# General notions regarding ex repairs

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**Abstract.** SR EN 60079 is a series of standards for the use of equipment in explosive atmosphere that covers a wide range of considerations for them, as well as the definition of various classifications of hazardous areas. An important section of the series specifically covers the repair, overhaul and modification of equipment. This is different from the maintenance of equipment, unless the repair and overhaul cannot be separated from the maintenance. SR EN 60079-19 edition 2020 establishes the general principles of repair, revision, and modification, which are common to all explosion-proof equipment, with additional clauses to provide instructions relevant to certain types of protection. Assuming that repairs and revisions are carried out using good engineering practices and details of the certificate, then the final equipment is considered to comply with the original standard and the manufacturer's specifications. Where these specific data are not available, the equipment can be simply described as having been repaired in accordance with SR EN 60079-19 and the relevant standards for which the equipment was designed.

## 1 Introduction

The EN 60079 series of standards for explosive atmospheres, covers a wide range of conditions for use of equipment in hazardous areas, as well as defining the various classifications of hazardous areas. [1 - 3] An important section of the series specifically covers equipment repair, overhaul and modification. This is distinct from equipment maintenance, unless repair and overhaul cannot be separated from maintenance. [4 – 7]

Ex equipment was first defined in the early 20th century after a serious (coal) mining accident. In 1984 England produced the first code of practice for repair of Ex-classified equipment, and in 1993 it was first adopted as a British Standard and published as BS EN 60079 Part 19.

The standard was internationalized in 2004 and published as IEC 60079-19, then EN, with additional requirements for the overhaul and repair of Ex equipment. Additionally, the updated standard removed mining exclusion and introduced all explosive atmospheres, including dust. It also introduced new requirements regarding the competence of persons, and when it comes to liability in case of an event (explosion), these last requirements also serve to define liability.

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SR EN IEC 60079-19 sets out the general principles of repair, overhaul and modification that are common to all explosion-protected equipment, with additional clauses to provide relevant instructions for certain types of protection. [7, 8] Assuming that repairs and overhauls are carried out using good engineering practice and certificate details, then the final equipment is considered to conform to the original standard and manufacturer's specifications. Where these specifications are not available, the equipment may simply be described as having been repaired in accordance with SR EN IEC 60079-19 and meeting the relevant standards for which the equipment was designed.

## 2 Analysis of revision and repair operations of the equipment Ex

All repair or overhaul work carried out must be fully documented and work reports sent to the user. Repair facility records should be maintained to provide full traceability of work performed and all steps taken. Measurements must be recorded and conform to criteria of relevant standards. Equipment returned to the end user must be clearly labelled as repaired or overhauled in accordance with relevant manufacturing standards met by the identified repairer.

If the equipment is to be modified rather than repaired, then either modifications must be specifically permitted in the certificate documentation, or proposed modification must be authorized by manufacturer, in writing, to be permitted by certificate. [7]
If, through a modification, the equipment can no longer meet the originally certified specifications, then user must be notified in writing, with a report stating that equipment cannot be used in an explosive atmosphere without further evaluation.

An important section of standard details additional requirements for the repair and overhaul of Ex d flameproof equipment. The standard focuses on requirements for enclosures, cable and conduit entries, insulation, internal connections and windings (including repair of electric machine rotors). Detailed instructions are also provided on a series of testing processes for windings after any repair.

Another section within the standard, goes on to detail additional requirements for repair and overhaul of Intrinsically Safe - Ex i equipment. This focuses on equipment such as enclosures, cable glands, terminals, soldered connections, fuses, relays, diode safety barriers, PCB, optocouplers, electrical components, batteries, internal wiring, transformers, encapsulated components and non-electrical parts. Not all of these parts can be repaired and should simply be replaced. If equipment is repaired or overhauled, the work must be followed by testing the dielectric strength of the insulation between the intrinsically safe circuit and metal casing.

Another chapter of the SR EN IEC 60079-19 standard details the requirements for repair and overhaul of Ex p pressurized equipment. Although it is preferable to use new parts from the manufacturer, in principle damaged parts such as housings can be repaired or replaced. Detailed instructions are provided regarding what can or cannot be done to enclosures, cable and conduit entries, terminations, insulation, internal connections and windings, along with instructions for testing after repair.

Flameproof enclosure, pressurized and intrinsically safe equipment represent the majority of repair and overhaul works, being most frequently used and most critical for safety in hazardous areas. The scope of SR EN IEC 60079-19 is more comprehensive, providing detailed instructions for protection type equipment. "e" (increased safety), type "n", group III "t" (dust) and type "p" (pressurized).

Another very important section of standard is that which defines the knowledge, skills and competences of *"responsible persons"* and *"operators"* - Annex B. Responsible persons are those who are responsible for the processes involved in overhaul and repair of types of explosion-protected equipment, such as are defined in standard.

Any repair facility must appoint a *"responsible person"* with necessary skills within the management organization who accepts the responsibility and authority to ensure that revised/repaired equipment complies with certification conditions and that work carried out has been agreed with user. That person must have a working knowledge of and understanding of the appropriate explosion protection standard. This requirement means that responsible person makes final decision that the Ex equipment is compliant and can be returned to customer.

Operators, as defined in standard, who will work on equipment and who can make decisions that would have an impact on Ex certification status of the equipment, must work under the supervision of person in charge. All operators involved in revision and repair processes must be independently assessed as competent according to SR EN 60079-19 and according to standards specific to types of protection involved.

**Table 1.** The necessary knowledge and skills for responsible persons and operators.

| Knowledge and skills | Responsible person | Operator |
|---|---|---|
| General knowledge of electrical and mechanical engineering, relevant, at higher level | Yes | - |
| Practical understanding of explosion protection principles and techniques | Yes | - |
| Understanding and ability to read and evaluate technical drawings | Yes | - |
| Familiarity with measurement functions, including practical metrology skills, to measure required quantities | Yes | - |
| Working knowledge and understanding of relevant explosion protection standards | Yes | - |
| Basic knowledge of quality assurance, including principles of measurement traceability and calibration of measuring instruments | Yes | - |
| Understanding general principles of protection types and marking | - | Yes |
| Understanding those aspects of equipment design that affect the type of protection | - | Yes |
| Understanding of examination and testing in relation to the relevant parts of latest standard 60079-19 | - | Yes |
| Ability to identify manufacturer authorized spare parts and components | - | Yes |
| Familiarity with the special techniques to be used in the repairs mentioned in the standard | - | Yes |

*"Persons in charge"* must fully understand the concepts of equipment protection, what can and cannot be repaired and what repair procedures can be used so that they can fully support the workshop staff and check any work made. The responsible person must be able to ensure that correct records are kept and that quality control systems are in place for Ex repairs. They must also be able to ensure that the company has the right tools for repaired equipment, relevant standards and certificates.

*"Operators"* are all engineers and technicians who service and repair hazardous area equipment. They must attend Ex training so that they fully understand the protective concepts of equipment they are repairing and what can and cannot be repaired and what repair procedures can be used.

Table 1 summarizes the necessary knowledge and skills, both for the responsible persons and for operators.

Both the responsible persons and operators must be able to provide sufficient evidence that they are familiar with theory, that they have the necessary skills and understanding for work in which they are involved in connection with explosion-protected equipment. [9] Staff must attend regular training every three years on repair and overhaul aspects of Ex equipment. This means that 'Attested' units for repairs in the Ex field stay up to date with the practical aspects of repair and any changes to the standards.

The competencies are applicable to each type of explosion protection for which a certified repair company is involved. For example: a person may be competent only in the field of repair and overhaul of Ex *d* motors and not fully competent in repair of Ex *d* switchboards or Ex *e* motors. In such cases, the management of repair facility must to document this in their quality system.

In situations where equipment is to be repaired by a specialist service provider, standard states that: *"The user must ensure that the service facility concerned can demonstrate compliance with the relevant provisions of this document [the standard] and any regulations/requirements additional"*.

In addition, it is responsibility of user to be aware of relevant legislation regarding periodic inspection and verification to ensure that equipment remains in optimal working order. In addition, the user must provide sufficient information to repair (service) companies and third-party installers to comply with occupational health and safety requirements.

Normative NEx 01-06 includes specific regulations regarding the capacity of the organization that carries out specific repair activities. It must have a quality system in which specific procedures are implemented (for repair activities). Another specified requirement is that the personnel involved in specific activities (including repairs) be authorized by INSEMEX Petrosani. The organization's capacity is attested to be able to carry out specific repair activities related to equipment/installations operating in potentially explosive atmospheres. [10]

A specific diagram for repairing an equipment designed for use in potentially explosive atmospheres is presented in figure 1.

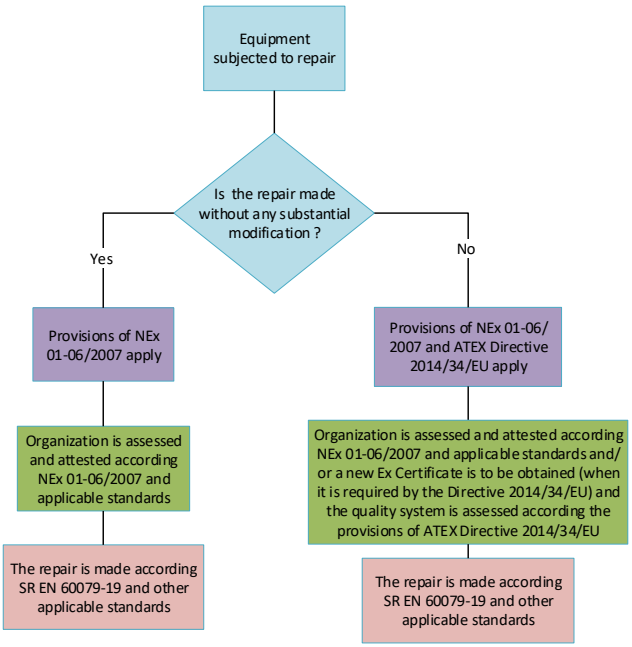


**Fig. 1.** Specific diagram for repairing an Ex equipment.

## 3 Conclusions

Repaired equipment must be marked to identify repair or overhaul and the identity of the repairer. Marking may be provided on a separate label. It may be necessary to modify, remove or supplement the label in certain circumstances, as follows:

a) If, after repair, overhaul or modification, the equipment still complies with requirements imposed by SR EN IEC 60079-19, standards of the type/types of protection with which it was designed and the design drawings, the label must not be removed, and the repair symbol *"R"* must be written in a square, figure 2.

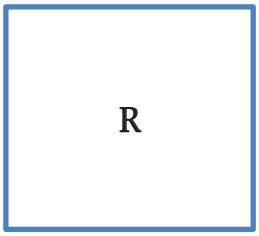


**Fig. 2.** Marking of repaired Ex equipment according to manufacturer's specifications.

b) If, after repair, overhaul or modification, the equipment still complies with requirements imposed by SR EN IEC 60079-19 and the protection type standards according to which it was manufactured, but compliance with design drawings has not been confirmed, the label must not be removed and the repair symbol *"R"* must be written in a triangle with the tip down, figure 3.

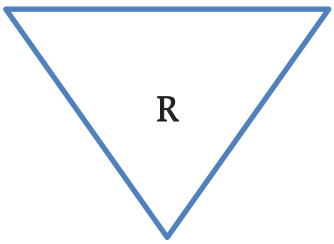


**Fig. 3.** CaMarking of repaired Ex equipment according to specific standards.

c) If, after repair, overhaul or modification, the equipment is changed in such a way that it no longer complies with the protection type standards or the design drawings, the "Ex" marking and mark of the certificate issuer on the label shall be removed, with unless an additional certificate has been obtained.

d) If the standards according to which the previously certified equipment was manufactured are not known, the requirements of SR EN IEC 60079-19 and current edition of relevant standards for the type of protection shall be applied.

e) For old equipment in groups II and III, if design drawings are not available or an identification plate is missing or unavailable, the user can perform an evaluation of repaired equipment in accordance with SR EN 60079-17. In this case, a replacement tag can be created by a competent person.

## Acknowledgments

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