

MIE TALK - October 2015

REPAIRS OF EXPLOSION PROTECTED EQUIPMENT

EXPLOSIVE ATMOSPHERES

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Introduction

The repair of equipment for use in explosive atmospheres is to restore the integrity of the equipment to its original design. This tutorial provides the reader with the knowledge and understanding relating to the Refurbishment, Reclamation and Repair of Explosion-protected equipment for use in Hazardous Areas. Such learning is a fundamental requirement for Electrical and Instrumentation Maintenance Staff and their Management in order to comply with the requirements of the Occupational Health and Safety Act.

Fire triangle

Before a fire or explosion can occur, three conditions must be met simultaneously. A fuel (ie. combustible gas) and oxygen (air) must exist in certain proportions, along with an ignition source (heat), such as a spark or flame. The ratio of fuel and oxygen that is required varies with each combustible gas or vapor.

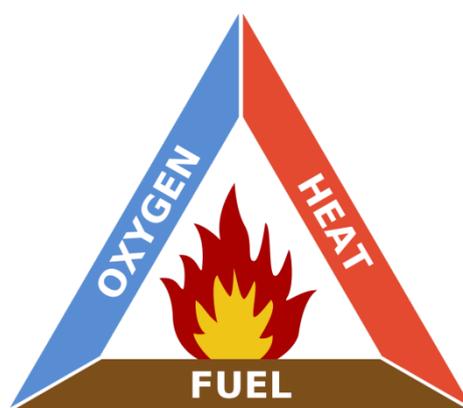


Figure 2: Fire triangle

Successfully suppressing or separating one or more of these three components can avoid a fire or explosion.

Mechanical, electrical, instrumentation and process equipment can be regarded as possible sources of ignition in potentially explosive atmospheres, as they can cause **sparks; friction** or **hot surfaces**. To prevent sparks or hot surfaces, electrical equipment has to be designed not to provide any source of ignition.

One of the main strategies to prevent explosions caused by flammable gases, vapours, mists and dusts capable of forming explosive atmospheres in conjunction with air, is to use explosion-protected (Ex) equipment, as such equipment prevents ignition of explosive atmospheres when correctly used.

What is deemed as a repair?

This is an action taken to restore a faulty apparatus to its fully serviceable condition, and in compliance with the relevant standard. The "relevant standard" means the explosion protection standard to which the apparatus was originally designed or a more recent version for example SANS 60079-1 for Ex d equipment.

All new, modified

, re-designed or repaired apparatus for use in hazardous locations in all surface industries and mines shall, in accordance with annex A, have an IA certificate number displayed on such apparatus before being entered into service

Repairs and overhauls shall be carried out in such a way that they will not invalidate the IA certificate.



Figure 1 : Ex d motor before repair



Figure 2 : Ex d motor after repair

Applicable standards and regulations

Electrical Machinery Regulation 9(2):

No person may use electrical machinery in locations where there is danger of **fire or explosion** owing to the presence, occurrence or development of explosive or flammable articles, or where explosive articles are manufactured, handled or stored, unless such electrical machinery, with regard to its construction relating to the classification of the hazardous locations in which it is to be used, meets the requirements of the safety standard incorporated for this purpose in these Regulations under section 44 of the Act.

The Occupational Health and Safety Act, 1993 (Act 85 of 1993) and the Mine Health and Safety Act, 1996 (Act 29 of 1996) require that Ex equipment be certified and that the certification not be invalidated by repair operations.

Golden rules for repairers

- Repaired Ex equipment shall be recertified unless the repair operation is conducted by an approved repairer.
- The repair principle for explosion-protected equipment is that an already certified product is brought back to original specification. This ensures that the

existing certification remains valid, and more practically, that the Ex equipment remains safe.

- Should a modification be required, re-certification will also be required to evaluate the effect of the modification on the explosion protection.
- All Ex repairs will be done under a Mark Scheme (ATL like Explolabs and MASC) to ensure that the quality of the repair process is controlled.
- The repaired equipment has to be assessed by an approved Ex test laboratory (ATL) if not done under a Mark Scheme.

SANS 60079-19: Equipment repair, overhaul and reclamation

Whilst some manufacturers recommend that certain equipment be returned to them for repair, there are also competent independent repair facilities that have the facilities to carry out repair work on equipment, retaining some or all of the types of protection covered by SANS 60079 series.

For repaired equipment to retain the integrity of the type(s) of protection employed in its design and construction, detailed knowledge of the original manufacturer's design (which may only be obtainable from design and manufacturing drawings) and any certification documentation may be necessary.

Where equipment is not returned to the original manufacturer for repair, the use of repair facilities that are recommended by the original manufacturer should be considered.

In circumstances where the certification documents are not available, then the repair or overhaul shall be carried out on the equipment in accordance with this standard (SANS 60079-19) and other relevant standard(s).

Clause 4.3 Instructions for the user

Certificates and documents

The user must be in possession of the equipment design certificate and other related documents and must be part of the original purchase contract.

Records and work instructions

The documentation mentioned in the previous paragraph, along with the records of any repairs, overhauls, alterations or modifications, should be kept by the user.

- The user must make this documentation available to the repairer at any time during repairs.
- The end user must be in possession of the documentation for the life time of the equipment.
- This is also a requirement as per Electrical Machinery Regulation 9(3): "The end user must be in possession of a certificate acceptable to the chief inspector:

- The user must inform the repairer of the fault and/or nature of the work to be done and any special application information, e.g. a motor supplied by an inverter.
- Special requirements stipulated in the user's specifications should be brought to the attention of the repairer.

Re-installation of repaired equipment

Re-installation of repaired equipment must be done in accordance with IEC/SANS 60079-14.

- A detail inspection for different types of protection must be completed as per Annexure C of the above standard and it is compulsory.
 - The selection of Ex equipment must follow the area classification.
- A Certificate of Compliance must be issued by a registered person (MIE) for the installation if it does not exist.

How do you, as a user of Ex Equipment, know that your Repair Facility is operating in accordance with the requirements of SANS 60079-19 and returning your Ex Equipment safe for use?

Repair facilities must comply with the following requirements as stipulated in SANS 60079-19 as per Clause 4.4:

“Instructions for the repair facility”.

- The repair facility shall operate a Quality Management System. Overhaul of explosion-protected equipment involves special techniques.
 - The Quality Management System should include documented procedures to ensure work is performed within an agreed refurbishment quality program. For additional information, see ISO9001.
- The repairer shall appoint a Responsible Person with responsibility and authority for ensuring the overhauled/repaired equipment complies with the certification status agreed with the user.
- Repairer shall have adequate facilities as well as the appropriate equipment necessary.
- The repairer of the apparatus will need to ensure that those concerned with the repair of the certified apparatus are properly trained, competent, and supervised on this type of work. Such training will need to cover:
 - general principles of the type of protection and marking;
 - those aspects of equipment design which affect the protection concept;
 - certification and standards;

- identification of replacement parts or components authorised by the manufacturer;
 - particular techniques to be employed in repairs referred to in other parts of this guidance.
- The Responsible Person shall only conduct assessments with the explosion protection techniques for which they have demonstrated his competence.
 - The repair facility shall include additional procedures and systems to carry out overhaul/repair work at sites external to the repair facility, where appropriate.

Clause 4.4.1.2 Certificates and standards

The repairer's attention is directed to the need to be informed of, and to comply with, the relevant explosion-protection standards and certificates, including any specific conditions of use, applicable to the equipment to be repaired or overhauled.

Clause 4.4.1.3 Competency

All personnel directly concerned with the repair and/or overhaul of the equipment shall be competent or supervised by a competent person. The competencies may be specific to the type of work. Training and competency assessments are specified in Annex B.

Appropriate training and assessment shall be undertaken from time to time at intervals depending on the frequency of utilization of the technique or skill and change of standards or regulations. The interval should normally not exceed three years.

Clause 4.4.1.4 Repair of components

When a component of complete equipment is taken off site for repair, such as a rotor of a rotating machine, and it is impracticable to carry out certain tests, the repairer shall document the details and communicate them to the user before starting the repair.

NOTE: *Clause 4.3.4 specifies that it is the responsibility of the user to ascertain that the repair facility concerned can demonstrate compliance with the relevant stipulations of this standard.*

The Repair Facility has the responsibility to demonstrate to the Ex Equipment user how they comply with the requirements of SANS 60079-19.

Understanding of different Symbols used during repairs.

All equipment repaired and/or overhauled shall be marked to identify the repair and the repairer's identity.

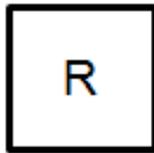
Symbol "X" used to denote specific conditions of use.

The symbol "X" is used to provide a means of identifying that essential information for the installation, use, and maintenance of the equipment is contained within the certificate. Therefore, the certificate documents should be

studied before such equipment is installed, repaired, overhauled, reclaimed, altered or modified.

In accordance with certificate documentation and/or manufacturer's specification

This mark is to be used only when the repair or reclamation is in accordance with this standard and the repairer has sufficient evidence of full compliance with the certificate documentation and/or manufacturer's specification.

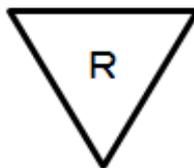


In accordance with the type of protection standards but not the certificate documentation

This mark is to be used when either

- a) the equipment is changed during repair or reclamation so that it still complies with the restrictions imposed by this standard and the explosion-protection standards to which it was manufactured, but repairer has insufficient evidence of full compliance with the certificate documentation; or
- b) the standards to which the equipment was manufactured are not known, but the requirements of this standard and the current edition of the relevant explosion-protection
- c) standards have been applied but repairer has insufficient evidence of full compliance with the certificate documentation. An assessment, by a person competent in assessing explosion-protected equipment has been conducted to verify compliance with the relevant level of safety prior to release of the equipment by the repairer.

In these situations the certification labels should not be removed.



ARP 0108 requirements

Repairs of Ex equipment with V or VM numbers

Existing IA certificates and government mining engineer (GME) certificates (the latter associated with V or VM numbers) issued after 1998 (only IA certificates), shall not be valid after October 2015.

NOTE: After October 2015, IA certificates must be issue for repaired equipment with V or VM numbers as per paragraph above, and must be delivered with the equipment.

Equipment Marking

Ex equipment must always mark correctly due to the potential disastrous consequences if the wrong equipment is used. The labels must be permanent and clear with information supporting the safe use of the equipment. These requirements are important for:

- Selection of equipment
- Inspection of equipment

Repair label

Any repairer shall attach to the equipment a durable, legible and noticeable label that gives at least the following information:

- a) the repairer's certificate number (when operating under an approved product certification mark scheme for Ex certified equipment)
- b) the IA certificate number;
- c) the name of the repairer; and
- d) the month and year of repair or overhaul.

The label fitted by the original equipment manufacturer (OEM) shall not be removed, but labels fitted by previous repairers shall be removed. If the OEM label is missing, the repairer may submit the finished product to an ATL and have the product re-certified to the current national standards. In this case, the repairer shall fit a supplier's plate displaying the new IA certificate number.



Figure 3: Original and repair label on Ex nA motor

How do you test the durability of labels as per ARP 0108 Clause 7.3

7.1.1 Rub the marking lightly for 15 s with a piece of cloth soaked with water.

7.1.2 After drying, rub for a further 15 s with a piece of cloth soaked with white spirit.

NOTE White spirit is also known as mineral spirits, mineral turpentine, turpentine substitute, petroleum spirits, and solvent naphtha (petroleum), and composed of a mixture of aliphatic and alicyclic C7 to C12 hydrocarbons with a maximum content of 25 %, by mass, of c7 to c12 aromatic hydrocarbons. This will not affect the marking.

Records

All records related to manufacture, repair or overhaul of Ex certified apparatus shall be kept for a minimum period of 10 years by the product certificate holder.

Repairer	A.3, A.5, A.6, A.13, A.14, A.17 and A.18
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Table 1: Applicable clauses for Ex repairers as per Annexure A – ARP 0108

Reclamation Procedures

Not all reclamation procedures are applicable to all types of protection. Upon completion of the reclamation, the repairer shall satisfy himself that the equipment is in a fully serviceable condition and complies with the standards for this type of protection.

The repairer will need to have copies of the relevant explosion protection standards available.

Before repairs are undertaken, the repairer will need to produce a documented specific repair procedure indicating how the repair will be undertaken for each type of protection.

Typical Inspection Report for a Flame proof Ex d enclosure

Inspection report will include but not limited to the following checks:

- Check of external and internal damage
- Dimensional check
- Corrosion on flame paths
- Result of static pressure test
- Check of flanged joint surfaces
- Check of all threaded holes
- Check of all windows and lenses

- Check of breathers
- Check of all bolt holes, studs, screws, etc.
- Check of all gland entries and fixing holes
- Check of all cables glands
- Check of all inspection covers
- Check of all mechanical interlocks
- Check of all flame path gaps



Figure 4: Corroded flange face and threaded hole on face



Figure 5 : Flame path scratch

Additional requirements for the repair and overhaul of equipment with type of protection "d" (flameproof)

Over-pressure testing

An over-pressure test shall be conducted where structural repairs of the enclosure have occurred or the integrity of the enclosure is in doubt.

Testing shall be completed at 1,5 times the reference pressure nominated in certificate documentation and held at least 10 s.

Cable and conduit entries

Entries into flameproof enclosures shall conform, after repair or overhaul, to the conditions detailed in the appropriate equipment standard.

Terminations

Care shall be taken when refurbishing terminations to maintain clearance and creepage distances.

Flameproof joints

Damaged or corroded flameproof joint faces shall be machined, after consultation with the manufacturer wherever possible, but only if the resultant joint gap and flange dimensions are not affected in such a way that they contravene the certificate documents.

- Correct procedures must be followed to repair flame paths and threaded holes.
- Metal removal shall be minimized and be just sufficient to remove the defect requiring repair.

Enclosures

- No modification affecting the explosion protection shall be carried out on parts of a flameproof enclosure without reference to the certificate documentation.

Cable or conduit entries

Additional entries shall not be made without reference to the certificate documentation. Indirect entry, where the external conductors are connected by means of a plug and socket or within a terminal box, shall not be changed to direct entry.

DOCUMENTATION

On completion of repairs, the repairer, who may also be the user, will need to provide the following details to allow the user's maintenance records to be updated:

- details of the fault detected;
- full details of the repair and overhaul work;
- list of replaced or reclaimed parts;
- the results of all checks and tests;
- the steps taken to obtain the certificate documentation;
- mechanical inspection record for compliance with relevant standards;
- electrical test records before and after repair including traceability of instruments used and pass/fail criteria;
- recovery procedure for repaired components;
- record of any assessments by the responsible person along with the justification for decisions taken;
- record of mechanical inspection during assembly and upon completion;

The inspection report must be delivered with the equipment on delivery to the end user.



Figure 6: Inspection report for a repair

MARK SCHEME PROCESS (Manufacture and / or Repair)

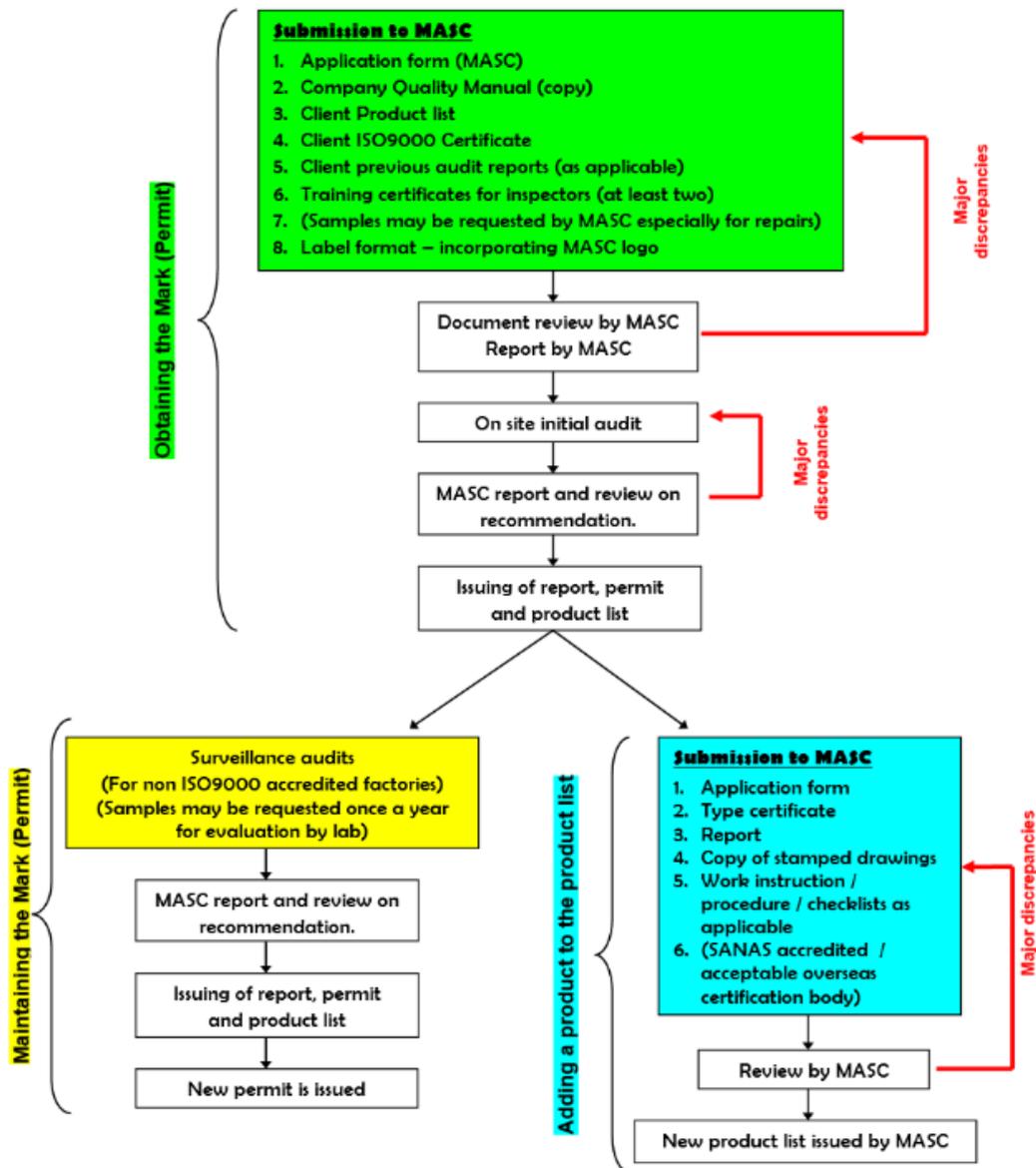


Figure 7: Typical mark scheme application process

Conclusion

I asked myself, what evidence I could produce for a court of law, to verify that my Repair Facility was overhauling & repairing Ex Equipment correctly. They have personnel who had been trained in Ex Equipment repair. How could I prove that they were following correct procedures? They have personnel who had been repairing Ex Equipment for many years, but were these many years' bad or good practice?

The only way to evaluate this is to assess the work done by auditing the repair facilities, by making use of subject matter experts. Remember you as a user are responsible.

Reference

[1] **Ex OD 015 Version 2 Title:** Additional Requirements for IECEx Service Facilities involved in repair, overhaul and modification of Ex equipment.

Applicable Standards

IEC/SANS 60079 Part 0: Equipment - general requirements

IEC/SANS 60079 Part 19: Equipment repair, overhaul and reclamation

ARP 0108: Regulatory requirements for explosion-protected apparatus

SANS 10108: The classification of hazardous locations and the selection of apparatus for use in such locations

MASC: Mark Scheme processes