fluorescent lamps from 10 different manufacturers (36 W and 58 W, 4 lamps of each category: Radium (Germany), OSRAM (Germany), Sylvania (Germany), Philips (Poland), GE (Hungary), NARVA (Germany), AURA (Sweden); and F32 lamps, 4 of each type: NARVA (Germany), USA, Canada).

Since the electrode power of 10 W currently is the switch-off threshold specified in the standard [7] for ballasts for T8 fluorescent lamps in explosion protected luminaires, the measured values (8 W, 25 °C) were converted into the electrode power of 10 W and the ambient temperature of the lamp of 75 °C using the factors determined above. The conversion results are shown in **FIGURE 11**.

2.2.3 Safety-relevant heating curve of fluorescent lamps with a diameter of the glass bulb of 26 mm (T8 lamp)

From the maximum surface temperature of the measured T8 fluorescent lamps, the worst-case safety-relevant heating characteristic curve can be determined with the aid of the above-mentioned factors for the range of 6W to 10W additional electrode power (**FIGURE 12**).

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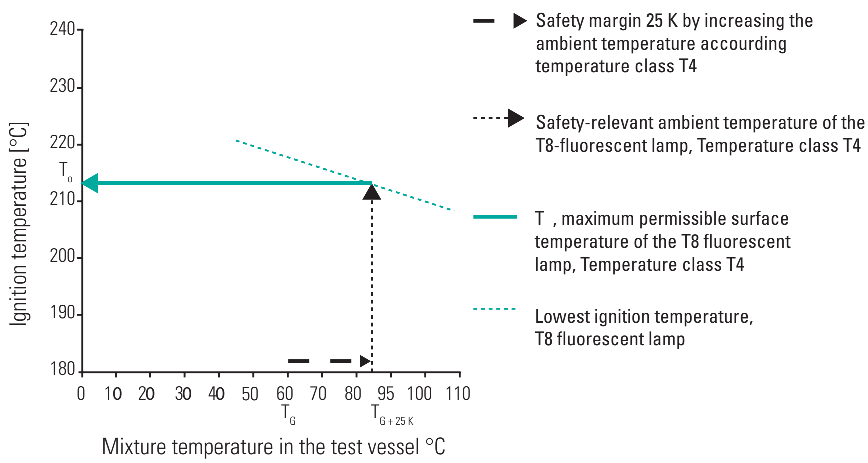

BILD 9
Estimation of the maximum permissible surface temperature of T8-lamps, mixture starting with an initial temperature of 60°C

MAXIMUM PERMISSIBLE SURFACE TEMPERATURE OF T8 FLUORESCENT LAMPS, TEMPERATURE CLASS T4

	SAFETY FACTOR OF 25 K IMPLEMENTED THROUGH	
MIXTURE TEMPERATURE	INCREASE OF AMBIENT TEMPERATURE	INCREASE OF TEMPERATURE OF THE COMPONENT
40°C	218°C	198 °C
60°C	214°C	195 °C
75°C	211°C	190 °C

MAXIMUM PERMISSIBLE SURFACE TEMPERATURE OF T5 FLUORESCENT LAMPS, TEMPERATURE CLASS T4

	SAFETY FACTOR OF 25 K IMPLEMENTED THROUGH	
MIXTURE TEMPERATURE	INCREASE OF AMBIENT TEMPERATURE	INCREASE OF TEMPERATURE OF THE COMPONENT
40°C	226°C	206 °C
60°C	223°C	202 °C
75°C	221°C	200 °C

The heating curve is based on measurements of the surface temperature of fluorescent lamps from 10 different manufacturers. At present, it is not known whether T8 fluorescent lamps for explosion protected luminaires are available throughout the world whose surface temperature – measured under the conditions described in this report – would lie above the worst-case temperatures determined to date (**FIGURE 11**).

The proposal currently discussed within the scope of the revision of EN/IEC 60079-7 relating to the switch-off threshold of electronic ballasts for fluorescent lamps with a bulb diameter of 26 mm in explosion protected luminaires provides for the following differentiations (**FIGURE 13**):

- 10 W at a maximum ambient temperature of the luminaire of 40 °C;
- 8 W at a maximum ambient temperature of the luminaire of 60 °C;
- 10 W at an ambient temperature of the luminaire of up to 60 °C for temperature class T3.

2.2.4 Temperature class T3 for luminaires with fluorescent lamps with a diameter of the glass bulb of 26 mm (T8 lamp)

Temperature class T3 requires compliance with a maximum surface temperature of 200 °C.

Taking into account a maximum ambient temperature of the luminaire of 60 °C and a switch-off threshold of 10 W of the electronic ballast this limit temperature is exceeded.

When the maximum surface temperature of temperature class T3 is exceeded, the safety should, as described above, be determined by means of ignition tests with gas/air mixtures [7] which are representative for temperature class T3.

Ignition tests with the hot, inhomogeneous heated surface of fluorescent lamps for temperature class T3 have not been performed yet.

A reference point to determine a permissible surface temperature of the T8 fluorescent lamp, when the maximum surface temperature of 200 °C at a luminaire assigned to temperature class T3 is exceeded, is provided in literature [3]. According to this report, the maximum permissible surface temperature, taking a safety interval of 50 K [7] for the worst-case T3 substance (interpolated to a mixture temperature of 80 °C), would be around 235 °C.

2.2.5 Summary of the results of the investigations and safety assessment for fluorescent lamps with a bulb diameter of 26 mm (T8 lamps)

In **FIGURE 14** the maximum permissible surface temperatures of T8 fluorescent lamps are displayed, taking the safety factor (horizontal lines) and the temperature class into account.

There is also an indication, how the safety factor was implemented and which temperature of the explosive mixture has been assumed.
The standard allows the implementation of the safety factor by increasing the ambient temperature (VB = increase of the temperature of the explosive mixture during the test).

The different service conditions of a luminaire as well as the safety-relevant variations at the lamps during service life are not considered here.

2.3 Heating curves of fluorescent lamps with a diameter of the glass bulb of 16 mm (T5 lamp)

The proposal currently discussed within the scope of the revision of EN/IEC 60079-7 relating to the switch-off threshold of electronic ballasts for fluorescent lamps with a bulb diameter of 16 mm with a nominal power of 8 W and for fluorescent lamps with a nominal power of 14 W, 21 W, 28 W, and 35 W in explosion protected luminaires provides for the following differentiations with regard to the lamp type, temperature class of the luminaire, ambient temperature of the luminaire and switch-off threshold of the electronic ballast:

T5 fluorescent lamp, nominal power 8 W:

- temperature class of the luminaire T4, ambient temperature of the luminaire up to 60 °C, switch-off threshold 5 W.

T5 fluorescent lamps,
nominal power 14 W, 21 W, 28 W, and 35 W:

- temperature class of the luminaire T4, ambient temperature of the luminaire up to 40 °C, switch-off threshold 5 W.
- temperature class of the luminaire T4, ambient temperature of the luminaire up to 60 °C, switch-off threshold 4 W.
- temperature class of the luminaire T3, ambient temperature of the luminaire up to 60 °C, switch-off threshold 5 W.

2.3.1 Fluorescent lamps with a diameter of the glass bulb of 16 mm (T5 lamp), rated power 8W

The thermal measurements to determine the heating curve of the 8 W T5 fluorescent lamp were performed at lamps from three different manufacturers, at 30 lamp ends in total (**FIGURE 15**). The course of the heating curve of the 8 W T5 lamps could, due to the properties and behaviour of the lamp during the electrical load of the electrode, be measured up to an electrode power of approx. 2.4 W so that the temperature values for higher electrode powers had to be calculated by extrapolation (**FIGURE 16**).

For comparison, the lamp's temperature at an ambient temperature of the lamp in the range from 25 °C to 75 °C reaches values around 300 °C when the fluorescent lamps are switched off by the electronic ballast (not designed for explosion protected luminaires) at an electrode power of 7.5 W, in accordance with IEC 61347-2-3 [6] – the switch-off threshold for electronic ballasts for T5 fluorescent lamps.

The horizontal lines show the maximum permissible surface temperature of the 8W T5 lamps dependent upon the maximum ambient temperature of the luminaire. The temperatures at the lamp surface are displayed in relation, given that the power dissipation in the electrode at the moment of switch-off of the lamp by the electronic ballast does not exceed the assigned value. The data are valid for the corresponding maximum surface temperature of the luminaire. From the diagram it is to be seen:

1. One lamp type is suitable to widely comply with the maximum surface temperature of the lamp up to a threshold value of the electronic ballast of 5.5 W and a maximum permissible ambient temperature of the lamp of 60 °C.
2. If the specifications shall be valid for all types of T5 lamps with a rated power of 8W, the threshold value for a maximum permissible ambient temperature of the luminaire of 60 °C would have to be lower than 4W.
3. A T3-classification of the luminaire would be possible, if the maximum permissible ambient temperature of the luminaire would be 40 °C and the threshold value of the electronic ballast would be 5 W. This is based on the values for the thermal ignition of 50 mm diameter pipes known from literature.

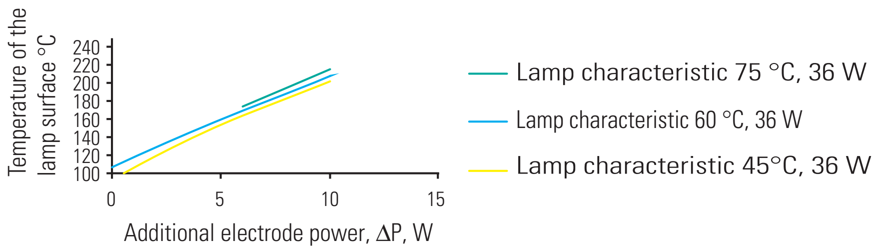

FIGURE 10
Heating curve, T8 fluorescent lamp, 36 W (lamp side without printed indications)

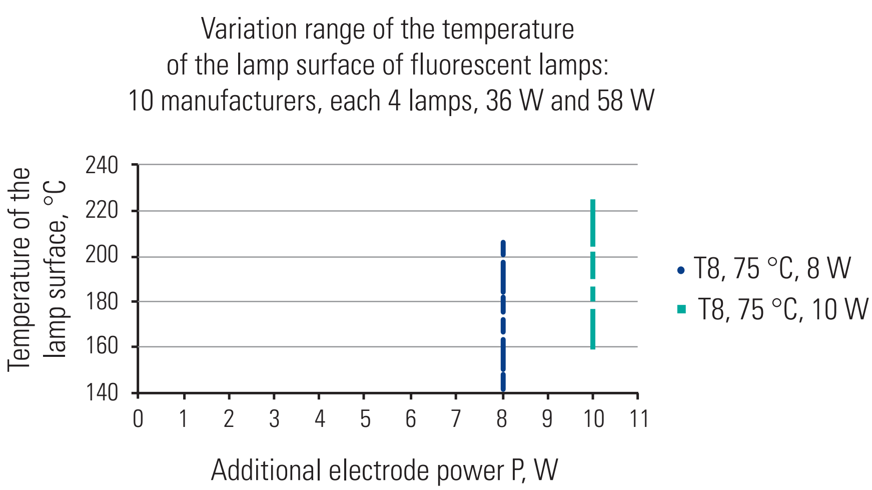

FIGURE 11
Variation of the surface temperature of T8 fluorescent lamps of different manufacturers, measured at 25 °C/8 W, converted to an ambient temperature of the lamp inside the luminaire of 75 °C and an electrode power of 10 W

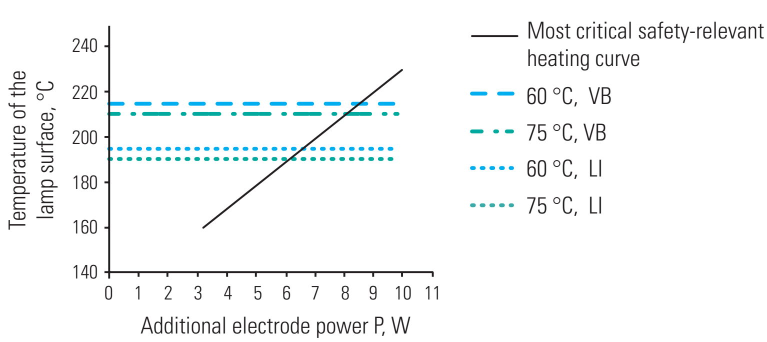

FIGURE 12
Safety-relevant heating curve of the fluorescent lamps having a bulb diameter of 26 mm with relation to the maximum permissible surface temperature, depending on the safety assessment, temperature class T4

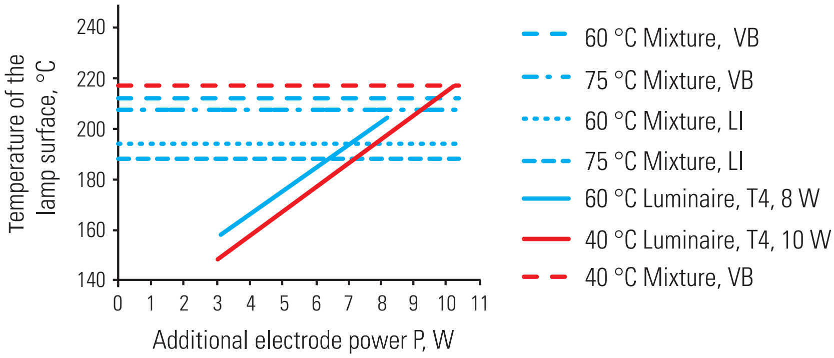

FIGURE 13
Heating curves based on a limitation of the electrode power to 10 W with a maximum ambient temperature of the luminaire of 40 °C resp. to 8 W with a maximum ambient temperature of the luminaire of 60 °C – temperature class T4 with relation to the maximum permissible surface temperature (T8 lamp), depending on the safety assessment procedure
Safety factor VB = increase of the temperature of the explosive mixture
Safety factor LI = safety factor linear: increase of the temperature of the component (the lamp)

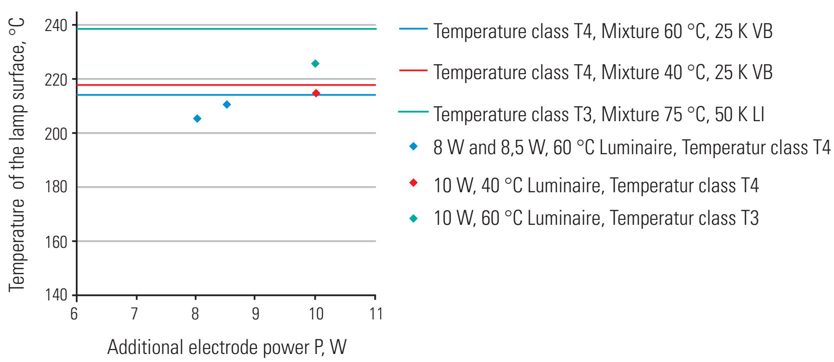

FIGURE 14
Variant for the interpretation of the results of the thermal tests and the ignition tests with T8 fluorescent lamps. The maximum permissible surface temperatures (horizontal lines) are related to the calculated temperature of the lamp surface, achieved when the power dissipation of the electrode in the instant of switch-off does not exceed the specified value, and based on the maximum ambient temperature of the luminaire

Basically, for the specification of the threshold switch-off values of electronic ballasts for T5 fluorescent lamps the following considerations should apply:

1. The relevant ignition temperature is not far from the maximum permissible surface temperature, if the safety factor is implemented in the form of increasing the mixture temperature by 25 K.
2. The variation of the surface temperature depending from the electrode power for these lamps was estimated to a value of kP = 22 K/1W ± 5 K/W.
3. The distance between electrode and glass surface is quite low.

2.3.2 Fluorescent lamps with a diameter of the glass bulb of 16 mm (T5 lamps), rated power 14 W to 35 W (HE lamps)

The thermal measurements to determine the heating curves of the T5 fluorescent lamps, rated power 14 W, 21 W, 28 W, and 35 W, respectively, were performed at lamps from three different manufacturers, on a limited number of lamps. The course of the heating curve could, due to the properties and behaviour of the lamps at higher electrical loads of the electrode, not be reproduced, so that a worst-case heating curve could only be approximated for this group of lamps.

The worst-case heating curve represented in **FIGURE 18** is based on the measurement of a few fluorescent lamps with a rated power from 14 W to 35 W from four different manufacturers as well as on the subsequent extrapolation of the temperatures measured with an electrode power of 5 W and an ambient temperature of the lamp of 75 °C.

For T5 fluorescent lamps with a rated power of 14 W to 35 W (HE lamps) in luminaires classified temperature class T4 also the ignition temperatures found for lamps with a diameter of the glass bulb of 16 mm apply. Applying the safety factor, the results of the maximum permissible surface temperatures of the lamp are displayed as horizontal lines in **FIGURE 19**.

If the luminaire is classified in temperature class T3, for a maximum ambient temperature of the lamp inside the luminaire of 75 °C a maximum permissible surface temperature of 235 °C for the T5 fluorescent lamp applies (**FIGURE 19**) and [3]). Otherwise, more detailed investigations would be necessary.

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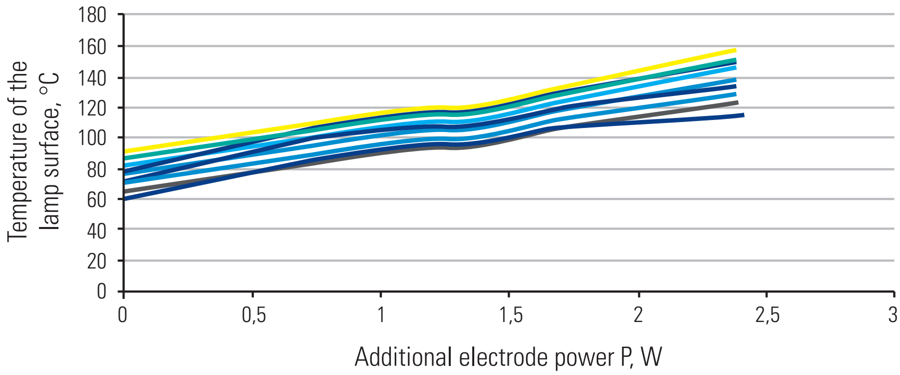

FIGURE 15
Heating curves of the random samples of T5 lamps, 8W, and ambient temperature of the lamps 25°C

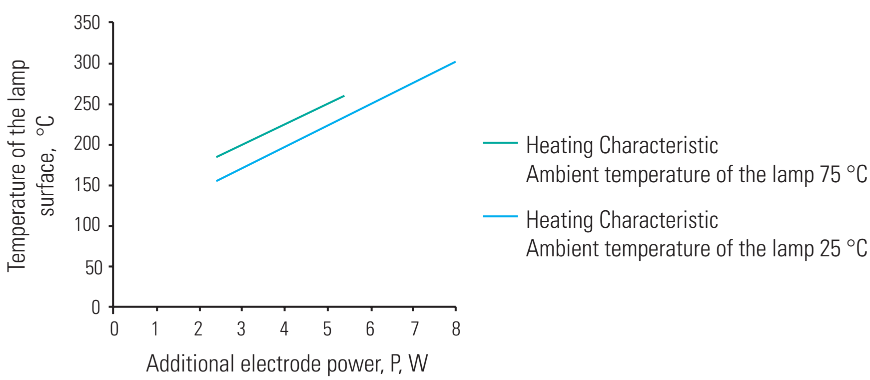

FIGURE 16
Heating curves of the random samples of T5 fluorescent lamps, 8W, determined by extrapolation

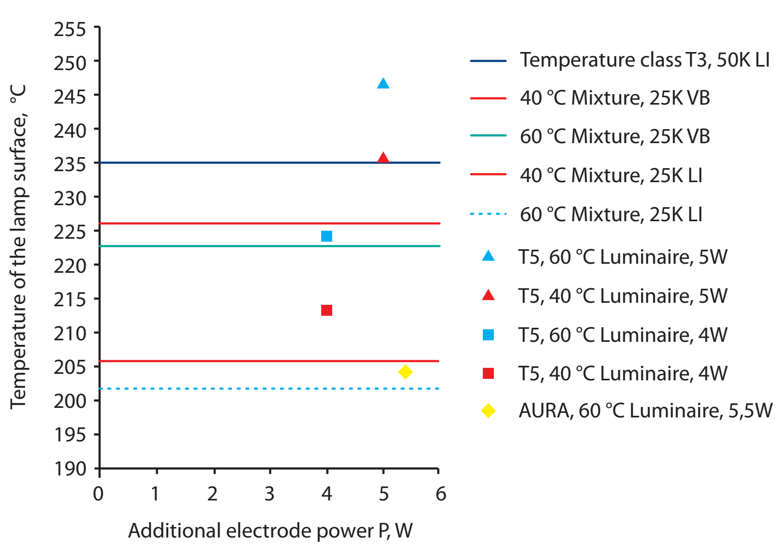

FIGURE 17
Variant for the interpretation of the results of the thermal tests and the ignition tests with 8 W T5 fluorescent lamps.

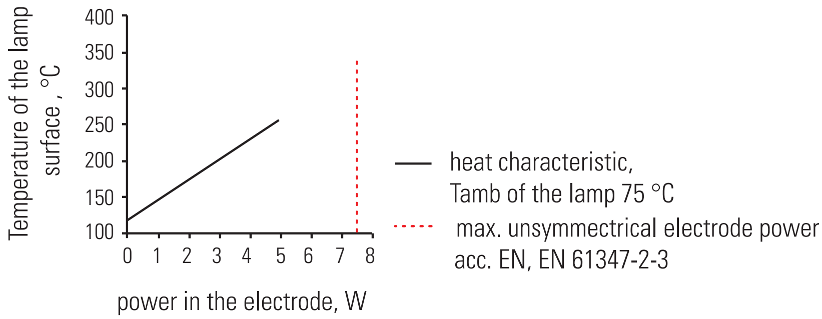

FIGURE 18
Temperature measurements at T5 fluorescent lamps, length 549 mm to 1449 mm

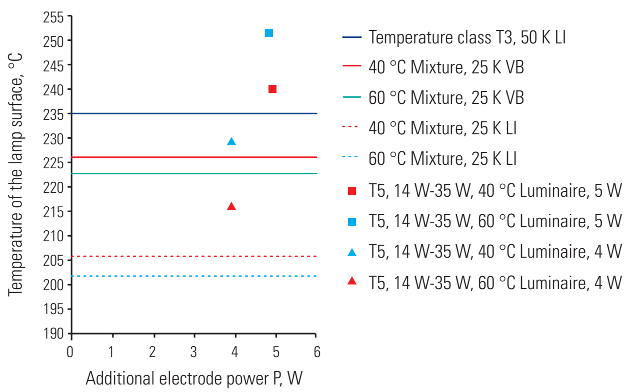

FIGURE 19
Variant for the interpretation of the results of the thermal tests and the ignition tests with T5 fluorescent lamps, rated power 14 W to 35 W

3. SUMMARY

Temperature class T4
From the results of the investigations it is to be seen, that the compliance with the maximum permissible surface temperature for T5 lamps in the power range from 14 W to 35 W are only possible and acceptable up to a maximum ambient temperature of 40 °C for the luminaire and a switch-off threshold of 4 W for the electronic ballast. Here, a full loaded through-wiring would cause a higher temperature rise, this would imply an even lower threshold value.

Temperature class T3
If the luminaire would be classified T3, the maximum permissible surface temperature of 235 °C could be complied with, given a maximum ambient temperature of 60 °C and a switch-off threshold of 4 W.

Current investigations aimed at determining the ignition temperature of fluorescent lamps with a nominal bulb diameter of 26 mm and 16 mm in connection with thermal measurements to determine the heating curve have yielded switch-off criteria for electronic ballasts. The results serve as a basis for discussion for the risk assessment of increased temperatures at the surface of fluorescent lamps at the end of their service life when electronic ballasts are used in explosion protected luminaires of temperature classes T4 and T3, of categories 2 and 3 resp. EPLs Gb and Gc in accordance with EN/IEC 60079-0.

Within the scope of the safety assessment, attention must be paid to the fact that no special fluorescent lamps are used in the explosion protected luminaires, but only commercially available lamps for general lighting and the that the trend to even less use of material in the lamps and the development of powerful ballasts are to be considered.

The future development of lamp construction will have to be observed and is clearly not under control of the explosion-protection standards. It thus remains the responsibility of the international standardization committees of IEC to assess the results described here and implement them into the standards, based on the best possible consensus.

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INTRODUCTION OF THE INTERNATIONAL "PTB EX PROFICIENCY TESTING SCHEME" FOR COMPARISONS BETWEEN EX-LABORATORIES

BY UWE KLAUSMEYER, JIA WU, TIM KRAUSE, THOMAS HORN, ULRICH JOHANNSMEYER

In the field of explosion protection, the steady increase in international networking of industry and progressing economic integration have also increased the necessity for standardised systems for the conformity assessment of equipment used in explosion protection, thus lowering trade barriers in the process. The IECEx system is a worldwide standardised test and certification system for explosion protection which is recognised by numerous countries with its numbers growing continuously. The tests are conducted on the basis of international IEC Standards and the certificates issued accordingly. These certificates are recognised in whole or in part by the participating countries and save the manufacturers of Ex equipment the additional expense of multiple approvals. In future, only a single certificate will be necessary to ensure worldwide marketing approval of the products. This growing harmonisation in the conformity assessment of explosion protection can only work if all those involved operate with the same fundamentals and deliver comparable quality. To ensure this, there are standardised regulations based on IEC Standards on the one hand, and now the additional active participation in interlaboratory comparisions. The "PTB Ex Proficiency Testing Scheme" is the first all-embracing proficiency testing program of its kind in explosive protection. It serves as proof of competence and offers the test laboratories a complete system for performance assessment.

FIGURE 1
Test Sample "EP"

1 INTRODUCTION

As a result of the IECEx Meeting in Denver 2007, the working group ExTAG WG10 was assigned the task of examining the options for conducting interlaboratory comparisons as round robin tests in explosion protection. As a consequence, and due to the growing importance of developing a system of proof of competence for the test laboratories, in 2009 in Melbourne, the chairman of the ExTAG WG10 was able to announce that the PTB had established a project team to actively take on this matter. In September 2009, the project named "PTB Ex Proficiency Testing Scheme" commenced, with PTB acting as coordinator.

The pilot phase with selected measuring parameters for the ignition protection types flameproof enclosures "d" and intrinsic safety "i" was completed successfully by July 2012 with the 44 participating laboratories. The fruitful results and positive feedback from the participating laboratories led to the decision to continue the proficiency testing project and expand it further. To this purpose, the new programs "Temperature Classification" and "Flame Transmission" will be conducted during the period 2013/2014.

2 OBJECTIVES AND PURPOSE

Due to steadily growing globalisation, the demands on test laboratories have increased enormously over the past few years. To meet this demand and comply with standardised requirements, it was necessary for the test laboratories to prove their competence. In principle, the Standard ISO/IEC 17025 [1] requires that all accredited laboratories should participate in interlaboratory comparisons. The "PTB Ex Proficiency Testing Scheme" has now become a major element for meeting this requirement through its various programmes.

The practical experience gained from conducting the individual programs ensures that the entire proficiency testing project is continuously developed further and improved. The ultimate objective is to achieve a step-by-step extension to all areas of conformity assessment within the framework of the IECEx system.

The results of the programs are of direct benefit to all participants, i.e. for:

- proof of competence for customers, regulators and endusers,
- for detecting and avoiding problems in and between the laboratories and the introduction of countermeasures,
- for determining the effectiveness ("Capability") and comparability of the applied test and measuring methods,
- for creating additional customer confidence,
- for avoiding unfair competition between manufacturers who are customers of the laboratories, and
- for furthering the "fair play" culture.

3 PTB EX PROFICIENCY TESTING SCHEME

A large number of tests and conformity assessments were conducted at an international level as part of the IECEX system for the ignition protection types flame-proof enclosures "d" and intrinsic safety "i". For this reason it was intended to conduct a proficiency test for exactly these ignition protection types. All participating laboratories met the requirements of the Standard ISO/IEC 17025 [1], which defines the "General requirements for the competence of testing and calibration laboratories". This provides a major precondition for the homogeneity and stability of the "Proficiency Testing Scheme" as part of the IECEx system. The design of the overall PTB Scheme takes the requirements of the ISO/IEC 17043 [2] Standard into account.

It is assumed that the routine processes of the respective test laboratories are applied to conduct the individual programs. The routine process is described by the basic standard of the respective type of ignition protection. This means that the basic standard of the respective ignition protection type needs to be applied as base for the selection of measurands to be compared, Standard IEC 60079-1 [3] for "d" and Standard IEC 60079-11 [4] for "i". Supplementary framework conditions for conducting the respective programs are given by the coordinator in the form of task descriptions, the so-called "Procedure Instructions".

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FIGURE 2
Contact array of the spark test apparatus according to IEC 60079-11

FIGURE 3
Test Sample "SI"

NO.	TYPES OF CIRCUITS
1	ohmic
2	ohmic
3	inductive
4	capacitive
5	ohmic – inductive – capacitive
6	ohmic – inductive – capacitive
7	electronic current limit
8	electronic current limit
9	electronic current limit
10	electronic current limit
11	electronic current limit
12	capacitive

TABLE 1
Kind of circuits, at the test equipment

3.1 Program "Explosion Pressure"

To determine the reference pressure as part of the "Explosion Pressure" program, the coordinator provides each participant with a test item (Test Sample "EP") consisting of two steel tubular chambers of different lengths which are sealed with flanges on both sides (**FIGURE 1**). To increase the variation options of the configuration, the test sample is equipped with a bore hole as orifice with a diameter of 15 mm. The simple design assures homogeneity and stability throughout the entire performance of the test. In addition, the selected design of the test sample allows favourable manufactruing, preparation and shipping. To assure comparability, all the test samples were prepared by PTB to ensure uniform positioning of the test bore holes. The participants also adapted preparation if required.

The reference pressure was determined for the individual chambers respectively as well as for the chambers with orifice and two gas-air mixtures selected according to IEC 60079-1 [3]. Based on four configurations of the test sample "EP", as well as two different gas mixtures and five ignitions each, a total of 40 explosion tests including pressure measurements need to be completed by each participant in the program. The requirements defined in the above mentioned standard as well as generally in ISO/IEC 17025 [1] are to be complied with for all measurements performed.

3.2 Program "Intrinsic Safety"

In the program "Intrinsic Safety", the ignition ability of twelve different circuits (**TABLE 1**) is compared through ignition tests using the standardised spark test apparatus according to IEC 60079-11 **(FIGURE 2)** [4]. It should be noted here, that the result is not a physical measure but a statement on the ignition ability of the respective circuit as result of the experiment.

Some of the test circuits were taken from the IEC 60079-11. In addition circuits were also added to the comparison which contained mixed reactants and therefore demonstrated a dynamic behaviour. The participating test centres were not aware of the features of the circuits to be tested so as to ensure objective conducting and homogeneity of the tests, and to exclude subjective influences with regard to the test results. The tests were performed with a mixture with a volume ratio of 21% hydrogen in air.

The number of contacts until ignition was determined for each circuit, and this test was then repeated 20 times. The arithmetic mean from the random sample values was passed to each participant as result for each test circuit. To obtain a comparison of the results between the individual participants, a reference value was required - to be precise, the so-called assigned value. As the random sample values of the experiment with the spark test apparatus did not stem from a universal set with normal distribution, the robust algorithms suggested in [5] could not be used to determine the assigned value. In a first approach, the random sample values of all participants of a circuit type were used to determine the arithmetic mean [6].

FIGURE 4
Nozzle of Test Sample "FT"

All results of the participants were included equally (with identical weighting) into the calculation of the test circuit-specific assigned values.

From a quantitative view, a comparison of the results of the individual participants was made via the performance key parameters. A simple performance key indicator is the difference between the participant's result and the assigned value. The quotient of this difference and the assigned value is referred to as the percentage difference ([5]). As this deviation component does not possess an absolute character, a comparison of the performance key parameters over the various circuits is possible.

3.3 Program "Flame Transmission"

The general test method for the "Flame Transmission" program is described in the ignition protection type Flame-proof enclosures "d", IEC 60079-1 [3]. A main characteristic for the test and the safety assessment is the experiment for flame transmission, which is a crucial criterion for the design of "d" products. For this reason, the flame transmission behaviour is the characteristic which was selected as comparative measure in the program.

The test sample "FT" consists of two steel tubular chambers of differing lengths, identical to test sample "EP" from the "Explosion Pressure" program. In addition it consists of a further prepared flange and three different nozzles **(FIGURE 4)**.

To ensure comparability and homogeneity, all the "FT" test samples were developed and manufactured entirely by the coordinator.

3.4 Program "Temperature Classification"

In the program "Temperature Classification", the temperature of the hottest point (maximum surface temperature) is the crucial criterion for testing and evaluating the safety of electrical equipment in explosion protection. For this reason, the maximum surface temperature was chosen as the measure to be compared in the program, as this is the most common source of ignition in practice.

The "TC" Test Sample consists of a steel heating block with four heating cartridges as well as three different surface materials, copper, plastic (polycarbonate) and glass. The "TC" Test Sample is heated with the four heating cartridges until the thermal state of equilibrium is reached. In the program, the maximum surface temperature corresponds to the end temperature of the surfaces. The end temperature is regarded as being reached once a temperature increase of max. 2 K/h is not exceeded.

Once the end temperature is reached, the temperature is to be determined at the hottest points of the prepared surfaces. Another part of the program consists of the task of finding the so-called "hotspot", the hottest point on the test sample. To ensure the homogeneity of the test samples, the development, manufacturing and control of the test samples is performed by the coordinator.

4 RESULT

4.1 Test Round "d"

An interesting result of the "Proficiency Testing Scheme" is the analysis and evaluation of the "Explosion Pressure" program. The task was to conduct an explosion pressure measurement as pre-defined in Standard IEC 60079-1 [3] with pre-defined identical test samples and conditions from the provider. By assigning the same measuring task to all laboratories, the intention was to find out whether the laboratories participating in the proficiency testing program would come to similar results.

Following the analysis and evaluation of the provided results there were more or less significant differences for various configurations in the determination of the reference pressures. As the "true value" was unknown, the reference value was calculated as robust mean value according to ISO 13528 [5] from the results of all participants.

Execution of the program was divided into two phases. After the first test run and subsequent evaluation, the laboratories were given the opportunity to repeat the tests. During this repeat phase, the coordinator was available to the laboratories for individual professional consultancy.

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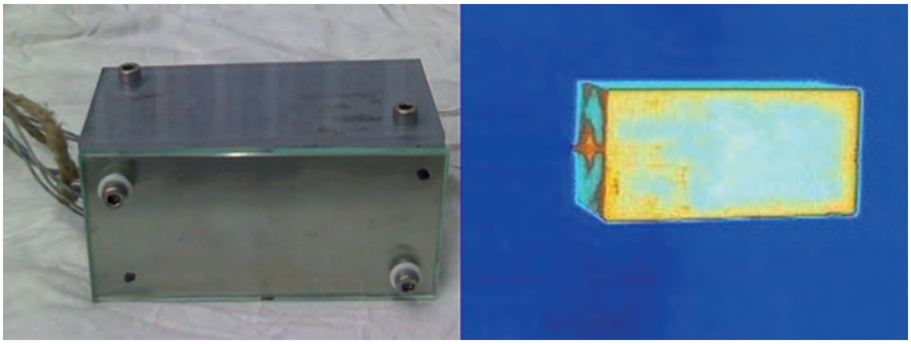

FIGURE 5
Test Sample "TC"

The graphic representation of the results gives a good overview of the distribution of results compared to the reference value. As an example, the results for a configuration without orifice with an ethylene-air mixture are given in **FIGURE 6**: if the distribution of the results of the first phase (**FIGURE 6**) are compared with the results of the second phase (**FIGURE 7**), it can be observed that the scatter between laboratory results was reduced significantly. The standard deviation of the reference value was reduced by 22% between phases 1 and 2. This trend was also observed for the other configurations.

4.1 Test Round "i"

The following is to give insights on the results of the first "i" test round.

The descriptive statistics describe a random sample of statistical parameters. To enable a comparison of the described parameters of various random samples, it proved opportune to present these jointly in a box plot. **FIGURE 8** shows the scatter parameters (i.e. spread, interquartile range test) and the position parameters (arithmetic mean, median) as an example of the random sample of each participant for circuit number 1.

At first glance, a broad distribution of values can be observed which cannot be compared with those of general metrology. This characteristic is representative for all random samples in the "i" test round. In addition, the distribution of the random sample values was not symmetrical for all participants for each circuit. When taking all circuits and participants into account the relative standard deviation (variation coefficient) as a dimensionless measure of scatter varied by a value of 1.

FIGURE 9 gives an example of the participants' results in relation to the assigned value for this circuit and its standard deviation. In principle, some "outliers" were observed for every circuit in terms of higher contact numbers.

For example, relative difference as the performance parameter showed a relative deviation from the assigned value of up to +210% for circuit 1 (**FIGURE 10**). Including all the trial circuits, maximum deviations of up to +495% were observed.

However, a major deviation of the result from the assigned value to a participant does not imply the same pattern for all circuits. Also, no correlation could be established between participant-specific result deviations and specific circuit types.

The deviations in results between the participants and the deviations with a random sample are partially due to the test method. For example, in tests with the spark test apparatus, the metrological imperative of complying with exact initial conditions for each individual test could not be adhered to. Conditions may also change during the experiment. Parameters, such as for example, the quality or condition of the electrodes, the gas composition, moisture as well as electrical parasitic effects influence the ignition process. Studies published in this field have not yet been able to comprehensively quantify the impact dimensions, which makes the provision of rules for reducing scatter dimensions difficult.

The significant broad scatter of the results in their current form is however not regarded as being critical to safety. Ignition testing to evaluate the intrinsic safety with the spark test apparatus was conducted on the assumption of numerous "worst case" conditions which do not occur together in practice. However, the divergent results between the various test laboratories may result in an economic bias which needs to be levelled.

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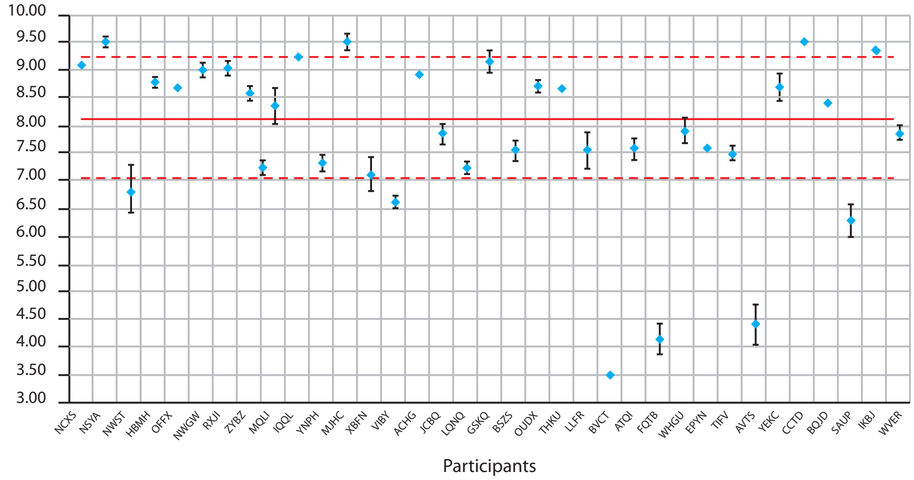

FIGURE 6
Results of the comparative measurement for a configuration without orifice with an ethylene-air mixture in phase 1

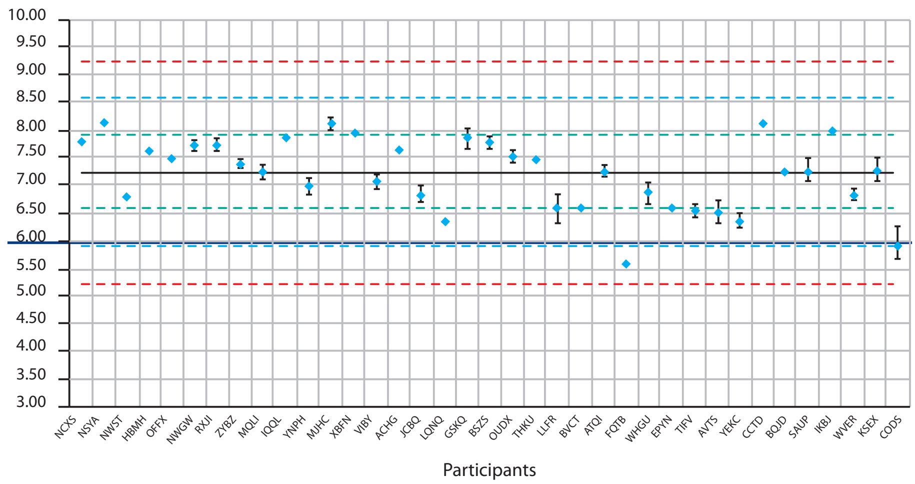

FIGURE 7
Results of the comparative measurement for a configuration without orifice with an ethylene-air mixture in phase 2

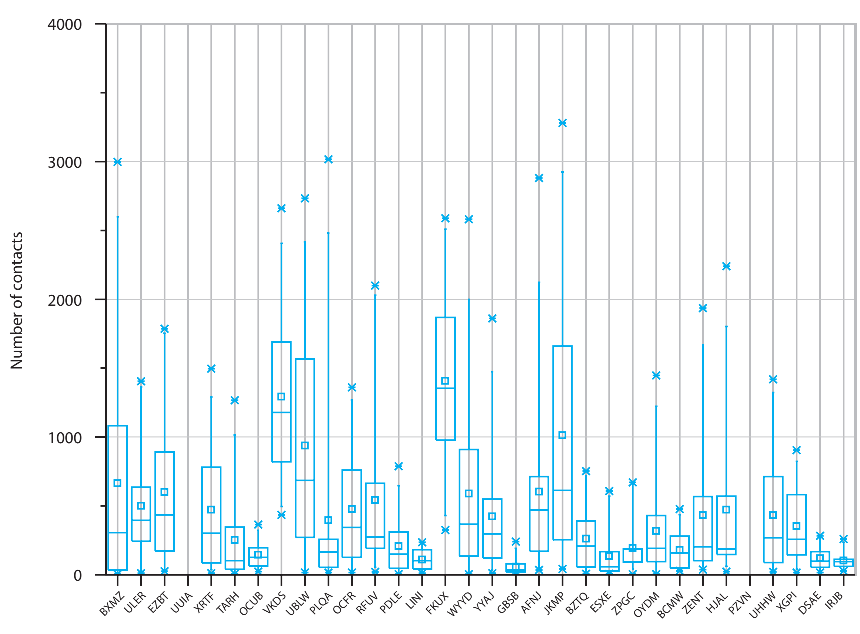

FIGURE 8
Box plots of the random samples of the 32 participants for circuit number 1 (the participant codes on the x-axis are encoded, antennas: 5% and 95% quantiles; Cross: max. and min.; small square: arithm. mean value)

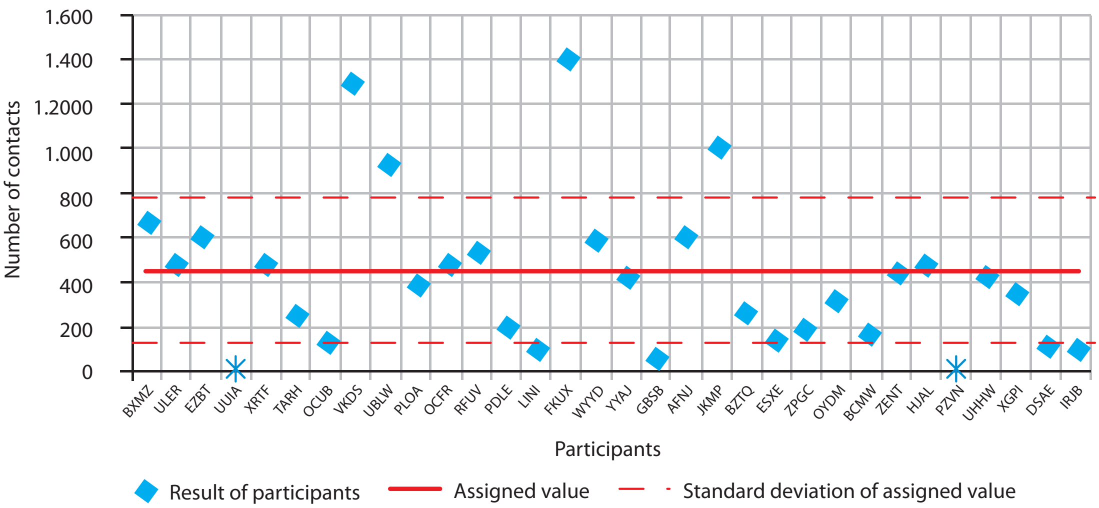

FIGURE 9
Results of the individual participants for circuit 1 (participants UUIA and PZVN did not provide usable results)

5 SUMMARY

The evaluation of the pilot phase of the proficiency testing program between international test laboratories has shown differing results in the determination of comparative benchmarks despite using uniform standards and pre-defined boundary conditions in the comparison program. A major part of the "Proficiency Testing Scheme" therefore consists of interpreting the results and subsequent intensive discussion on measuring methods, as well as workshops. Together with the participating laboratories, measures and comments are discussed, which are published as a so-called "Best Practice Paper" after completion of the comparative programs and which can be regarded as supplementary instructions to the requirements of the standards. The individual programs are repeated in cycles to achieve improvement in quality for all concerned in the long term. As the national German institute of metrology, the PTB will remain permanently responsible for the scientific follow-up, in particular for the development of the comparative methods, their methodology and evaluation algorithms. Further, it is planned to also develop methods for determining the measurement uncertainty of individual measuring setups in addition to the measurands. On average, it is intended to develop two new comparative methods every two years until complete coverage of all relevant test methods has been achieved.

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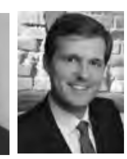

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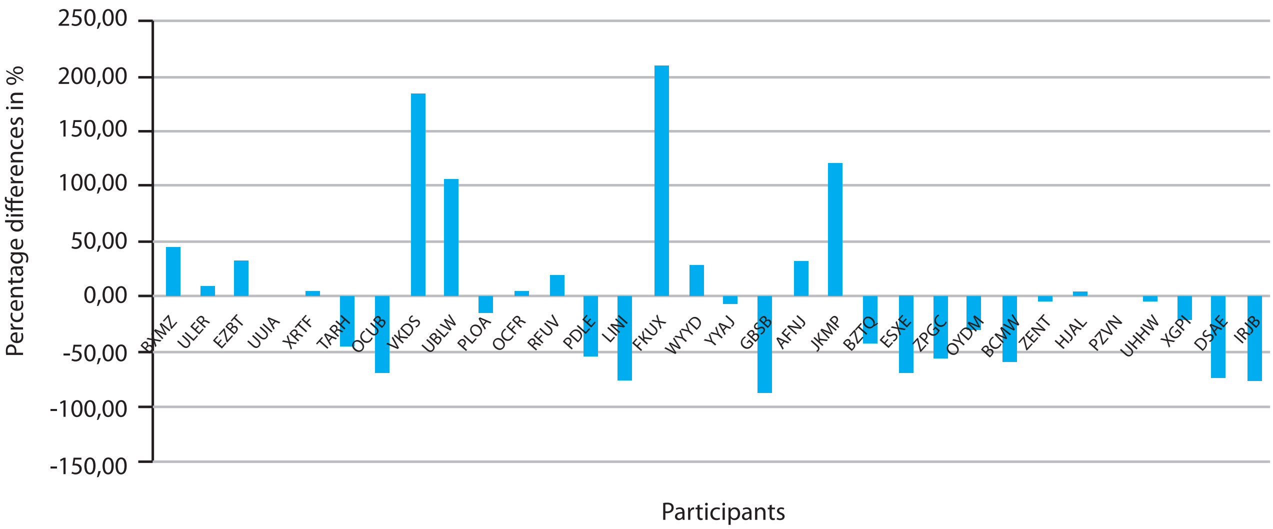

FIGURE 10
Relative difference to the assigned value of the individual participants for circuit 1

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THE NEW ORDINANCE ON WORK EQUIPMENT AND PLANT SAFETY – ARBMITTSICHV – AND EXPLOSION PROTECTION

BY URSULA AICH

The German Federal Ministry of Labour and Social Affairs (BMAS) is in the process of preparing a revision of the Ordinance on Industrial Safety and Health (BetrSichV). This draft was made available to the public in mid-2012 on the internet site of the BMAS for commenting purposes and has also been discussed extensively in the Advisory Committee on Protection at Work (Ausschuss für Betriebssicherheit, ABS). The BMAS has a new concept and has made structural and linguistic changes. The regulations are grouped together with a view to contents (e.g. basic obligations, extended obligations, maintenance and operational malfunctions). The previously applicable Appendix 1 containing minimum requirements of work equipment and Appendix 2 for using work equipment have largely been redefined as protection goals and included in the operative part. It is politically desired to design the BetrSichV as a pure work safety regulation, whose requirements apply to all work equipment and also to industrial plants. The group of protected persons includes employees and "other persons" (for the operation of installations subject to mandatory inspection), but does not include the general public, the protection of the population or the protection of the environment. The BMAS starts from the essential prerequisite for the safe use of work equipment that only safe work equipment shall be made available which satisfy in particular the requirements of the Product Safety Act (ProdSG). However, wherever the ProdSG is not applicable, such as process plants, the protective measures for operation result from the requirements of the BetrSichV and the employer's hazard assessment. Installations subject to mandatory inspection are regarded as an historic relic and as a national particularity exceeding EU legislation. The suitable measures in each case must be defined by the employer. In general, the measures are those of the customary work safety guidelines.

MODIFICATION OF THE ORDINANCE ON HAZARDOUS SUBSTANCES

During revision, the contents of Appendices 3 and 4 of the BetrSichV have been moved to the Ordinance on Hazardous Substances. Appendix I Number 1 of the previous Ordinance on Hazardous Substances shall be supplemented accordingly while making editorial changes. The test regulations according to Number 3.8 of Appendix 4 of the BetrSichV shall remain within the ordinance. Also included in Appendix I is the request to observe safety clearances when storing hazardous materials. A safety clearance is the required distance between storage locations and persons to be protected, while a protective clearance is the required distance for protecting the storage from exposure to external hazards.

SIGNIFICANT CONTENTS AND AMENDMENTS OF THE REVISION OF THE ORDINANCE ON INDUSTRIAL SAFETY AND HEALTH (BETRSICHV)

- The hazard assessment is introduced as a central element for defining protective measures also for the operation of installations subject to mandatory inspection (previously referred to as safety assessment). This also applies to installations subject to mandatory inspection in which exclusively other persons or, in the previous wording, "third parties" are at risk.
- The material requirements of the second section of the BetrSichV must now also be applied to the operation of installations subject to mandatory inspection. This is to ensure that, independently of the protective objective, uniform requirements apply to all work equipment and plants. This makes the employer and operator also responsible for defining the extent of the protective measures in respect to the operation of particularly hazardous plants, thus deemed as subject to mandatory inspection. Special requirements are only those with respect to the inspections to be performed.
- The previous material requirements are maintained, but are now formulated as protection goals. They apply to all work equipment, irrespective of whether they are old or new or self-produced. The employer is obliged to decide with sole responsibility as part of a hazard assessment whether or not retrofitting measures are required. This is why the new ordinance does not contain any transitional provisions and in particular no "status-quo" regulations for the unchanged continued operation of existing plants.
- Included are all technical work equipment used for performing a work activity. Not included are typical furnishings such as a cabinet, which must be included in the workplace. A plant is an assembly of machines or devices that are connected spatially and functionally, and also form a unit in terms of control technology and safety. Installations subject to mandatory inspection (in particular requiring inspection and in some cases requiring approval) are named concretely and definitively in Appendix 2, since the test specimen must be clearly designated. Installations subject to mandatory inspection are equivalent to work equipment as specified in directive 2009/104/EC.
- The employer obligations for the provision of work equipment compliant with the internal market and their testing was modified, in order to achieve more legal clarity. Article 5, paragraph 3, of the draft requests that the employer may only make available and allow the use of work equipment that comply with the legal provisions applicable to them on safety and health protection. These legal provisions include, apart from the provision of this ordinance, in particular legal provisions used for implementing EU-directives in German law and applicable to work equipment at the time of placing on the market. Work equipment manufactured by the employer himself for his own purposes must comply with the basic safety requirements of EU-directives to be applied. They do not have to comply with the formal requirements of these directives, unless it is stated otherwise in the directive concerned. This will be the case starting with the new ATEX Directive 2014/34/EU from 26 March 2016, as it provides a self-production regulation. The existing difference between "change" and "significant change" is also no longer applicable.
- The inspection obligations for work equipment and plants particularly subject to mandatory inspection (because particularly hazardous) are grouped together plant-related in accordance with individual ordinances valid prior to 2002 and listed in appendices of the ordinance. The new Annex 3 opens up the possibility of including newly identified plants particularly subject to mandatory inspection in the ordinance with minimum effort. However, it may also be necessary to adjust the protective measures to a special group of persons. The term "change subject to testing" replaces the terms "change" and "significant change". Whether a measure affects the safety of specific working equipment shall be decided by the employer as part of a hazard assessment.
- Since an explosion hazard is primarily due to a hazardous substance, the hazard assessment and the definition of protective measures for explosion protection are now also performed exclusively according to the Ordinance of Hazardous Materials. The same applies to the documentation of this hazard assessment. Article 9, paragraph 4, of the draft of the BetrSichV then establishes that for work equipment used in areas with a potentially explosive atmosphere the required protective measures must be taken in compliance with the Ordinance on Hazardous Materials, using in particular the devices suitable for the relevant zone. Prior to the first use of the work equipment, these protective measures must be documented in the explosion protection document according Article 6, paragraph 8, of the Ordinance on Hazardous Materials.
- Annex 2 contains concrete requirements and definitions for installations subject to mandatory inspection from Article 1, paragraph 2, Article 2, paragraph 11 et seq. (Scope, Definitions), Articles 14, 15 (First and Recurring Tests) Article § 17 in connection with Annex 5 (testing of special pressure equipment) and of the Approved Inspection Authority (Article 20) from the BetrSichV in revised form adjusted to the state of the art.

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EXPLOSION HAZARD INSPECTIONS

Annex 2, paragraph 3, describes the regulations for the inspections of "Ex systems". Included in this paragraph have been in particular the extent of the "Ex system" to be inspected and the test procedures substantially following the suggestion by the Advisory Committee on Protection at Work (ABS) Subcommittee 3 Study group "Fire and Explosion Protection". Accordingly, in practice there will be no changes with respect to the test procedures and to the extent of the system to be tested. For the test procedures, special qualification requirements have now been established in the ordinance itself and qualified inspectors will be used. This concept has now also been applied by the BMAS to storage facilities, filling stations for flammable liquids, and airfield filling stations, which were previously tested by an Approved Body (zugelassene Überwachungsstelle ZÜS). In contrast, filling stations for motor vehicles remain subject to testing by an Approved Body, since these stations are used by everyone.

The Upper House might require some modifications refering to the inspections by the Approved Body (Zugelassene Überwachungsstelle ZÜS), because the Federal States want to keep the previous scope of the inspection obligations.

- For inspections, a legal replacement rule was introduced, in order to avoid double tests with tests from other legal areas; this also applies to installations subject to mandatory inspections and refers in particular to explosion protection. The option of having plants particularly subject to testing, tested by one's own employer / operator in sole responsibility instead of by an external Approved Body (zugelassene Überwachungsstelle ZÜS) shall be extended.
- In the future, in-house Approved Bodies shall be admitted.
- The maintenance regulations shall be improved not only with a view to the safe state of the work equipment but also with a view to the maintenance activity itself, thus placing greater importance on an area with a high frequency of accidents.
- The obligations to obtain a permit according to current law are maintained. However, it will now also be necessary to submit a statement from an Approved Body (zugelassene Überwachungsstelle ZÜS) for storage facilities, for flammable liquids in mobile tanks and for airfield filling systems. The obligation to obtain a permit now only applies to the first installation, while for changes in design or in the operating mode a notification instead of a change permit is sufficient, to make it easier on the employer. From the point of view of the law enforcement authorities, this is viewed skeptically.
- Until clarification, the transitional provisions of the BetrSichV shall be maintained (see Article 27 of the BetrSichV).
- The Directive 2006/123/EC on services in the internal market ("EU Services Directive") does not have to be applied to tests in the area of installations subject to mandatory inspection, as these are mainly tests for the protection of employees. For work safety, an exception has been included in the EU Directive.

SUMMARY

The revision of the BetrSichV and the amendment to the Ordinance on Hazardous Substances do not raise new requirements for operational practice. In some areas, they rather constitute an adjustment to the existing procedures in plants. Nevertheless, due to the fundamentally new structure and the move of the explosion protection requirements in the GefStoffV and BetrSichV rise for discussion may come up. In the Upper House of the German Parliament (Bundesrat), the federal states can still propose amendments. Accordingly, the above statements must be viewed with this reservation.

WHEN IS THE REVISION LIKELY TO COME INTO EFFECT?

On August 27th 2014 the German Government has decided on the new Ordinance on Industrial Safety and Health (BetrSichV). After approval by the Upper House (Bundesrat) the Ordinance will be put into force in the beginning of 2015.

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ROBOGAS INSPECTOR RESEARCH PROJECT:

DETECTING GAS LEAKS WITH AUTONOMOUS MOBILE ROBOTS

BY ABDELKARIM HABIB, GERO BONOW, ANDREAS KROLL, JENS HEGENBERG, LUDGER SCHMIDT, KASSEL, THOMAS BARZ, DIRK SCHULZ

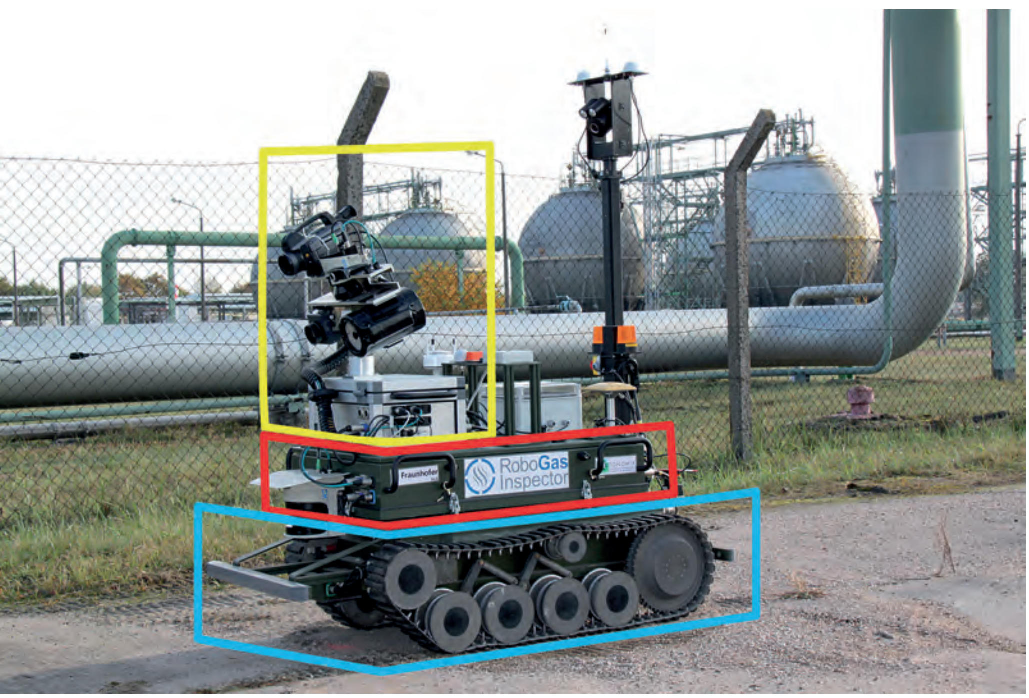

FIGURE 1
RoboGasInspector-inspection robot consisting of platform (blue), navigation module (red) and measuring module (yellow)

Nine project partners developed the prototype of an autonomous mobile robot for detecting gas leaks in extensive industrial plants within the context of the "AUTONOMIK" programme of the German Federal Ministry for Economic Affairs and Energy. The system's autonomous mobility was put into practice using various sensors for auto-localisation and navigation. In addition, it includes an option to intervene manually in the process using teleoperation. Equipped with video and remote gas detection technology, the robot can carry out inspections in industrial plants without having to enter possible hazard areas and without any person present on site.

The robot can be used for routine inspection of plants or systematic examination of specific parts of the plant. Using remote metrology technology, it is also possible to inspect parts of the plant that are difficult to inspect using traditional measuring instruments due to limited accessibility.

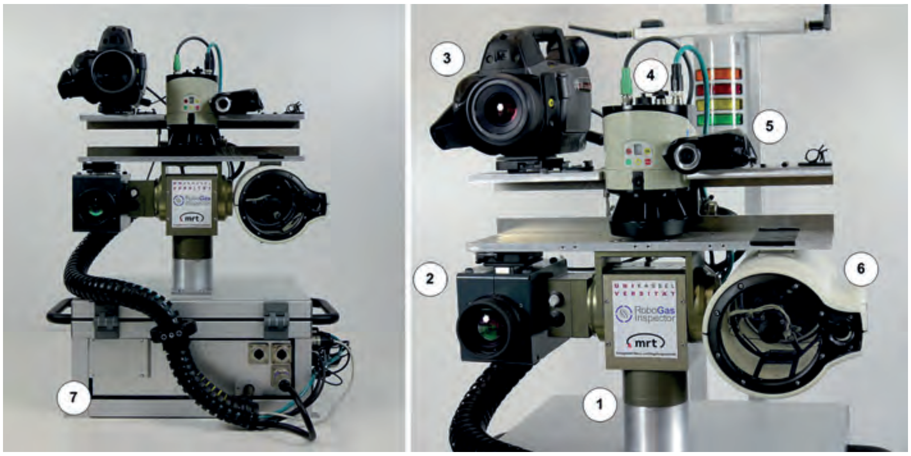

FIGURE 2
Inspection module: pan-tilt unit (1), infrared camera (2), gas camera (3), laser scanner (4), video camera (5), RMLD (6), switch cabinet with computer (7)

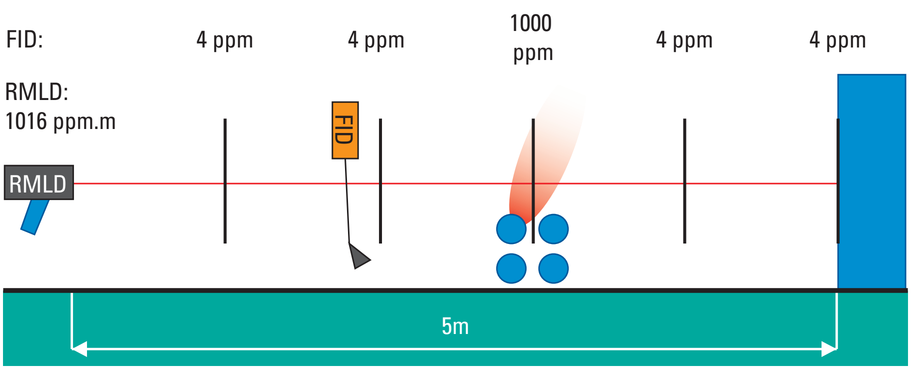

FIGURE 3
Comparison of the measurements made by RMLD and an on-site measuring instrument

In industrial plants, flammable and/or toxic materials are frequently used. To guarantee operational safety and to avoid damage to people, the environment and assets, any unexpected release of material should be avoided. According to the "leak before rupture" assumption generally accepted in the field of safety technology, larger damages of the plants can mostly be anticipated by means of smaller defects that can easily be controlled [1]. Therefore, regular inspections are carried out in plants. The correct working order of the plant is checked by a member of staff, mostly without measuring instruments, and visual, acustic and olfactoric inspection based on his experience.

The RoboGas^Inspector project is aimed at developing and evaluating a human-machine system with autonomous mobile robots, by means of which gas leaks in extensive industrial plants can be monitored and eventual leaks can be located autonomously. The motives behind this project are that an autonomous inspection system promises better quality and efficiency of inspection due to the use of modern measuring instruments, while relieving individuals of monotonous routine tasks. The use of remote gas detection and video technology also permits an objective and quantifiable comparability of the individual inspection travels and measurements. Automatic recording of the results allow plant operators to document monitoring of their systems. In particular in plants with toxic gases, the use of an inspection robot is a great advantage because people no longer have to enter potentially hazardous areas on a regular basis so that the health risk for plant operators can be minimised. In the following, selected results of the RoboGas^Inspector project will be presented.

PROJECT OVERVIEW

In the RoboGas^Inspector project, a prototype of the partially autonomous inspection system was developed and successfully evaluated in several Labscale and field tests. The system includes autonomous mobile inspection robots for detecting gas and locating leaks, telemanipulation robots for remote control of valves [2], for example, and a control room for planning, monitoring, documentation and teleoperation.

The inspection robot consists of three assemblies (**FIGURE 1**): one chain-driven travel platform suitable for outdoor use, one navigation module, and one inspection module. The tEODor platform made by Cobham (telerob Gesellschaft für Fernhantierungstechnik mbH) was specially developed for uses in the field. It consists of an electrical drive system and standard car batteries that also provide energy to the navigation and inspection modules (5, 12 and 24 V). While a detailed description of the hardware used can be found in [3], the following is a short general description. The sensor system of the navigation module includes 2D laser scanners mounted to the front and rear of the robot and a

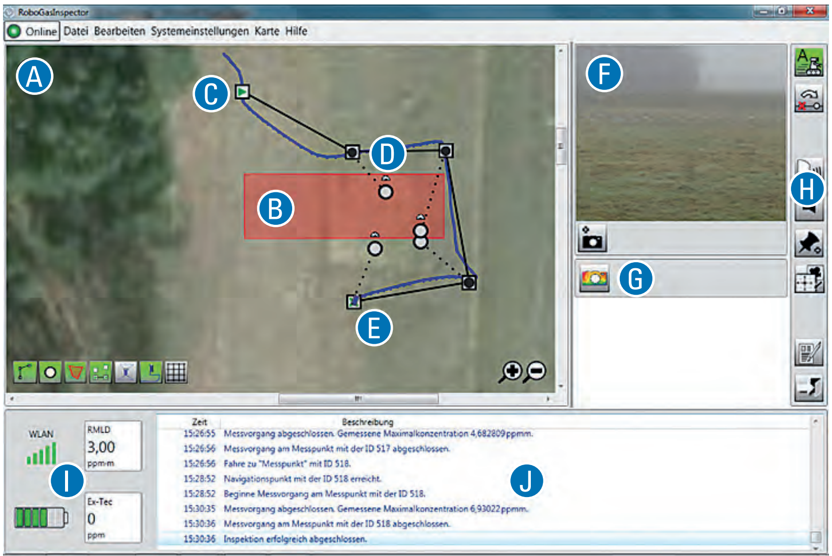

FIGURE 4

Screenshot of the control room software. (A) Zoomable map or satellite image of the area to be inspected. (B) Manually defined restricted area that the robot may not enter. (C) Starting point of the inspection route. (D) Point at which a function is required. At this point, an inspection measurement was defined – the target is shown by the white circle coneced with a dotted line, (E) End point of the route. The blue line shows the actual travelled path. (F) Image of the robot's video camera. (G) Additional views, e.g. for infrared or gas camera. (H) Operating elements. (I) Status displays for robot and gas detection technology. (J) Protocol of all status messages

(D)GPS receiver. The GPS system is mainly intended for field use with good GPS reception. (D)GPS is mainly used for auto-localisation and navigation of the robot in open areas without obstacles. For navigation in interiors, areas with impaired GPS reception and many obstacles, the 2D laser scanners are used. Based on the previously uploaded digital map of the area to be travelled, the robot continuously verifies the actual distance measured by its 2D laser scanners. This procedure allows the robot to notice where it is located in the map and where to expect obstacles. In addition to actual physical obstacles, areas which the robot may not enter may also be marked on the map (e.g. Ex 1 Zones, areas with obstacles that are difficult to detect, etc.). The 2D laser scanners are also used for detecting obstacles not marked in the digital map. These might be moving vehicles or persons on the premises, or static objects, such as pallets or barrels. If the robot detects an obstacle in its route, the data is used to avoid a collision and to calculate a bypass route. If a bypass is not possible, the robot waits until the route is clear . Furthermore, there are inclination sensors that guarantee that the robot does not move on inclined surfaces which could cause it to tilt.

The inspection module (**FIGURE 2**) consists of a pan-tilt unit (PTU, Schunk PW90), on which the systems for remote gas detection are mounted. Remote gas detection technology mainly consists of an active TDLAS-based (Tuneable Diode Absorption Spectroscopy) remote methane leak detector ("RMLD" provided by SEWERIN). The sensor emits an infrared laser beam. If the laser beam hits a surface, it is diffusely reflected, and the remaining intensity being reflected is measured by the RMLD. Contrary to normal lasers, the RMLD laser permanently switches between two wavelengths. If the beam hits methane on its way, the laser light is absorbed – depending on the gas concentration – with one wavelength, while methane does not have any effect on the laser light when the reference wavelength is active. The RMLD converts the difference between the light intensities into an integral gas concentration using the Lambert-Beer law. Conventional gas measurement instruments installed on site give the gas concentration in ppm or % by volume. In contrast, the RMDL gives the concentration in ppm • m since the measurement is not made at a point but over the measuring path through which the laser beam shines. Whether there is a large cloud with low concentration or a small cloud with high concentration in the measuring path cannot be detected by an RMLD measurement (**FIGURE 3**).

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FIGURE 5
Plants for plant tests: PCK petroleum refinery in Schwedt/Germany (top) and GASCADE natural gas compression station in Reckrod/Germany(bottom). Photos: PCK and GASCADE

RMLD measurements depend on the measuring path length. To take into account such dependency, the inspection module has a laser distance meter that returns the measuring path length for each RMLD measurement. In the RoboGas^{Inspector} system, the integral gas concentration measured by the RMLD is divided by the measured path length. Therefore, the resulting gas concentration in ppm is the average gas concentration in the measuring path. By comparing it with the natural gas concentration, a potential leak may be detected more easily and reliably. Furthermore, an infrared camera (InfraTec VarioCam hr head) and a passive remote gas detection system (gas camera FLIR GF320) are mounted on the inspection module [3]. Using the infrared camera, leaks may be detected because they have different surface temperatures. Either due to hot spots when hot gases escape or cold spots that are produced at the leak when gases expand and cool down. On the other hand, the infrared camera can also be used to detect other undesired conditions in the plant, e.g. overheating ball bearings of pumps or leaking liquids that produce a cold pool when evaporating. The gas camera used is able to detect other gases, e.g. from the homologous series of alkanes, in contrast to the RMLD that can only detect methane. As the camera is a passive measuring instrument (only the thermal radiation of the background is used), its sensitivity in contrast to the active RMLD (RMLD sensitivity with a measuring path length of 30 m is 10 ppm • m) is 100 times lower. As it cannot be excluded at all times despite the remote gas detection technology used, that the robot may be surrounded by a potentially explosive atmosphere (e.g. by sudden changes of the wind direction or gas releases), there is an on-site gas sensor (Sewerin EX-TEC HS 680) whose alarm output switches off energy supply to the entire system when a value of currently 4% of the LEL of methane is reached. For remote diagnosis and teleoperation, there is a video camera mounted on the measuring module. Its image can be retrieved from the control room (**FIGURE 4**) so that the operator can inspect in detail certain parts of the plant without having to be present on site. Furthermore, the inspection robot has computer systems for autonomous navigation and gas leak detection as well as a WLAN data conection (IEEE 802.11bgn). This is used for transferring all measured data to the control room and, if required, for remote control of the robot from the control room. Having analysed the tasks in detail, the division of work between human beings and machine was defined [4]. The "Human-Machine Systems Engineering" department of the University of Kassel planned, implemented and evaluated the HMI interface in the control room. The navigation and mobility algorithms (Fraunhofer FKIE) and the gas detection and leak localisation strategies (Department of Measurement and Control of the University of Kassel) were developed and tested in simulations and extensive field tests. Tests and simu-

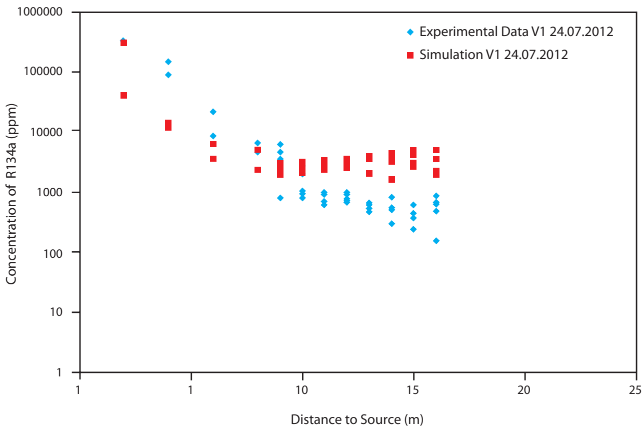

FIGURE 6
Comparison of the measured values of the concentration over the distance from a point source with a mass flow of 55 g/s R134a with the results of the simulation using ANSYS CFX

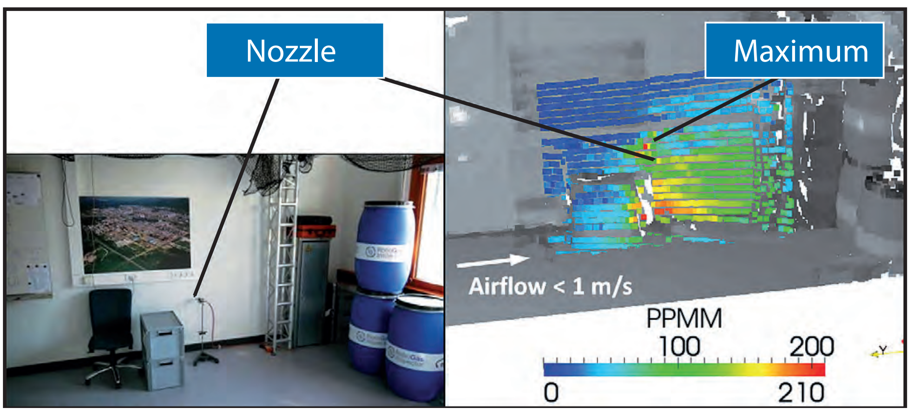

FIGURE 7
Test measurement with RMLD in the laboratory with a leak mass flow of 2 mg/s (methane 2.5) without considering the measuring path length

GAS PROPAGATION AND SYSTEM TESTS

lations on gas dispersion were carried out in the German Federal Institute for Materials Research and Testing (BAM) so as to have data as realistic as possible for developing the gas detection and leak localisation strategies [5]. Experimental data obtained in field tests were used to validate the simulations with the CFD program ANSYS CFX. The results of the simulations, on the other hand, were used in the robot simulations to develop gas detection and leak localisation algorithms. Functionality of the RoboGas[Inspector] system was tested and demonstrated in extensive plant tests. Functionality of the entire system with autonomous navigation and leak detection in real plants (**FIGURE 5**) was tested at the project partners GASCADE and PCK.

In the gas dispersion tests realized at BAM, R134a with mass flows of approx. 50 g/s was released at the BAM Test Site Technical Safety in Horstwalde. To create a dispersion situation as realistic as possible, a cylinder with a diameter of 5 m and a height of 4 m was built. It was used as a flow obstacle and represented a tank as it can be found in industrial plants. Simulations of this scenario with ANSYS CFX showed good conformity with measurements. By way of example, **FIGURE 6** shows the comparison of the measured maximum concentration with the maximum values of transient simulation for a test. At each x-th position, there were several sensors located next to each other during the measurements. The measured values and associated simulation results of all sensors are shown in **FIGURE 6** so that a variability of the measured concentration is represented for each distance. Considering the total of all experiments, simulation shows a quite good concentration gradient in terms of quality and quantity.

This data was then used in developing the leak localisation strategies, which were again tested in laboratory and field tests. Leaks are located in a multi-level procedure. First, the direction of the maximum visible gas concentration is determined. **FIGURE 7** shows test under laboratory conditions. In this test, methane with a mass flow of approx. 2 mg/s was released from a nozzle with a diameter of 0.1 mm (more or less the quantity released from a gas lighter). Even if no absolute concentrations can be read, at least the visible maximum and areas with potentially increased concentrations can be seen quite clearly. On this basis, RMLD scanning at the inspection site was first carried out using a coarse screen. When a significant concentration is detected, the direction to the potential leak is determined following the concentration gradient and using each time a finer screen (dynamic

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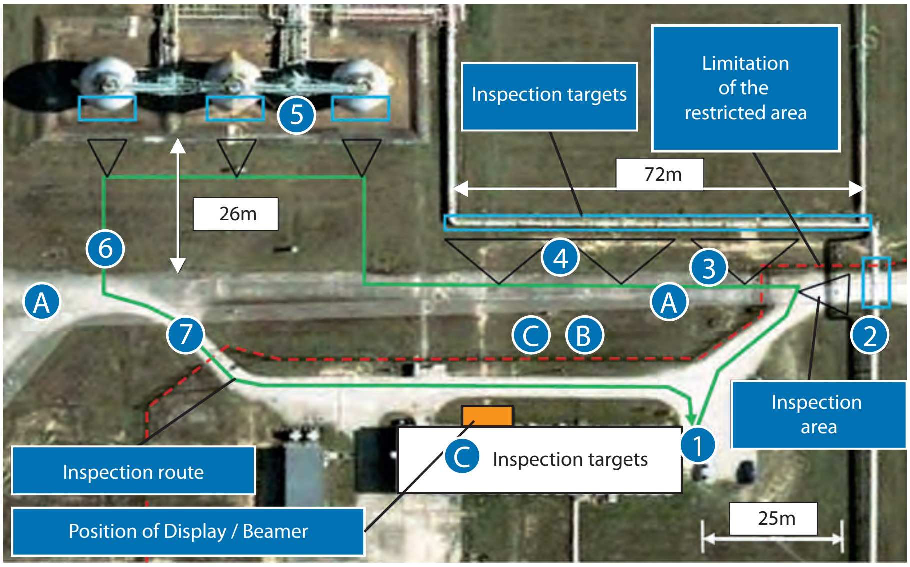

FIGURE 8
Final test in the PCK refinery in Schwedt/Germany to demonstrate the functions of the RoboGas^Inspector system (background: Google Maps)

screen-based detection strategy DRS [6]). The robot is then moved laterally to the assumed leak position, and the process is repeated. Based on the measurement results from different points of view, the leak is then located by means of triangulation.

In addition to various tests, a plant test was carried out at the end of the project. This was to demonstrate all functions of the robot. The test route is shown in **FIGURE 8**. The test route between point 1 and point 7 is of special interest. The points A to D show demonstrated additional tasks, such as testing the Emergency Stop system that switches off the energy supply to the robot when 4% of LEL of methane are exceeded (point C), demonstration of the control room with regard to inspection planning and monitoring (point D) and teleoperation (point B). The test route starts and ends at point 1. On this route, a pipe bridge (point 2) and pipelines (point 3) with randomly positioned, simulated leaks have to be inspected and the leaks have to be located. At point 4, a defined restricted area has to be circumnavigated to then approach inspection point 5. While robot localisation and navigation between points 1 and 5 are based on 2D laser scanners and the digital map, navigation of the free space between points 5 and 7 is GPS-based. At point 7, an artificial bottleneck was simulated with barrels. The robot was moved through by means of teleoperation and then continued autonomously to its starting point. The navigation and inspection tasks were carried out perfectly. **FIGURE 9** shows the concentration scans of the RMLD along the pipeline with a simulated leak at inspection point 3. While the robot is located in the lower area of **FIGURE 9**, the pipeline from **FIGURE 8** can be clearly seen in the upper part of the image. The gas cloud around the simulated leak with a maximum concentration at the simulated leak (red dots in the scan) can be seen. The robot also detected it as such. In the final tests, the position of the simulated leaks was located within approx. 3 min with a precision of 0.5 m (1 s), using a volume flow rate of 150 l/h. Similar results and further details of the leak localisation strategy are presented in [7].

CONCLUSION

The prototype of an inspection and service robot system developed in the RoboGas^Inspector project for autonomous gas detection and leak localisation makes possible a remote inspection and localisation of possible gas leaks on parts of an industrial plant due to the remote gas detection technology used. It is also possible to inspect points that are difficult to access due to their positions. In most cases, a sufficient distance to the leak may be kept. This avoids the robot entering a potentially explosive atmosphere. In detailed test series, the system prototype has proven its functionality and met all requirements with regard to mobility and inspection functions. However, further development with regard to explosion protection, mobility, sensor system and software development (e.g. acc. to ISO/IEC 9126), for example, is still required before it can be used in the industry. In addition to technical issues, legal issues with regard to autonomous operation (e.g. product liability, warranty, etc.) have to be clarified for commercial use.

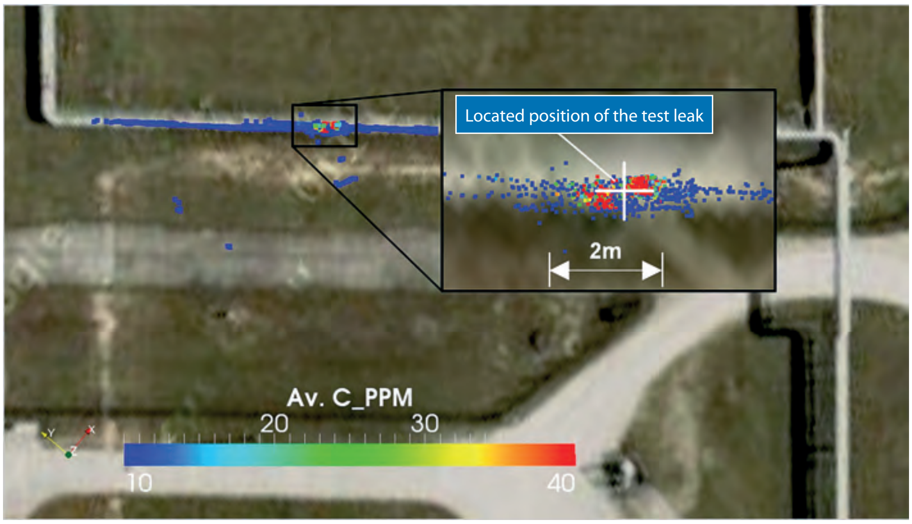

FIGURE 9
Overlapping processed measured values of the RMLD at the pipeline during final tests. The position of the test leak (WGS 84: N53.10810, E14.23158) can be clearly seen. The robot could locate it in three steps (background: Google Maps)

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US STANDARD DEVELOPMENT AND THE IEC STANDARDS

BY JIM ROCCO (ONLY CAPITEL IV), BRAD J. ZIMMERMANN

FIGURE 1
United States Coast Guard Cutter Shermann

I. HISTORY OF US STANDARDS AND CODES IN HAZARDOUS (CLASSIFIED) LOCATIONS

NEC® – Class, Division

The National Electric Code (NEC®) was first published in 1897 and is known as NFPA70. Updated every three years, the current revision of NFPA70 is the 2014 revision. This document serves as the installation guide for electrical equipment in the United States. It is for all electrical installations, not just for hazardous (classified) locations.

The sections of the NEC® that relate to hazardous (classified) locations have developed over several major steps. The NEC® first introduced the concept of "extra hazardous" locations in 1923. The introduction of "groups" to differentiate between the hazards associated with different materials came in 1937. The two division system to differentiate between varying levels of risk and release was then introduced in 1947.

This code specifies which products can be safely installed in the area, but not how the area should be classified. The classification of hazardous locations for gas and vapor is referenced in NFPA497, API500, ANSI/ISA 60079-10-1. For dust locations the classification for areas is ANSI/ISA 60079-10-2.

UL Standards, UL 1203 & UL 1604

The NEC® refers to the use of equipment for hazardous (classified) locations. Area classification is covered by NFPA497 and API500, but these do not cover the requirements of the products to be used in the hazardous (classified) locations. Underwriters Laboratories (UL) wrote the equipment standards by which the equipment is tested. UL 1203 is the standard for equipment to be used in Class I, Div. 1. UL 1604 had been the standard for Class I, Div.2, Class II Div.2 locations. UL 1604 has since been replaced by ANSI/ISA 12.12.01.

ANSI Influence on the process

The American National Standards Institute (ANSI) regulates the process by which a standard is developed and maintained. Every standards writing organization must have the process by which they develop standards approved by ANSI. It is then the responsibility of that organization and ANSI to make sure that the approved standard development process is followed.

NEC®-1996 Edition

In 1996, Article 505 was introduced into NFPA70, NEC®. This article allowed for the classification and requirements for equipment according to the Zone system, AEx approved.

The Zone system was an adoption of the system used in many international locations, particularly in Europe. With this addition there are now two parallel systems for hazardous (classified) location equipment, the Class, Division system NEC® 500-504 or the Zone system NEC® 505 – gas and 506 – dust (introduced in 2005).

II. DEVELOPMENT OF ZONE PRODUCT STANDARDS BY ANSI

ISA takes the Task

An addition to the installation code alone did not help. In the NEC® 1996 edition there was now the new Article 505, which allowed for equipment to be used according to a Zone system, but there were no American product standards for this equipment to be designed, tested and approved. The International Society for Automation (ISA), an ANSI recognized standard writing and development body, began work adopting the IEC 60079 series for hazardous location products, and issued the first set of equipment standards to meet the new AEx marking.

National Deviations – NEC® Driven

The NEC® has been the requirement for electrical installations for many years. With the addition of the Zone system, advantageous protection techniques were introduced resulting in innovative equipment designs. These advantages could never be fully utilized since there was no change to the traditional Class and Division installation methods. This disconection between equipment and installation techniques caused additional issues for those working with the system. Only recently, in the NEC® 2014 edition, was non-armored cable Type TC-ER for use in Class I, Zone 1 allowed (see section VII, A. of this article).

III. FIRST REFERENCE TO ZONE SYSTEM IN NORTH AMERICA

First Introduction

The first proposal of a three Zone system was made in 1971. This initial proposal was based on the IEC system which had already been recognized internationally. While recognized much earlier, it would not be until the NEC® 1996 edition that this system was adopted.

US Exceptions; Birth of AEx

1. Equipment Requirements – Ordinary Locations

One of the major differences between the US Zone system, AEx approved, and the IEC Zone system has always been the way ordinary location requirements are handled. The US notes this difference in that hazardous location protection methods are marked, with the "AEx". The "AEx" is to notify the user that the equipment is to the ANSI/ISA or ANSI/UL standards for the Zone system, AEx approved, and more so to inform the user or installer that the equipment has been tested for the applicable ordinary location requirements as well as hazardous location requirements.

In many parts of the IEC equipment standards, ordinary location requirements are referenced; however, there is no part of these standards which make these references requirements. Ordinary location requirements are in the standards so that the manufacturers are aware of which requirements they need to meet, but unlike in the US Zone system, AEx approved, there is not an approval lab testing in the ATEX or IECEx system for ordinary location requirements.

Adaptors as "Fixes"

Even though the Zone system had been successfully adopted by the NEC® not all of the equipment was ready for immediate use. Every part used to make a standard European part fit into a North American application, as well as any part that is to make a standard North American part fit into a European application was called an adaptor. The two areas that caused the most issues were the types of entries and the equipment voltages.

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FIGURE 2
Source SBM

IV. BRINGING IEC & IECEX TO NORTH AMERICAN MARKET

1. Entry Threads

In the US the predominate entry thread is NPT (National Pipe Thread) type threads; where the rest of the world mostly uses ISO metric straight threads. For much of the available equipment that uses Ex e or Ex d e technology for IECEx or ATEX applications a hole is punched or drilled in the Ex e enclosure and the metric thread is secured by a lock nut. This type of entry is not as effective with a tapered thread as there is no determinate of secured fit. To solve this, many European manufacturers will take the step to install a metric to NPT adaptor to assure that the enclosure is tight; where American manufacturers will use a self-securing nut.

This entry thread difference is further seen in Ex d type enclosures. Where both a metric and NPT thread requires 5 full threads of engagement for field installation; a metric thread will have a shoulder to secure sealing , but an NPT thread will be fitted until tight, and this is usually before the end of the thread (either thread requires 4½ engaged thread for factory installation). In most cases, when an NPT thread has been installed to the end of the threads, it is a sign the thread tolerance is incorrect.

To add to the issues, there is a different tolerance standard for NPT threads between Europe and the US. This often leads to hole and thread engagements that do not mate as they are too tight or too loose.

2. Transformers

Many of the initial issues between equipment used for IECEx or ATEX applications and North American applications revolved around power supplies. The low voltage standard for ATEX or IEC applications rates equipment for 400 V AC; where as in the US this rating is 480 V AC. However, when it comes to where low-voltage is limited, it is 690 V AC per IEC standards and in North America it is limited to 600 V AC. This makes using equipment a challenge when the supply voltages may not meet the equipment rating.

USCG's Intent for clarification
of Hazardous Zone Electrical Regulations,
with excerpts from CDR. Jim Rocco, USCG

The intent of the United States Coast Guard's (USCG) latest regulatory effort addressing electrical equipment installations in hazardous locations is to resolve a regulatory juxtaposition between required U.S. and accepted international standards. The proliferation of equipment installations in hazardous locations approved under the ATEX Directive has brought about considerable inconsistency with respect to determining proper compliance for vessels and MODUs visiting U.S. ports and operating on the U.S. OCS (outer continental Shelf). Existing U.S. regulations addressing hazardous zone requirements make clear the need for such equipment to be "listed or approved". In accordance with the 46 Code of Federal Regulations (CFR) part 111.105-5, "system integrity" prohibits the use of non-approved equipment. By definition, approved equipment is equipment that has been third party tested by a Coast Guard accepted independent laboratory. Thus, self-certification, third party certification provided by a laboratory that is not a Coast Guard accepted independent laboratory, or certification that does not fully test equipment to the applicable international standard, does not meet the requirement in 46 CFR 111.105-5, Through this , USCG generally seeks to clarify the ambiguity that has resulted from these seemingly opposing processes for certification and approval of electrical equipment in hazardous zones.

For hazardous location electrical equipment, the current USCG general system integrity and the equipment requirements accepts several different documents. It refers to equipment and systems that meet the traditional Class, Division system of article 500 of the NEC®; it refers to the Zone system, AEx approved as outlined in article 505 of the NEC®; and it refers to the product standards of the IEC 60079 series. This broad acceptance covers the major protection systems that are recognized throughout the world. The forethought by the USCG recognizes that there are acceptable systems of protecting electrical equipment in hazardous locations outside the U.S. codes, and thus making it possible for vessels that are built for global service to be able to be truly global.

As mentioned above, the USCG's electrical equipment requirements are referenced in the Code of Federal Regulation, 46 CFR 111.105. This CFR allows for a variety of protection techniques, including explosion-proof and flameproof; intrinsically safe systems, and other approved protection methods. The other protection methods specifically referenced in 46 CFR 111.105-15 include the following: "q" sand-filled per IEC 60079-5, oil immersion type "o" per IEC 60079-6, "e" increased safety per IEC 60079-7, "n" non-sparking or energy limitation per IEC 60079-15, and "m" encapsulation per IEC 60079-18.

On any vessel subject to 46 CFR subchapter J, electrical equipment approved for use in hazardous locations must be listed or certified by a USCG accepted independent laboratory. Subchapter J covers electrical systems on several different classes of vessels. The vessels which primarily fall into this requirement are those covered in subchapters D, I, I-A, L, & O which are Tank Vessels, Cargo Vessels, MODUs, Offshore Supply Vessels, and Vessels for Certain Bulk Dangerous Cargoes.

A Coast Guard Notice of Policy was published on December 3, 2012, that provided guidance regarding electrical equipment installations in hazardous areas on foreign-flagged Mobile Offshore Drilling Units (MODUs) that have never operated, but intend to operate, on the U.S. Outer Continental Shelf (OCS). Chapter 6 of the 2009 version of the International Maritime Organization (IMO) Code for the Construction and Equipment of Mobile Offshore Drilling Units (2009 IMO MODU Code) sets forth standards for testing and certifying electrical equipment installations on MODUs. The 2009 IMO MODU Code recommends that electrical installations in hazardous areas be tested and certified in accordance with the International Electrotechnical Commission (IEC) 60079 series of standard(s). The IEC offers an international certification system called the "Certification to Standards Relating to Equipment for use in Explosive Atmospheres" (IECEx). Under the Notice of Policy, the Coast Guard provided interim recommendations to owners and operators of foreign-flagged MODUs that have never operated, but intend to operate, on the U.S. OCS stating that electrical equipment installations in hazardous areas obtain independent laboratory certification under the IECEx system, which include the appropriate IECEx Certificate of Conformities.

In June 2013 a Notice of Proposed Rulemaking (NPRM) was posted to the Federal Register that would add a new subpart to 46 CFR, 111.108. This new subpart is titled "Hazardous locations requirements on U.S. and foreign MODUs, floating OCS facilities and vessels conducting OCS activities, and U.S. vessels that carry flammable and combustible cargo." The purpose of this NPRM was to propose that foreign MODUs, which have never operated on the U.S. OCS, either comply with standards equivalent to the existing regulations for U.S. MODUs or Chapter 6 of the 2009 IMO MODU Code including testing and certification by an independent laboratory under the IECEx scheme. As noted the USCG recognizes that more and more foreign flagged vessels will be built to international standards. Since 2009 the USCG has accepted compliance with the IECEx System, where the electrical equipment for hazardous locations is listed by an IECEx test laboratory and that laboratory is also recognized by the USCG. There are at least 35 USCG accepted independent laboratories worldwide. The NPRM would allow more options for U.S. vessels to test and certify electrical equipment for installation in hazardous locations. In essence, this gives three (3) options for electrical installations in hazardous locations.

The first is to comply with NEC® articles 500-504. The traditional Class, Division area classification with the equipment permissions which are associated with that part of the code, and with the equipment standards that equipment for those areas are tested.

Second would be for the area to be classified to the Zone system, AEx approved as in NEC® article 505, and the equipment to comply with the standards for equipment to meet those requirements. These AEx equipment standards are recognized as ANSI/ISA or ANSI/UL 60079 series.

Finally, the equipment for hazardous locations that comply with IEC 60079 series product standards and tested by an IECEx and USCG authorized test laboratory are allowed for installation.

The final rule to add subpart 111.108 to 46 CFR has not been issued. The NPRM has been closed for comments, and as of May 2014 comments from the posting to the Federal Register are being reviewed by the USCG. Once all of the comments have been resolved, there will be a final rule issued. The final rule will reference when the subpart will take effect.

How the equipment is applied is also influenced in part by the class societies. The organization that classifies the vessel will be involved in the detailed design review. This organization will review how the systems are developed and how they are intended to be installed. The class society will collaborate with the Flag State to which the vessel is being constructed, and will also engage the USCG to determine required compliance for operating in the U.S.. The class society, in coordination with the Flag State, will establish design and installation requirements after which consultation with the USCG may be undertaken to address further clarification or resolve remaining questions as required. For example, the vessel designers request to use a type of equipment which is currently not in use and does not have an IEC standard. The classing society will then make the submittal to the USCG. It is most common for the default answer to be the system is not normally accepted if there is no approved third party listing. Only when there is a unique situation does the classing society make a request of acceptance for equivalent component or system. All exception requests must be submitted for review of equivalency.

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FIGURE 3
Shells platform on the Mars oil and gas field in the Gulf of Mexico, some 130 miles south of New Orleans

The USCG is not the only organization having jurisdiction for MODUs. The Coast Guard's jurisdiction primarily covers propulsion, vessel control systems and classification of hazardous locations (although not explicit, Coast Guard jurisdiction includes equipment certification). The Bureau of Safety and Environmental Enforcement (BSEE) has jurisdiction over all equipment directly associated with the drilling operation (ie. all drill floor equipment, derrick structure & tools, and mud & cement processing equipment).

There is a set of Memorandums of Agreement (MOAs) under the USCG's and BSEE's Memoranda of Understanding that delineate the divisions between each agency's MODU authorities. Details of these authorities may be found in the MOA titled "BSEE/USCG MOA OCS-08". This and other MOA documents may be found at the following website: **HTTP://WWW.USCG.MIL/HQ/CG5/CG522/CG5222/MOU.ASP**.

While this and the other MOAs attempt to clarify the muti-agency oversight that exists offshore, there may still exist some ambiguity in particular circumstances requiring further case by case assessment. In such cases a dialogue between the operator, the USCG, BSEE, the class society, and other stakeholders is critical to resolving unique or otherwise technically complex circumstances. The issuance of the Coast Guard Engineering Policy Letter -(CG ENG Policy Letter No. 01-13 **HTTP://WWW.USCG.MIL/HQ/CG5/CG521/DOCS/CG-ENG.POLICYLETTER.01-13.PDF**) clarified the Coast Guard's position on the USCG-BSEE MOA with regard to USCG jurisdiction on the classification of hazardous locations and equipment certification on FOIs and FPSOs.

It should however be noted that BSEE has not made the same acceptances of the IECEx system as the USCG. BSEEs 30 CFR § 250.114 simply points to API RP 500 or 505 and API RP 14F or 14FZ. Enforcement and verification of compliance with the referenced standards are not clearly addressed in 30 CFR Part 250. For IECEx certified equipment, verification of compliance may require a PE certification. Consequently, a system which has USCG approval may not be accepted by BSEE. In this regard, it is very much up to the vessel designer and builder to work with the class society and the offshore authority having jurisdiction to be sure the planned systems are acceptable.

The US Coast Guard realizes that with so many vessels being flagged in foreign states they are moving toward IECEx equipment for hazardous locations. The Coast Guard is working to keep up to date with the equipment and to make sure that the operations are safe in US waters.

V. AREAS OF SUCCESS AND INTEREST

Arco Alpine Projekt

As discussed in the article "The first zone classified oil and gas facility in North America" by W. Berner, H. Böckle, and R. Seitz (Ex Magazine 2002), the Alaska Alpine Project was the first major new complete oil production facility in North America to utilize the NEC® article 505 Zone system, AEx approved.

OEM- and Skid Builders

Many of the OEM and skid builders, particularly in the Houston area, have been looking for components that can be used on an equipment skid and then supplied to different areas of the world without having to make a modification to the electrical system. The introduction of NEC® article 505 allowed a way for the equipment from Europe to be certified and used in North American systems. Where the installations still need to be per the North American system and the NEC®, the equipment has a chance to be global with multiple certifications.

Customers using the Zone type of equipment in Class and Division applications

While some users have not changed their facilities to a Zone system classification, they have not ignored some of the advantages that Zone type of equipment can provide. For instance, where applications call for circuit breakers or switches mounted in explosion-proof enclosures for Class I, Division 2, the new Class I, Zone 1 equipment mounted in stainless steel or fiberglass reinforced polyester enclosures can now be used as needed for the application. Some features to end users and customers such as the lighter weight enclosures and installations that do not require sealing are advantages the allowance of NEC® 501.5 to use Class I, Zone 1 listed and marked equipment in Class I, Div. 2 provide.

Offshore Rig Users

For many years, the primary push for the Zone system, AEx approved has come from the offshore industry. The desire to use lighter weight equipment, in being able to replace many of the cast type explosion-proof enclosure in place of stainless steel NEMA 4, 4x type or FRP enclosures has always been an advantage in the weight conscience offshore industry. The allowance for the use of shipboard cable in place of MC-HL or conduit has made installation easier for the user.

VI. AREAS NOT SO SUCCESSFUL

Onshore Rig operators

Unlike their offshore counterparts, weight is not as much of an issue for onshore drilling rigs. As the onshore rigs are normally very compact much of the working area of the rig itself is Class I, Division 1, where there is not the same cross-over influence as has been seen in Class I, Divisions 2 applications.

Chemical Industry

There has been little change to the practices in the U.S. chemical industry over the past 30 years. It is estimated that there are more Class I, Division 1 areas classified in a chemical facility than are in a refining facility.

Established Customer Bases, particular by other major suppliers

Some industries are so tied to the current major explosion-proof suppliers that they are not likely to readily change to a different equipment type. This may include some heavy manufacturing, oilfield production equipment, and loading facilities in addition to those previously mentioned industries. Over time these industries have changed at a much slower rate, however there have been signs of change.

VII. UPDATES TO NEC® 505

Flexible Cable in Class I, Zone 1

Installation has always been one of the major hurdles for using equipment in the Zone system, AEx approved. With the NEC® 2014 edition the introduction of TC-ER-HL cable and its allowed use in Class I, Zone 1 reduced the instances where MC-HL cable or conduit were required for use. This new cable allowance is found in the NEC® article 505.15(B)(1)(i), for Class I, Zone 1. This makes such installations easier, and brings the equipment usage in Class I, Zone 1 for the U.S. closer to the Zone 1 installations in other parts of the world and makes the overall installation more economical.

CONCLUSION

Many efforts have been taken up to become more globally harmonized in the application of electrical equipment in hazardous locations. The U.S. Coast Guard has recognized that there is a greater foreign influence in offshore industries than was seen several years ago, and to keep up they have made adjustments. The changes are also influencing the product standards, but this is not just a foreign influence in the American product standards; there is also a definite American influence on the IEC standards. While the North American and IEC standards have become more harmonized; in many regards they are still very far apart. Even though there are some areas of the standards that have a long way to go, we must realize we have already come a very long way in the development of the standards. With the continued efforts of those people who are working towards the common goal of a usable global set of standards, progress is continuously being made.

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LITERATURE

[1]
NFPA 70; National Electrical Code®

[2]
U.S. Coast Guard regulations and requirements, http://www.uscg.mil/hq/cg5/ocsncoe/

[3]
R. STAHL Ex-Magazine 2002

A QUESTION PLEASE...

CUSTOMERS ASK – WE ANSWER

WHAT IS AN IECEX UNIT VERIFICATION CERTIFICATE?

ANSWER: An IECEx Unit Verification Certificate is a conformity certificate for a single product or a group of identical products from a closed manufacturing process. The introduction of this type of certificate was a reaction to the fact that manufacturers often manufacture single products (unique specimen) or single small series of such products. As this does not constitute a continuous batch production, the effort for auditing and monitoring the manufacturing sites is too large and therefore does not make sense.

Each individual product must be identified by way of a serial number. The serial number(s) is/are listed in the certificate. There is no limitation with regard to the number of certified identical products.

Products that are manufactured at a later point in time cannot be covered by the original IECEx Unit Verification Certificate. Another IECEx Unit Verification Certificate must be created for these.

An IECEx Unit Verification Certificate roughly corresponds to the approval according to the module "Routine Test" in Annex IX of the ATEX directive 94/9/EC.

The manufacturer applies for certification with an IECEx certification body. This body engages an IECEx test laboratory for executing the required type tests. Until this point the specifications for regular certificates of conformity are followed. In derogation thereof, the manufacturing facility will not be audited. The IECEx Unit Verification Certificate will be issued after confirmation of the test report without a quality assessment report being available and will be included in the IECEx online database (www.iecex.com). In the certificate list, the IECEx Unit Verification Certificates are marked with a red "V".

The specifications are described in the operational document OD 033, which can be downloaded free of charge from the abovementioned URL.

IS IT PERMISSIBLE FOR AN OPERATOR TO INSTALL TERMINALS OR OTHER COMPONENTS IN A CERTIFIED EMPTY ENCLOSURE (U CERTIFICATE) AND TO USE IT IN ZONE 1?

ANSWER: The use of a self-equipped empty enclosure (with U certificate) without additional testing and certification by a notified body is not permissible.

Electrical devices used in Zone 1 or Zone 21 must have an EC Type Examination Certificate issued by a notified body.

Enclosures certified as components are normally considered "empty enclosures". This is indicated by the letter 'U' after the number of the examination certificate.

Checked components are only checked with regard to certain properties of their explosion protection.

The installation conditions, however, are not checked or specified.

The kind and number of components that may be used is specified only in complete devices such as terminal boxes with an examination certificate without "U". It has been taken into account that the components and/or the enclosure must not heat up beyond the permissible extent. Further installation conditions such as minimum distances have also been specified.

Certification of an empty enclosure with a "U Certificate" is therefore only beneficial for manufacturers of complete devices such as terminal boxes, control boxes, switches etc. who apply for declarations of conformity for the complete device. The notified body engaged for testing the device does not have to test the enclosure characteristics in this case as this is already covered by the "empty enclosure" certificate.

AS A MANUFACTURER OF EXPLOSION PROTECTED PRODUCTS, WHAT CHANGES AND DEADLINES DO I HAVE TO CONSIDER AS A RESULT OF THE NEW ATEX DIRECTIVE 2014/34/EU?

ANSWER: The new ATEX Directive 2014/34/EU is to be applied as of 2016-04-20. EC type examination certificates issued according to 94/9EC will remain valid under the new directive!

The declaration of conformity must be amended according to the new directive as of 2016-04-20 and the new number 2014/34/EU must be indicated.

The declarations of conformity are no longer called EC Declaration of Conformity but EU Declaration of Conformity. They must still be supplied with the product.

For further information, please refer to the article in this issue of the Ex-Magazine.

WHAT MUST BE CONSIDERED WHILE SELECTING DEVICES IF AN EXPLOSIVE GAS AND DUST ATMOSPHERE IS EXPECTED SIMULTANEOUSLY?

ANSWER: If both explosive dust and flammable gases or vapours are present, this is called a hybrid mixture.

The behaviour of hybrid mixtures may differ from the behaviour of the pure individual substances.

The first step is to determine whether an explosive atmosphere is present at all. The explosive limits play an important role in this. An explosive mixture is only to be expected between the lower explosive limit (LEL) and the upper explosive limit (UEL).

The lower explosive limit (LEL) of hybrid mixtures, however, is often far below the LEL of the individual substances. The draft standard IEC 60079-14 from 2011 therefore recommends to classify a hybrid mixture as explosive if the concentration of gas/vapour exceeds 25% of the LEL for gas or vapour. This means that an explosive atmosphere can form even at comparatively low gas or vapour concentrations as soon as dust is introduced.

It must be ensured that selected devices are designed for use in areas that are hazardous due to gas as well as due to dust.

However, the devices have only been tested for use in areas with only gas or with only dust as the temperature class of devices for gas atmospheres is determined without a settled dust layer. The surface temperature of the enclosure or the installed devices will increase due to dust deposits. This case must be considered separately.

When using flameproof enclosures in conjunction with hybrid mixtures, the possibility of dust located in the flameproof joint must be considered. In the event of an internal explosion, the dust can be expelled in form of hot particles that can be a source of ignition.

Dust can also cause problems in devices carrying a warning note regarding electrostatics. Additional hazards resulting from the dust atmosphere must be considered.

Conclusion: Devices carrying markings for gas and dust may only be used with hybrid mixtures if this scenario has been considered and tested separately.

PRODUCT NEWS

FLASHING BEACONS FOR RUGGED CONDITIONS IN HAZARDOUS AREAS

NEW FX15 SERIES OF FLASHING SIGNAL LIGHTS FOR USE IN EX ZONE 1/2 AND 21/22

Robust flashing beacons from R. STAHL's new FX15 series are suitable for rugged conditions in Ex Zone 1, 2 or 21, 22 applications

R. STAHL is introducing a new signalling solution that withstands extreme environmental conditions, e.g. a wide operating temperature range from -55 C to +70 °C. FX15 beacons feature an enclosure manufactured from corrosion-resistant glass-reinforced polyester (GRP) that is designed to provide IP 66/IP 67 protection. All fixings are stainless steel. While the standard finish is natural black, painted units with epoxy coatings in red, yellow and blue are also available. The beacons are supplied with a robust stainless steel lens guard as standard to protect the flame-retardant polycarbonate lens. The light source is a xenon tube providing a high light output. FX15 beacons flash at a rate of one per second. Lenses are available in seven colours (red, amber, green, clear, blue, yellow, magenta). The Fresnel lens that covers the well glass and houses the xenon tube produces a flash energy of 5 Joules, which ensures an excellent luminous intensity of 49 cd for the clear version. The beacons are suitable for use in a variety of onshore and offshore applications and environments, notably including marine use, the oil and gas sector, and skid packages. Operating voltages range from 24 and 48 V DC to 115 and 230 V AC. All units feature 3 x M20 cable entries that enable a variety of wiring and mounting options. FX15 flashing beacons are ATEX- and IECEx-certified, with other relevant approvals (GOST, PESO, Inmetro and North American listing) to follow soon. Essential installation material such as mounting brackets, straps, glands, tag and duty labels, along with replacement parts are also available at launch.

ENERGY-SAVING LIGHT FITTINGS FOR HAZARDOUS AREAS:

COMPACT AND INNOVATIVE LED DESIGN

R. STAHL now offers compact LED-based tubular light fittings for use in Ex zones 1/21 and 2/22 that provide users with an alternative to typical conventional linear luminaires. With a diameter of merely 55 mm, the new light fittings take up less than half the space required by conventional linear luminaires, and reach less than half their weight. What is most striking, however, is the design that makes the new 6036 series extraordinarily light-efficient: 30 four-foot long LED-based tubular light fittings, for instance, ensure an illuminance of approximately 500 lx, which would usually require 35 linear luminaires with two 36 W fluorescent tubes each – or alternatively 48 conventional box-type units retrofitted with LEDs. However, R. STAHL's new light fittings consume only about half as much power and the specific power consumption per 100 lx is merely 1.5 W/m². This ensures enormous savings regarding operating costs – depending on the comparative solution and the time frame, just under 20 % to more than 50% savings are realistic in practice.

The tubular light fittings can be operated in a very wide temperature range from -40 to +60 °C. The maintenance-free units are suitable for general lighting purposes or for use as machine lamps. Due to their slim design, they can be installed in hard-to-access locations. Even at an ambient temperature of +60 °C, they reach a lifetime of 80,000 hours. The vibration-proof units are IP66/IP67-protected by default, resulting in excellent suitability for maritime applications. In addition to ATEX and IECEx certificates, they also feature certificates for many major markets (GOST, Gazpromnadzor, UL do Brasil, GL).

Thanks to extraordinary light efficiency, the LED-based tubular light fittings from the new 6036 series save considerable operating costs

OPTIMUM LIGHT YIELD, PROVEN HOUSING FOR EX ZONES:

LIGHT-WEIGHT, DURABLE LED LIGHTS FOR GENERAL LIGHTING PURPOSES

The new EXLUX 6402 linear luminaires are easy to install and provide an exceptionally high light yield thanks to LED technology

R. STAHL introduces the new EXLUX 6402 series for installation in ex zones 2/22 that comprises LED-based linear luminaires for especially efficient general lighting. One 52 W model can replace two standard 36 W fluorescent lamps while ensuring a much better lifespan of 100,000 operating hours and an excellent light yield of more than 100 lm/W thanks to a high luminous flux of 5,800 lm. The new series features a slim, flat GRP housing with Ex nR protection. Accessories are compatible as well – existing facilities can therefore be easily modified or retrofitted with LED technology. The new units also weigh at least a third less than comparable competing standard products, which further facilitates handling. The IP66/IP67 devices are mechanically robust and can be operated in an extended temperature range between -30 and +55 °C. If required, EXLUX 6402 lights are available with customer-specific modifications, which will soon also include accessories for pole-mounted installations. Standard models with a 28 W or 52 W power consumption with or without diffusers and with a length of 700 mm or 1,310 mm are available at short notice and at particularly attractive prices.

LIGHTER, BRIGHTER, LONGER-LIVED:

NEW GENERATION OF ROBUST FLUORESCENT LIGHTS FOR HAZARDOUS AREAS

R. STAHL's new line of light fittings for use in Ex zone 1/21 and 2/22 hazardous areas achieves better energy efficiency than comparable devices and provide approximately 10 % more luminous flux. New EXLUX 6001 luminaires also feature a design that is considerably more compact, stable, and torsion-resistant than their EXLUX 6000 predecessors. While more than one million of the long-proven EXLUX 6000 lights have been deployed worldwide over the last twenty-odd years, the new generation now meets increasing user demand for a similarly economic, yet enhanced product with improved technical features reflecting the most current state of the art. Depending on their performance class, the 6001 luminaires are a quarter to a third lighter than their predecessor models and many competing products. Users now also benefit from the extremely robust design of these slimmer, narrower units: unlike most lights, the new devices can be operated at extremely low ambient temperatures (as low as -30 °C). In many cases, this amounts to a decisive extension of the application range that saves costs by making extra specifications unnecessary.

In order to facilitate a step-by-step exchange of existing EXLUX pendants, the installation of the new units remains fully compatible to the predecessor series. Moreover, swiftly removable replacement parts ensure quick and easy maintenance. Like before, the new lights are available with customer-specific modifications on request. In addition, R. STAHL provides especially cost-efficient standard models with a power consumption of 18 W, 36 W, or 58 W that are available at short notice. Featuring 4 mm² cage clamp terminals, 5-core through-wiring, and a full-phase safety shutdown, these models are adequately equipped for the majority of all typical applications. The new series fully complies with the requirements of all current industry standards. Notably, the new silicone-based foamed gasket has been optimised for maximum durability, as stipulated by IEC 60079. This sealing solution, which is resistant to various chemicals as well as UV radiation, the fitting's hinge, and a newly designed central lock reliably ensure IP 66/IP 67 protection over many years.

The explosion-protected EXLUX 6001 luminaires are more compact, lighter, more robust and more versatile than their predecessors and many competing products

6001 series lights are available as of now. However, more products are due to follow in the new EXLUX generation: in the near future, the program will be extended both by optional accessories, such as pole mount adapters, and by additional models such as emergency lights, lights with an address module, and models with T5 fluorescent lamps for use in zone 2/22. Moreover, LED lights from R. STAHL will also be available soon, though these will be based on a completely different housing and equipped with materials and features optimised for LED technology.

VERSATILE, MAINTENANCE-FRIENDLY FLOODLIGHTS FOR HAZARDOUS AREAS:

MODULAR FLOODLIGHTS WITH SEPARATE BALLAST UNITS

Suitable for installation worldwide, the explosion-proof 6121 floodlights from R. STAHL are especially maintenance-friendly thanks to separate ballast units

Thanks to their modular design, R. STAHL's new explosion protected 6121 series of floodlights provides users with versatile installation options. If required, the floodlight system for zone 1 allows for separate installation of the lamps and the ballast units. This can considerably facilitate maintenance. Since the terminals remain easily accessible regardless of the placement of the floodlight, regularly scheduled checks of e.g. insulation and contact resistance can be performed easily even if the lamps are installed in hard-to-reach places. As connection chambers, R. STAHL provides separate explosion protected housings with Ex d or Ex e type of protection, thereby covering the different requirements of various markets and regions with one series.

The compact floodlights can be equipped with 150 W, 250 W, or 400 W high-pressure gas discharge lamps (halogen metal halide (HIT) or sodium vapour (HST). The efficient ballast unit for the series is suitable for all models. With a power factor of more than 90%, it already fulfils the European Union's energy efficiency requirement that will come into effect in 2018. Alternatively, users can equip the E40 lamp sockets with 500 W halogen lamps (QT). In addition to lighting with a symmetrical wide-beam light distribution (85% efficiency), the reflectors also provide narrow-beam spots (87% efficiency). The lamps can be easily exchanged by means of a special opening which ensures a long service life even under adverse conditions thanks to suitable materials. Made from robust, seawater-resistant cast aluminium, the systems are protected according to IP66. The floodlights can be operated in hazardous areas with group IIC gases and in an ambient temperature range between -40 °C and +60 °C.

RAISING THE ALARM IN EXTREME CONDITIONS AND HAZARDOUS AREAS:

R. STAHL INTRODUCES CORROSION-RESISTANT "YODALEX SUPER SERIES" BEACON, HORN, AND COMBINATION UNITS

R. STAHL's new "Yodalex Super Series" comprises a suite of signalling devices designed for use in hazardous areas and harsh environments. The units are equipped with a lightweight GRP "Ex d" flameproof enclosure which provides a strong, robust, and safe housing designed to withstand the environmental demands of extreme temperatures and sealed against water and dust ingress according to IP66 and IP67. The Super Series is ATEX and IECEx-approved for use in zones 1, 2, 21, and 22 for gas and dust atmospheres. Global onshore and maritime approvals, such as GL, CUTR, Inmetro, and Peso will follow shortly, enabling operation across many industries throughout the world.

The omnidirectional horn featured on the YL6S and YA6S units has a maximum sound output of 110 dB at one meter. Its patented product design, unique to the Yodalex range, disperses sound radially outwards, providing excellent sound coverage, which ensures maximum safety within the designated area. A further feature of the sounder is that the user can control the release of a sound tone over three individual stages, allowing a system for managing test and real time emergency procedures. The user can individually select the tone for each alarm stage from 32 internationally recognised frequencies. The FL6S beacon is fitted with a 5 Joule Xenon strobe. When used in conjunction with the new lens designed specifically for the Super Series, it produces a 49 effective candela flash at a rate of 1 Hz. Whether used individually or as part of the combination unit, the beacon is available with a choice of seven different lens colours including magenta. The YL6S combines all of the features present in both the YA6S and FL6S, housed within a single enclosure. This unique, light-weight and cost-effective design reduces the amount of field cables and installation time compared to individual devices. The units are suitable for an extremely wide operational temperature range of -55…+70 °C. With voltage options starting at 24 V DC, R. STAHL also provides variants suitable for 48 V DC and 115 or 230 V AC power supplies. All mechanical fixings including the lens guard are manufactured from 316/V4A stainless steel, ensuring optimal resistance to salt water in coastal, offshore or marine applications. The release of the Super Series completes the new line of GRP signalling equipment offered by R. STAHL that also includes the YA90 directional sounder, the MCP manual interface, and the FX15 beacon. Together, these robust products provide customers with the complete range of audible and visual signalling as well as manual interface equipment for ATEX and IECEx hazardous zones 1, 2, 21, and 22 in extreme and aggressive environments.

R. STAHL's new "Yodalex Super Series": YA6S horn, FL6S beacon, and YL6S combination unit (from left to right)

LARGE EX d HOUSINGS MANUFACTURED FROM ROBUST LIGHT ALLOY

R. STAHL's new 8250 series of aluminium Ex d housings offers reliable protection for industrial components even in very rugged environments

R. STAHL introduces new, cost-efficient aluminium housings with Ex d explosion protection that protect standard industrial electrical components in hazardous areas. The 8250 series is designed for stand-alone wall installation and can be used in zone 1, 2 (gas group IIB) or in Zone 21, 22 hazardous areas. R. STAHL offers two models with internal dimensions of 250 x 150 x 110 mm and 300 x 230 x 125 mm. Three further models with internal dimensions up to 540 x 360 x 300 mm will follow until the end of 2014. The spacious enclosures can accommodate motor starters up to 45 kW and bulky control technology. While the flameproof enclosures are an economical solution to provide for safe use of the normal industrial components, the housings are still easily accessible for installation work and reconfigurations: the lids can be hinged at any side, open wider than 180 °C, and can be equipped with captive screws if required.

Electrical components can be mounted either directly on profile rails or on mounting plates. Through a CAD-optimised design, the housing's weight was reduced by 15 %. Moreover, its copper-free aluminium alloy also ensures exceptional robustness, allowing for use in different climatic regions throughout the world. The material is seawater-resistant. Depending on the housing's mechanical features, it will tolerate environmental temperatures between -60 °C and +70 °C. Rated IP66, the 8250 series is also dust-tight and withstands strong water jets. The new aluminium housings are available with or without drill holes and can be equipped with an optional powder coating.

KEEPS ON RUNNING: BATTERY-LESS UPS SOLUTION FOR HAZARDOUS AREAS

MAINTENANCE-FREE COMPACT EX de UPS WITH CAPACITORS FOR ENERGY STORAGE

R. STAHL takes a new direction in the field of explosion-proof Uninterruptible Power Supply (UPS) solutions for zones 1/21 and 2/22. The 8265/C-TEC line provides backup power from capacitors mounted directly on the PCB. Unlike standard solutions, these new UPS systems require no accumulator batteries, which makes the emission of dangerous gases technically impossible. Since the capacitors can be charged very quickly, the systems are ready for operation within minutes. They can be connected to PCs running a shutdown software via a USB port. The combination of flameproof main enclosures with Ex d ignition protection and Ex e-protected enclosures as connection chambers ensures a very compact and user-friendly design. Compliant with ATEX and IECEx, R. STAHL's Ex de technology is completely certified: in addition to excellent safety, this also enables users to easily connect the UPS units and allows for immediate smooth operation.

The robust solutions withstand even very harsh conditions. They tolerate an extremely wide ambient temperature range between -50 °C and +55 °C (optional extension, standard range is -20 °C to +40 °C). This makes it possible to operate them without restrictions virtually anywhere between the Arctic Ocean and the equatorial region. Even at high temperatures, the 100% maintenance-free systems reach a service life of 20 years. Made from seawater-proof aluminium, the flameproof enclosures can be powder-coated if required, ensuring long-lasting protection especially in rugged maritime climates with moist and salty air. In addition to ship approvals, the UPS units feature many country-specific enclosure certificates for major markets. R. STAHL's versatile UPS portfolio enables users to specify individual systems ranging from compact to high-performance models. By request, the expert for explosion protection systems also provides extensive engineering support in order to identify savings potentials already in the early planning stages.

R. STAHL's UPS solutions with capacitors for energy storage are available as ATEX/IECEx models with combined Ex de ignition protection (left), and in various regional versions, for instance in Ex d enclosures with an NEC® certificate (right image)

THE WORLD'S FIRST 7" WIDE SCREEN HMI SYSTEM FOR ATEX ZONE 1

The new HMI series 200 from R. STAHL HMI Systems provide 7 inch touchscreens that can be read easily even in bright sunlight

The world's first operating devices with a 7" wide screen suitable for use in ATEX zone 1 from R. STAHL HMI Systems combine state-of-the-art, user-friendly equipment with a highly robust design. The virtually indestructible devices are ideally suited for visualisation close to machines in drilling rigs or in the vicinity of compressors, mixers, and centrifuges in machine building applications.

Their wide 15:9 format display provides an 800 x 480 pixel resolution. Powerful processors and a bright display technology ensure high-contrast, glare-free display of process information. A modern capacitive touchscreen allows for easy, comfortable control of all process sequences. The HMI systems are designed to provide high reliability during continuous operation even under extreme conditions: they can be operated around the clock for years at ambient temperatures between -40 °C and +65 °C, and nearly all over the globe. The vibration-resistant interfaces feature a hardened glass front and a seawater-proof metal housing that ensures IP66 protection.

Even during outdoor use with strong incident daylight, the full-colour 7" displays remain easy to read, since an anti-reflection coating minimises glare and overexposed areas.

By default, the new SERIES 200 operator interfaces are equipped with the Windows Embedded Compact 7" operating system. Alternatively, they are available as OPEN VERSIONS, allowing for the use of third-party software and enabling customers to easily install their own programs. Moreover, mechanical engineers can continue to use the comfortable Windows project engineering software SPSPlusWIN to create and edit screens as well as process connections and messages. Projects from existing devices can be imported and adapted for further use.

Integration into virtually all major automation systems is supported. The units are connected via explosion-proof Ethernet ports for copper or fibre optic cables, standard serial interfaces, or an optional WLAN module. Apart from Ex zones 1 and 21, the multilingual devices are of course also suitable for use in zones 2 and 22. Standard regional certifications (such as NEC®, TR, CSA, KCC, INMETRO) will follow soon.

Additionally, the SERIES 200 provides excellent compatibility with units from the widely established, proven FALCON series (ET-/MT-65, ET-75, and ET-125). The new line is mechanically compatible to the dimensions of the predecessor generation – either directly or with an adapter frame. This also applies to units with additional application-specific stainless steel or plastic push buttons. Users can therefore easily exchange previous models with monochrome displays for modern colour wide screen displays.

HAZARDOUS AREA MEDIA CONVERTERS FOR FIBRE OPTIC ETHERNET

R. STAHL's 9721 series of media converters for optical cables enable hot plugging of Ethernet connections in zone 1 and 2 hazardous areas, i.e. the safe plugging and unplugging of communication links during operation. The compact, cost-efficient converters connect Twisted Pair copper cables and fibre optic cables by means of standard plug connectors (RJ45 and SC types), creating a joint network. On the fibre optic side, the converters provide the ignition protection class "inherently safe optical radiation (op is)", which allows for the use of conventional fibre optic cables in hazardous areas according to EN 60079-0:2013 and 60079-28. Just like intrinsically safe bus connections, these optical cables can be disconnected and reconnected as required during operation. Even in hazardous areas, fibre optic cables can thus be used for interference-free bridging of distances up to 5 km (multi-mode version) or up to 30 km (single-mode version).

Featuring an elegant, painted stainless steel design, the converters are delivered with mounting clips for space-saving horizontal or upright installation on C-profile DIN rails. This is the default method for zone 2. In zone 1, users can install units in compact flameproof enclosures. Two diagnostic LEDs signal various operating conditions. Measuring merely 80 x 63 x 25 mm and designed to tolerate a wide ambient temperature range of -30°C … +75°C, the media converters can be used in applications with limited installation space and rugged environmental conditions. Moreover, the 9721 series is optimised for use with R. STAHL's explosion-protected IS1+ Remote I/O system as well as operating and monitoring systems from R. STAHL HMI SYSTEMS.

R. STAHL's 9721 series of media converters enables hot plugging of Ethernet conNEC®tions in zone 1 or 2 hazardous areas

HART OVER PROFIBUS ASSET MANAGEMENT WITH IS1+ REMOTE I/O

NEW COMMUNICATION COMPONENT FROM TREBING + HIMSTEDT FOR EMERSON AMS SUITE

A new software component enables HART over PROFIBUS asset management with R. STAHL's IS1+ Remote I/O system

TACC, a new software component for the AMS Suite from Emerson Process Management enables comfortable central management of HART devices in PROFIBUS networks that are connected by means of the IS1+ Remote I/O system. This enables a universal diagnostics of intelligent field devices and so a more intelligent operation and service. The new 2.4 version of the TACC software package (TH AMS Device Manager Communication Components) from industrial IT expert Trebing + Himstedt thus supports the latest generation of R. STAHL's Remote I/O solution for hazardous areas for the first time. Any station in a higher-level Ethernet network running the AMS Intelligent Device Manager can access diagnosis and configuration data of the field devices via the Remote I/O. Hardware access from the Ethernet to the PROFIBUS level is implemented by means of TH LINK PROFIBUS gateways. Easy to retrofit, the communication component TACC is available free of charge at the company website **HTTP://WWW.T-H.DE** – Emerson suite users do not require an additional license.

With its IS1 product line, R. STAHL is the market leader for Remote I/O components that are used in industrial automation solutions for hazardous areas. In combination with the established IS1 system, the predecessor of IS1+, gateways and software products from Trebing + Himstedt have already proven themselves on many occasions with earlier versions of Emerson's Asset Management solution. Applications include the chemical and pharmaceutical industries as well as various other branches. IS1+ provides outstanding new functions and features, such as mixed modules with I/O parameterisation as well as diagnoses and maintenance alerts according to the NAMUR NE107 scheme. Supporting hot work and hot swapping, the system can be flexibly and cost-efficiently extended and reconfigured.

TRIED-AND-TESTED IS1+ SYSTEM NOW FEATURES TRIPLE WARRANTY

REMOTE I/OS FOR HAZARDOUS AREAS ACE ENDURANCE TESTS IN TOUGH CONDITIONS

While other remote I/O solutions on the market usually have a one-year warranty, R. STAHL has voluntarily extended the warranty for its robust hazardous area IS1+ system to three years – without any extra charge. The explosion protection expert takes this step in the wake of extremely successful lab trials as well as very positive experiences garnered from extensive practical tests. Even under very rugged conditions and strained to the limit of their resilience, e.g. in continuous operation at temperatures up to +90 °C and exposed to repeated temperature changes from -40 to +95 °C, IS1+ modules proved virtually indestructible: no defects or failures occurred. Due to a new low power design for the modules that ensures minimal power loss and effective heat dissipation via the housing, IS1+ allows for an extended ambient temperature specification covering a wide range from -40 to +75 °C. This also means that the modules will reach an extraordinary lifespan of up to 15 years in applications with more moderate conditions. In addition, since the modules' power consumption has been reduced by up to 50%, energy costs for the operation of process plants are decreased as well.

IS1+ offers outstanding functions and features, such as mixed modules with I/O parameterisation as well as diagnoses and maintenance alerts according to the NAMUR NE107 scheme. The versatile Remote I/O system supports hot work and hot swapping, which makes it very cost-efficient: thanks to its consistently intrinsically safe structure with an intrinsically safe fieldbus based on either PROFIBUS DP or an Industrial Ethernet implementation with Modbus TCP, EtherNet/IP or PROFINET, the system can be easily extended or reconfigured in hazardous areas. In addition to international explosion protection certificates for all major and medium-sized markets, IS1+ also features several shipbuilding approvals, which makes the system suitable for virtually universal use worldwide. Offering more than 30 years of experience in the systems business and know-how regarding all standard automation systems as well as corresponding bus protocols, R. STAHL is capable of customising IS1+ setups to user requirements and delivering turnkey solutions.

R. STAHL's very robust Remote I/O system IS1+ now offers a warranty that has been extended to three years

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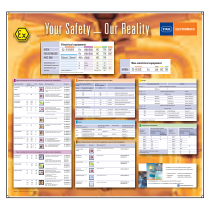

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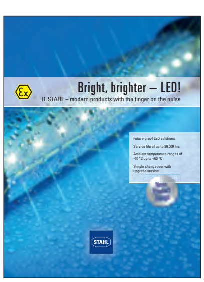

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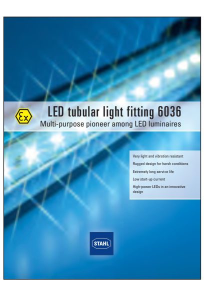

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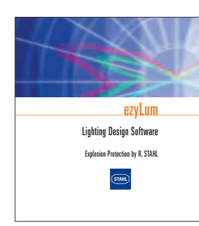

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