

## **100 years of tested electrical explosion protection**

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Explosion protected barcode scanners, Panel PCs, electrical switchgear and various other pieces of electrical equipment are considered commonplace these days, however, this has not always been the case – harmonising of regulations relating to explosion protection in Europe and throughout the world has also been a challenge.

This article provides a historical overview of explosion protection, beginning with the first safety lamp in 1815, testing the first electrical motors built in accordance with the available knowledge in explosion protection back in 1905 up to current day European directives 94/9/EC and 1999/92/EC whose contents have been around and used for some time.

### **Explosions are older than man**

Was the big bang an explosion? Probably. One thing is for sure: Atmospheric discharges (lightning) caused fires long before mans existence in the world. Millions of years later the Greeks discovered another form of discharge, they observed electrical discharges with amber. Electron – the Greek word for amber – was chosen as name for the theory of electricity. Until well into the second millennium, these phenomena were known but neither could they be controlled nor could they be used.

### **First inspiring ideas for prevention of ignition sources**

Development began in 1753 when the first lightning arrester was invented which considerably reduced the hazards arising from thunderstorms as an ignition source for fire.

In the mining industry illumination has always been dangerous, causing fires as the air in mines mixed with methane (so-called firedamp) which could also lead to explosions given the correct concentration of gas / air. It was not until 1815, when Sir Humphrey Davy presented the first safety lamp for use in the mining industry, the lamp consisted of two meshed screens separating the flame (which had to be set as small as possible) from the combustible mixture. Combustion could take place within the screens, however the screens prevented external ignition when the correct flame was used. The explosion hazard had been considerably reduced with the invention of the safety lamp, but has not been totally averted, when the flame was set too high, the screens could heat up and this would lead to an external ignition

### **Directives 94/9/EC and 1999/92/EC: Many of their contents originates from the 19th century**

Already we have recognized the parallels to today's explosion protection. The petrol safety lamp from 1815 made great demands on the manufacturer and operator (the two were usually mates). The following three requirements were therefore important for the safe handling of the safety lamp:

- consistent adherence to design requirements,
- an operating manual linking the manufacturer and operator – including operating and maintenance specifications,
- and a precondition to identify and define the hazardous areas.

In principle, these requirements are still true today. For equipment and systems, Directive 94/9/EC provides for consistent adherence to design and safety requirements. It requires an operating manual to be compiled with important detail given to the operation and maintenance of the equipment. At the same time, Directive 1999/92/EC requires hazardous areas to be identified and defined. It demands that the operator (actually the employer) continuously guarantees the safety of equipment and systems supplied by the manufacturer by adhering to the requirements for intended use, continuous testing, maintenance and repair.

### **Invention of first electrical equipment**

We will have a closer look again at the safety lamp invented in 1815. It was considered to be an item of equipment, but not an electrical one. Electrical items of equipment were invented in the following decades when man succeeded in converting chemical energy into electrical energy e.g. lead acid batteries. Another milestone was Werner v. Siemens' innovative discovery of the dynamo-electric principle enabling man to convert mechanical energy into electrical energy. The area of electrical engineering was born as was the idea of using these inventions for the mining industry. In 1882 the first electrically driven train drove into the coal mine Zaukerode in Freital near Dresden. One year before, different light bulbs for use in the mining industry were presented at the electricity exhibition in Paris. They represented an important technical innovation replacing existing coal filament with metal wire element. Tests showed that the hot wire elements did not ignite firedamp it was the initial sparks at high current intensity due to the melting of the wire elements. However, the electrical light bulb was at that time not fully developed as the spark generated when the wire element was mechanically destroyed continued to remain a potential ignition source, burning times and charging cycles were also very limited. A solution to this was developed by CEAG in 1912 – the mechanically

resistant miner's lamp – resulting in prize of 1,000 pounds awarded by the British Home Office. At the same time in England, circuits were being developed where breaks and short circuits as well as overheating of wires due to load would not ignite the explosive mixtures. When this development was completed a definition of „intrinsic safety“ type of protection was born.

### **Systematic testing is necessary**

Economic dynamism and inventiveness has resulted in ever new inventions and application possibilities for electrical equipment. As general industrial use and use in the mining industry has decreased electrical engineering has increasingly developed into power engineering, however the hazards emanating from both are well known.

Protection principles and their regulation (how hazards should be averted) were not developed at that time due to a lack of practical experience. This was to change following a suggestion by the Oberbergamt Dortmund (state authority responsible for the supervision of mines), tests were to be carried out at the „Berggewerkschaftlichen Versuchsstrecke“ (Mining Test Station) in Gelsenkirchen-Bismarck, Germany. Several companies were asked to participate in these tests with proportionate financing of the project being offered. Among these companies were Siemens & Halske AG located in Berlin as well as the AEG Allgemeine Elektrizitätsgesellschaft. The mining divisions of both companies are today part of the BARTEC Sicherheits-Schaltanlagen GmbH in Menden, Germany. Under conditions that would today be considered adventurous, the first basic tests were carried out to develop the firedamp concepts, closed encapsulation (today would be known as the flameproof enclosure), close meshed screen, oil immersion and plate encapsulation at the Mining Test Station in 1904. These tests were supervised by Mr. Beyling, the director of the test station. In 1905

the first testing of motors took place. The motors built using experience gathered in the previous year passed these tests, thus the birth of electrical explosion protection which is now 100 years old.

In 1912 the results of these examinations and tests as well as the tested concepts were combined in the „Design principles of firedamp protection systems on electrical machines, transformers and switchgear“. The authors of these principles also demonstrated their vision when pointing out that other designs and concepts were permissible provided that they pass a special test carried out by the Schlagwetter-Schutzbehörde (firedamp protection authority). This procedure is still applies today in the European Community in a slightly adapted form. Bodies notified in Brussels were allowed to test concepts diverging from these standards and to certify them as suitable, thus providing room for the development of new reasonable explosion protection solutions.

### **Dynamic development of protection principles, guidelines and regulations**

Due to war, electrical explosion protection only developed moderately on a national and international level during the next four decades. In 1935 the commission responsible for explosion protection published the VDE 0165/1935, „Guiding principles on the installation of electrical systems in potentially explosive production areas and storage rooms“. In 1938 the common regulation VDE 0170/0171 was published, including requirements for firedamp protected (VDE 0170) as well as explosion protected (VDE 0171) equipment. The two newly developed types of protection „Forced ventilation“ and „Increased safety“ complemented the protection concept. The first meeting of the IEC (International Electrotechnical Commission) in London in 1948 resulted in increased internationalisation of explosion protection. Nine years later the first edition of „Design recommendations

for flameproof encapsulation of electrical equipment“ was accepted by 16 national committees. In the 70s – the time when the company BARTEC was founded – the legal as well as technical preconditions for the development of the Single European Market in the area of explosion protected equipment was being established with the EC directive 76/117/EEC, among others.

### **Explosion protection internationally standardised**

This development was completed with the directives 94/9/EC and 1999/92/EC. These directives created a standardised legal basis for the requirements of electrical equipment and systems as well as the minimum requirements of work places, i. e. the protection of employees. The experience gathered in electrical explosion protection has now been transferred to non-electrical (primarily mechanical) equipment and systems. The concepts of electrical explosion protection are also harmonised on an international level, were the relevant documentation is coded IEC – world, EN – Europe and DIN EN – Germany and comply in terms of contents and registration number. Examination certificates also comply with internationally standardised requirements.

For the future the following conclusions can be drawn from the past 100 years of tested electrical explosion protection from the point of view of manufacturers:

- explosion protection means identifying and preventing hazards in an anticipatory way,
- considering explosion protection at an early stage when developing new products as the period between general use and use for explosion protection is constantly decreasing,
- paying attention to changes in standards carried out by committees, being actively involved in this work would be even better.

Each manufacturer should use the chance offered by the Directive 94/9/EC of developing new explosion protection concepts.

### **Latest solution trends in explosion protection**

Whether dealing with barcode scanning, Pocket PCs, plant visualisation or radio data communication – technologies tested for general applications are increasingly used for applications in hazardous areas. One of the most interesting examples is the Panel PC series „POLARIS“ from BARTEC for the chemical, petrochemical and pharmaceutical industries. The series is certified for use in hazardous areas, zones 1 and 2 as well as 21 and 22. With Polaris, it is now possible to exchange data via a wireless lan or bluetooth using an internal USB interface. Due to the innovative POLARIS series, the familiar computer in non-hazardous areas is now also available in hazardous areas. Furthermore the POLARIS TFT colour graphic display is available in six different sizes. The smallest 5.7" displays are perfectly suitable as „human machine interface“ used to control simple machines such as mixers, dryers or fuel filling stations. The medium-sized 10.4" graphic displays are ideal for controlling complex machines or simple systems such as reactors, centrifuges or ball mills. The PCs 15" and 19" allow for complex systems to be controlled such as pharmaceutical production lines. Another example is the wireless BARTEC hand-held radio scanner BCS370<sup>ex</sup> featuring intrinsic safety type of protection. The sturdy hand-held radio scanner is perfectly suitable for scanning applications in industrial areas where flexibility and work flow should not be constrained by cables that often need to be replaced. The serial receiving cradle not only allows for simple system integration but also for free movement within a distance of up to 30 meters. Thus demonstrating that a standard solution for use in an industrial area – can be adapted for use in hazardous areas, zone 1.

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Pressebericht

Operating terminals or barcode scanners represent the wide product range of sensors, actuators, systems and complete solutions whose application in potentially explosive atmospheres could only be realised – according to manufacturers as well as operators – with the harmonisation of protection concepts and their international validity. 100 years of tested electrical explosion protection considerably contributed to this development.

## 100 years of tested electrical explosion protection



ComEx is a flexible series including standardised as well as customised local control and display units.



The new Panel PC series POLARIS with wireless communication is suitable for local control and process visualisation applications in potentially explosive atmospheres.

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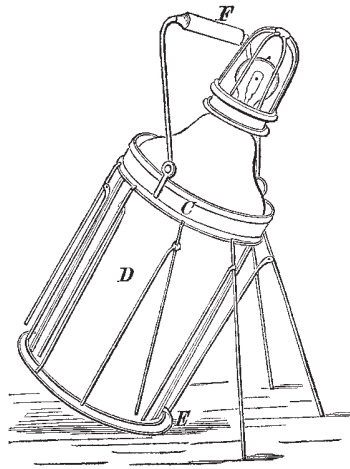


Fig. 46.

Explosion protected safety lamp developed by Sir Humphrey Davy in 1815.



Mobile radio scanners such as the MC 9060<sup>ex</sup> represent the wide product range including sensors, actuators, systems and complete solutions. The design of this equipment for potentially explosive atmospheres has only become possible with the harmonisation of protection concepts and their international validity.

## 100 years of tested electrical explosion protection



With directives 94/9/EC and 1999/92/EC, there is a standardised legal basis for requirements on electrical equipment as well as on work places in Europe.