

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Explosive atmospheres –
Part 19: Equipment repair, overhaul and reclamation**

**Atmosphères explosives –
Partie 19: Réparation, révision et remise en état de l'appareil**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES –**Part 19: Equipment repair, overhaul and reclamation**

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International Standard IEC 60079-19 has been prepared by subcommittee 31J: Classification of hazardous areas and installation requirements, of IEC technical committee 31: Equipment for explosive atmospheres.

This fourth edition cancels and replaces the third edition published in 2010 together with Amendment 1:2015. This edition constitutes a technical revision.

The significance of the changes between IEC 60079-19, Edition 3 (2010), including Amendment 1 (2015), and IEC 60079-19, Edition 4 (2019) are as listed below:

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Relationship between IEC 60034-23 and IEC 60079-19	Introduction	X		
Document applicable to Type(s) of Protection “o” and “q”	1		X	
Standard for electrical resistance trace heating added	2		X	
Terms “repair facility” and “service facility” are considered equivalent. Changed “repair facility” to “service facility”	3 to 15	X		
Terms and definitions aligned alphabetically	3	X		
Clarification of definition “certificate”	3.2	X		
Addition of definition “Component Certificate”	3.2.1		X	
Addition of definition “Ex Equipment Certificate”	3.2.2		X	
Addition of definition “schedule drawing”	3.2.3		X	
Change in terms used from “certificate documents” to “schedule drawing”	4 Annex E	X		
Change in terms used from “certificate documents” to “Ex Equipment Certificates” and “schedule drawings”	4.2.1	X		
Change in terms used from “motor”, “rotating machine”, “rotating electrical machine” to “electric machine”	All	X		
Addition of specific operating requirements	4.3.2.1		X	
Clarification of requirements for repair of components	4.3.2.3		X	
Addition of a requirement to review “X” conditions	4.3.2.4.2		X	
Change in terms from “bolt” to “fastener”	4.3.2.5.2	X		
Addition of bullet point for marking of repairs to certification documentation	4.3.2.6 a)		X	
Addition of bullet point for fitness for purpose assessment to IEC 60079-17	4.3.2.6 e)		X	
Additional actions to be taken in case of uncertainty of a reclamation	4.3.3.1		X	
Change of “subject to repair” to “repairable”	4.3.3.2	X		
Elimination of duplication of requirements	4.3.3.3.1	X		
Addition of bullet point including other welding techniques to ISO 4063	4.3.3.4.5		X	
Addition of requirement for threaded hole verification using GO, NO-GO gauges and threaded hole reclamation test	4.3.3.4.7		X	
The role of a service facility clarified to exclude the role of a manufacturer when making alterations	4.3.4.1		X	
Addition of requirement that the Ex report following equipment modification shall not have an attestation of compliance	4.3.4.2		X	
Clarification of repairer's duty to confirm service condition following any reclamation	4.3.6.2	X		
Restructuring of requirements relating to testing of electric machines as subclauses of 4.3.6 from Type of Protection clauses 5, 7, 8, 9, 10 and 11 in previous editions.	4.3.6.3.1 and 4.3.6.3.2	X		
Addition of a requirement for greases with non-evaporating solvents for joint corrosion protection materials	5.2.1.1		X	
Revised a recommendation to a requirement “should” to “shall”	5.2.4		X	
Revised a recommendation to a requirement. “is necessary” to “shall be taken”	5.2.7.2		X	
Text amended to make requirement clearer	5.2.8.1	X		

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Addition of requirement for threaded hole verification using GO, NO-GO gauge and threaded hole reclamation tests	5.3.2.3		X	
Addition of requirements for Type of Protection “i” requiring repair to manufacturer’s documentation and certificate requirements only Repair of multilayer boards or any board with surface mounted devices are excluded	6.1			C1
Addition of “thermal property” requirement for terminations	6.2.3		X	
Change in text of requirements for soldered connections	6.2.4	X		
Revised a recommendation to a requirement for fuses, “inappropriate” to “not permitted”	6.2.5		X	
Addition of requirement for printed circuit board repair	6.2.8		X	
Change in text of requirement for electrical components replacing “certification” by “assessment by a suitable competent person”	6.2.10	X		
Elimination of duplication of text	6.2.11	X		
Change in text for internal wiring replacing “certification” by “assessment by a suitable competent person”	6.2.12	X		
Addition of Type(s) of Protection marks with Explosion Protection Levels	7		X	
Addition of new subclause detailing requirements for verification of pressurization system	7.5		X	
Addition of “Level of Protection” to clarify “eb”	8	X		
Change in requirements for copy winding as introduced in IEC 60079-19:2010/AMD 1:2015	8.2.6.1.2		X	
Elimination of duplication of note and text and correction of bullet point letters	8.2.6.1.2			
Change in text to clarify the requirements for windings with voltage > 1 000 V	8.2.6.1.3	X		
Change in text to clarify the requirements relating to “light transmitting parts”	8.2.7	X		
Addition of Type of Protection “e” with Level of Protection “ec”	9	X	X	
Change in text to clarify the requirements for windings with voltage > 1 000 V	9.2.6.1.4	X		
Text moved from body of text in 9.2.6.1.3 to a new subclause to clarify that copy winding requirements apply to all voltages	9.2.6.1.5		X	
Addition of requirement from IEC 60079-19:2010/AMD 1:2015 that core losses after stripping shall not exceed 110 % of core losses before stripping	9.2.6.1.5 j) – s)		X	
Elimination of duplication of requirement in 4.3.6.2.1	9.2.6.1.5 t)	X		
Addition of Type of Protection standard numbers	11.1	X		
Addition of new Level of Protection marks “pxb”, “pyb” and “pzc”	7.1	X		
Addition of new clause with requirements for Type of Protection “o”	12		X	
Addition of new clause with requirements for Type of Protection “q”	13		X	
Addition of new clause with requirements for Type of Protection “s”	14		X	

Explanation of the significance of the changes	Clause	Type		
		Minor and editorial changes	Extension	Major technical changes
Addition of new clause with requirements for electric resistance trace heating"	15		X	
Addition of new Figure 1 description to clarify the intent of R in a square	A.2.1	X		
Addition of new Figure 2 description to clarify the intent of R in an inverted triangle	A.2.2	X		

NOTE 1 The technical changes referred to include the significance of technical changes in the revised IEC standard, but they do not form an exhaustive list of all modifications from the previous version. More guidance can be found by referring to the Redline version of the standard.

Explanations:

A) Definitions

Minor and editorial changes

- clarification
- decrease of technical requirements
- minor technical change
- editorial corrections

These are changes which modify requirements in an editorial or a minor technical way. They include changes of the wording to clarify technical requirements without any technical change, or a reduction in level of existing requirement.

Extension

- addition of technical options

These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements from the previous standard.

Major technical changes

- addition of technical requirements
- increase of technical requirements

These are changes to technical requirements (addition, increase of the level or removal) made in a way that an overhaul or repair of product to the preceding edition will not always be able to fulfil the requirements given in the later edition. For these changes additional information is provided in clause B) below.

NOTE These changes represent current technological knowledge. However, these changes do not normally have an influence on equipment already placed on the market.

B) Information about the background of 'major technical changes'

- C1 Due to the detailed nature of Type of Protection "i", repair to other than manufacturers schedule drawings risks violation of the Type of Protection. Some components such as multi-layer boards are not suitable for repair.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
31J/295/FDIS	31J/297/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60079 series, published under the general title *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

When equipment is installed in areas where dangerous concentrations and quantities of flammable gases, vapours or dusts may be present in the atmosphere, protective measures are applied to reduce the likelihood of explosion due to ignition by arcs, sparks or hot surfaces produced either in normal operation or under specified fault conditions.

This part of IEC 60079 is supplementary to other relevant IEC standards, for example the IEC 60034 series, in particular IEC 60034-23, and also refers to the IEC 60079 series and its appropriate parts for the design requirements of suitable electrical equipment.

The nature of the explosion protection offered by each Type of Protection varies according to its unique features.

This document gives guidance on the practical means of maintaining the explosion protection of repaired equipment. This document also defines procedures for repair, overhaul or reclamation and verification of continued compliance of the equipment with the provisions of the Ex Equipment Certificate or with the provisions of the appropriate explosion protection standard where an Ex Equipment Certificate is not available.

It is intended that the users utilize the most appropriate service facilities for any particular item of equipment, whether they be the facilities of the manufacturer or a suitably competent and equipped repairer.

This document recognizes the necessity of a required level of competence for the repair, overhaul and reclamation of the equipment. Some manufacturers may recommend that the equipment be repaired only by them.

Much of the content of this document is concerned with the repair and overhaul of electric machines. This is because they are items of repairable Ex equipment in which, irrespective of the Type of Protection involved, sufficient commonality of construction exists as to make possible more detailed instructions for their repair, overhaul, reclamation or modification.

EXPLOSIVE ATMOSPHERES –

Part 19: Equipment repair, overhaul and reclamation

1 Scope

This part of IEC 60079:

- gives instructions, principally of a technical nature, on the repair, overhaul, reclamation and modification of Ex equipment designed for use in explosive atmospheres;
- applies to overhaul and repair which mitigates deficiencies identified during operation, inspection and maintenance;
- does not give advice on cable and wiring systems which can require a renewal when the equipment is re-installed; and
- is not applicable to Type of Protection “m”.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-23: Rotating electrical machines - Part 23: Repair, overhaul and reclamation

IEC 60079-0:2017, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-1, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures “d”*

IEC 60079-2, *Explosive atmospheres – Part 2: Equipment protection by pressurized enclosure “p”*

IEC 60079-6, *Explosive atmospheres – Part 6 Equipment protection by liquid immersion “o”*

IEC 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety “e”*

IEC 60079-11:2011, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “i”*

IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection “n”*

IEC 60079-26, *Explosive atmospheres – Part 26: Equipment with equipment protection level (EPL) Ga*

IEC/IEEE 60079-30-1, *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements*

IEC/IEEE 60079-30-2, *Explosive atmospheres – Part 30-2: Electrical resistance trace heating – Application guide for design, installation and maintenance*

IEC 60079-31, *Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure “t”*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 61241-0¹, *Electrical apparatus for use in the presence of combustible dust – Part 0: General requirements*

IEC 61241-1², *Electrical apparatus for use in the presence of combustible dust – Part 1: Protection by enclosures “tD”*

IEC 61241-1-1³, *Electrical apparatus for use in the presence of combustible dust – Part 1-1: Electrical apparatus protected by enclosures and surface temperature limitation – Specification for apparatus*

IEC 61241-4⁴, *Electrical apparatus for use in the presence of combustible dust – Part 4: Type of Protection “pD”*

ISO 4526, *Metallic coatings – Electroplated coatings of nickel for engineering purposes*

ISO 6158, *Metallic coatings – Electrodeposited coatings of chromium for engineering purposes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426.

3.1

alteration

change to a product that results in an alternative construction that is described in the certificate documentation

¹ Withdrawn.

² Withdrawn.

³ Withdrawn.

⁴ Withdrawn.

3.2 certificate

document that conveys the assurance of the conformity of a product, process, system, person, or organization with specified requirements

Note 1 to entry: The certificate can be either the supplier's declaration of conformity or the purchaser's recognition of conformity or certification (as a result of action by a third party) as defined in ISO/IEC 17000.

3.2.1 Ex Component Certificate

certificate prepared for an Ex Component

3.2.2 Ex Equipment Certificate

certificate prepared for Ex Equipment

3.2.3 schedule drawing

drawing or document listed in the certificate or test report

3.3 competence

ability to apply knowledge and skills to achieve intended results

[SOURCE: ISO/IEC 17024:2012, 3.6]

3.4 component part

indivisible item

Note 1 to entry: Normally an assembly of components constitutes an equipment.

3.5 copy winding

process by which a winding is totally or partially replaced by another, the characteristics and properties of which are at least as good as those of the original

[SOURCE: IEC 60050-426:2008, 426-15-12]

3.6 encapsulation “m”

Type of Protection whereby parts that are capable of igniting an explosive atmosphere by either sparking or heating are fully enclosed in a compound or other non-metallic enclosure with adhesion in such a way as to avoid ignition of a dust layer or explosive atmosphere under operating or installation conditions

[SOURCE: IEC 60079-18:2014, 3.1]

3.7 flameproof enclosure “d”

Type of Protection in which the parts capable of igniting an explosive gas atmosphere are provided with an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture, and which prevents the transmission of the explosion to the explosive gas atmosphere surrounding the enclosure

[SOURCE: IEC 60050-426:2008, 426-06-01]

3.8**increased safety “e”**

Type of Protection applied to electrical equipment in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and against the occurrence of arcs and sparks in normal service or under specific abnormal conditions

[SOURCE: IEC 60050-426:2008, 426-08-01, modified – "apparatus" has been replaced with "equipment" and "specified" has been replaced with "specific".]

3.9**intrinsically safe circuit**

circuit, in which any spark or any thermal effect produced in the conditions specified in IEC 60079-11, including normal operation and specified fault conditions, is not capable of causing ignition of a given explosive atmosphere

[SOURCE: IEC 60079-11:2011, 3.1.4]

3.10**liquid immersion “o”**

DEPRECATED: oil immersion “o”

Type of Protection in which the electrical equipment or parts of the electrical equipment are immersed in a protective liquid in such a way that an explosive gas atmosphere which may be above the liquid or outside the enclosure cannot be ignited

[SOURCE: IEC 60079-6:2015, 3.1]

3.11**maintenance**

combination of any actions carried out to retain an item in, or restore it to, condition in which it is able to meet the requirements of the relevant specification and perform its required functions

3.12**manufacturer**

maker of the equipment (who may also be the supplier, the importer or the agent) in whose name usually the certification, where appropriate, was originally registered

[SOURCE: IEC 60050-426:2008, 426-15-07, modified – "apparatus" has been replaced with "equipment".]

3.13**modification**

change to the design of the equipment which affects material, fit, form or function

Note 1 to entry: As the schedule drawings describe a specific construction of the equipment, a modification of the equipment would no longer comply with the construction described in the Ex Equipment Certificate and schedule drawings.

[SOURCE: IEC 60050-426:2008, 426-15-06, modified – "apparatus" has been replaced with "equipment" and the note has been added.]

3.14**operative**

person who can demonstrate a combination of knowledge and skills to effectively carry out activities on, or associated with, hazardous area equipment

3.15

overhaul

action to restore to a fully serviceable condition, equipment which has been in use or in storage for a period of time, but which is not faulty

3.16

powder filling “q” sand filling “q”

Type of Protection in which the parts capable of igniting an explosive gas atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an external explosive atmosphere

[SOURCE: IEC 60050-426:2008, 426-07-01, modified – The note has been deleted.]

3.17

pressurization “p”

Type of Protection for guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere

[SOURCE: IEC 60050-426:2008, 426-09-01, modified – "or room" has been deleted.]

3.18

reclamation

means of repair involving, for example, the removal or addition of material to reclaim component parts which have sustained damage, in order to restore such parts to a serviceable condition in accordance with the relevant standard

Note 1 to entry: The 'relevant standard' means the standard according to which the individual parts were originally manufactured.

[SOURCE: IEC 60050-426:2008, 426-15-05]

3.19

repair

action to restore faulty equipment to its fully serviceable condition complying with the relevant standard

Note 1 to entry: The 'relevant standard' means the standard according to which the individual parts were originally designed.

[SOURCE: IEC 60050-426:2008, 426-15-02, modified – "apparatus" has been replaced with "equipment", "in compliance" with "complying" and in the note "apparatus was" has been replaced with "individual parts were".]

3.20

service facility

repair facility

facility providing a service that consists of repairs, overhauls, or reclamations of Ex Equipment who can be the manufacturer, the user or a third party (repair agency)

3.21

responsible person

person who can demonstrate a combination of knowledge and skills to effectively carry out, and supervise, activities on hazardous area equipment

3.22**serviceable condition**

condition which permits a replacement or reclaimed component part to be used without prejudice to the performance or explosion protection aspects of the equipment, with due regard to the certification requirements as applicable, in which such a component part is used

[SOURCE: IEC 60050-426:2008, 426-15-01, modified – "apparatus" has been replaced with "equipment".]

3.23**symbol "X"**

suffix to the certificate number used to denote Specific Conditions of Use for Ex Equipment

Note 1 to entry: 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.

[SOURCE: IEC 60079-0:2017, 3.84]

3.24**Type of Protection "n"**

Type of Protection applied to electrical equipment such that, in normal operation and in certain specified regular expected occurrences, it is not capable of igniting a surrounding explosive gas atmosphere

Note 1 to entry: Additionally, the requirements of IEC 60079-15 are intended to ensure that a fault capable of causing ignition is not likely to occur

[SOURCE: IEC 60050-426:2008, 426-13-01, modified – "apparatus" has been replaced with "equipment" and Note 2 has been deleted.]

3.25**Type of Protection "pD"**

Type of Protection whereby a protective gas is applied to an enclosure in order to prevent the formation of an explosive dust atmosphere inside the enclosure by maintaining an overpressure against the surrounding atmosphere

[SOURCE: IEC 60050-426:2008, 426-17-01]

3.26**special protection "s"**

concept to allow design, assessment and testing of equipment that cannot be fully assessed within a recognized Type of Protection or combination of recognized Types of Protection because of functional or operational limitations, but which can be demonstrated to provide the necessary equipment protection level (EPL)

3.27**dust ignition protection by enclosure "t"**

Type of Protection for explosive dust atmospheres where electrical equipment is provided with an enclosure providing dust ingress protection and a means to limit surface temperatures

Note 1 to entry: The Type of Protection "t" was formerly referred to as "tD".

3.28**user**

organization or person which is the owner, or operator, of the equipment, and that is primarily responsible for repairing it; not the equipment manufacturer or repairer

3.29

verification dossier

set of documents showing the compliance of electrical equipment and installations, including certificates, manufacturer's instructions, records of previous repairs, overhauls and reclamations

4 General

4.1 General principles

Clause 4 covers those aspects of repair, overhaul, reclamation, alteration, and modification which are common to all Ex Equipment. Clauses 5 to 15 provide instructions for the additional requirements relevant to specific Type(s) of Protection. When equipment incorporates more than one Type of Protection, reference shall be made to the appropriate clauses.

Where Type of Protection "m" is used in association with other Type(s) of Protection, for example "d" or "e", the relevant clauses of this document apply for the overhaul or repair of those other Type(s) of Protection, but if the "m" component is defective, it can only be replaced.

NOTE 1 Additional requirements for Type of Protection "m" have not been defined.

Repairs and overhauls impacting the Type of Protection shall be presumed as being in conformity with the schedule drawings when:

- a) manufacturer's parts or parts specified according to the documentation given in 4.3.2.4 are used;
- b) repairs or alterations are carried out specifically as detailed in this document and the schedule drawings; and
- c) when performed by competent persons according to 4.3.2.2.

In circumstances where the relevant documentation in accordance with 4.3.2.4.1 is not available, then the repair or overhaul shall be carried out on the equipment in accordance with this document and other relevant standard(s), to which the equipment was originally verified. The steps taken to obtain the relevant documentation shall be recorded in the service facility records (see 4.3.2.4.3).

If the equipment has been modified, it shall comply with the requirements of 4.3.2.6 where a new certificate is required to be issued or the equipment is no longer suitable for use in a hazardous area.

NOTE 2 In some countries, in accordance with legal requirements, repair cannot be carried out without relevant documentation to Group I equipment unless subjected to complete retesting and a new Ex Equipment Certificate issued.

If other repair or alteration techniques are used which are not in accordance with this document, then it shall be necessary to confirm, from the manufacturer or the certificate issuer, that the equipment is suitable for continued use in an explosive atmosphere.

4.2 Instructions for the user

4.2.1 Ex Equipment Certificates and schedule drawings

The equipment user should be aware of any relevant legislation with respect to periodic inspection and verification to ensure that electrical equipment installed in explosive atmospheres is fit for purpose. The user should consider whether sufficient facilities and competencies are available to undertake the repair or overhaul of such equipment by the user or whether it should be contracted to specialist repair and overhaul service providers. In addition, the user should be aware that sufficient information has to be provided to third-party service facilities and installers to meet occupational health and safety obligations.

The user is responsible for obtaining the Ex Equipment Certificate and other related documents (see 4.3.2.4) as part of the original purchase agreement for Ex Equipment.

4.2.2 Records and work instructions

All relevant documentation (see 4.3.2.4.1) that was obtained as part of the original purchase contract, together with records of any previous repairs, overhauls or modifications, should be kept in a verification dossier and made available to the service facility.

NOTE The documentation and records are normally retained in the users verification dossier for the lifetime of the equipment.

It will be in the interests of the user that the repairer is notified, whenever possible, of the fault and nature of the work to be done and any special application information, for example an electric machine supplied by an inverter.

Special requirements stipulated in the user's specifications, which are supplementary to the various standards, for example enhanced ingress protection, specific environmental conditions, should be brought to the attention of the repairer.

The repairer shall be informed of any statutory requirement for compliance with the Ex Equipment Certificate.

4.2.3 Re-installation of repaired equipment

Re-installation of repaired equipment shall be in accordance with IEC 60079-14.

NOTE It is a requirement of IEC 60079-14 that before the repaired equipment is re-commissioned, cable and wiring systems are checked to ensure that they are undamaged and are appropriate to the Type of Protection.

4.2.4 Service facilities

Specific requirements in relevant national or regional legislation may govern repair or overhaul operations

NOTE It is possible the user has to ascertain that the service facility concerned can demonstrate compliance with the relevant stipulations of this document and any regulatory requirements.

4.3 Instructions for the service facility

4.3.1 Statutory requirements

The service facility, which may be the manufacturer, user or a third-party, shall be aware of any specific requirements in relevant national or regional legislation which can govern the repair or overhaul operation.

4.3.2 Repair and overhaul

4.3.2.1 General

Service facilities shall operate an effective quality management system which shall include the requirements detailed below:

NOTE ISO 9001 and ISO/IEC 80079-34 provide additional guidance

- a) Each service facility shall appoint a 'responsible person' with the required competence (see Annex B), within the management organization, to accept responsibility and authority for ensuring that the overhauled/repaired equipment complies with the Ex Equipment Certificate as agreed with the user. The person so appointed shall have a working knowledge of the appropriate explosion protection standards and an understanding of this document.

- b) A quality process plan shall be established incorporating appropriate inspection, diagnostic, test and check procedures to ensure that the repairs and overhauls meet the functional and compliance requirements of this document, other relevant standards, or the Ex Equipment Certificate, and the schedule drawings to be able to affirm to the user the suitability for re-installation in a hazardous area.
- c) The service facility shall establish procedures or work instructions for the overhaul and repair of Ex Equipment.
- d) The service facility shall identify and record the range of test and measurement capabilities and their limitations for use in the repair and overhaul of Ex Equipment.
- e) The service facility shall maintain a system for calibration of measuring equipment to international or national standards.
- f) The service facility shall maintain records, which shall be legible, provide traceability of measured results to calibrated instruments for the specific measurements recorded, and the records shall be retrievable for the specified storage period.
- g) When conducting dimensional and electrical measurements the service facility shall record “as found” and “as left” values in the reports for future reference.
- h) The service facility shall establish an internal audit programme to address the effectiveness of the service facility in meeting the requirements of this document.
- i) Where a process can affect the integrity of a Type of Protection, and where the resulting integrity cannot be verified after repair, that specific process shall be measured and monitored to demonstrate compliance with required parameters.
- j) Where tests are required, they shall be performed as specified in this document, or in other relevant standards with no sampling techniques being permitted.
- k) Where non-conforming equipment is identified the service facility shall assess the risk to determine any remedial action required. The service facility shall maintain records to identify the user and full details of the remedial action taken.
- l) The service facility shall have adequate repair and overhaul facilities as well as the appropriate equipment necessary and trained personnel with the required competency (see Annex B) and authority to carry out the activities, taking into account the specific Type of Protection.
- m) The service facility shall conduct an assessment of the status of the equipment to be repaired, and agree with the user the expected status of the equipment after repair and the scope of work to be done.
- n) Any overhaul or repair shall require the service facility to confirm all Ex requirements relating to the Type of Protection to be able to verify compliance with either the schedule drawings or other relevant standards and including any Specific Conditions of Use. This should include the justification for omission of any tests mentioned within this document that the user could reasonably assume to be included.
- o) The assessment shall be documented and shall address the relevant clauses of the appropriate Type of Protection standard, this document, and be included in the job report to the user. Such assessments shall be conducted by the responsible person, supported by appropriate operatives. The responsible person shall only conduct assessments with the Types of Protection for which they have demonstrated competence.
- p) Overhaul and repair activities can only be conducted external to the service facility where the quality management system allows for the work to be completed at other locations, i.e. by generation of additional procedures and records to document the overhaul or repair.

4.3.2.2 Competence

All personnel directly concerned with the repair or overhaul of the equipment shall be competent or shall be supervised by a responsible person or competent operative. The competence may be specific to the type of work.

Training and assessments are specified in Annex B.

4.3.2.3 Repair of components

When a component of an Ex Equipment is taken off-site for repair, for example a rotor of an electric machine or a cover from an enclosure, and it is impracticable to carry out certain tests as required by this document or the relevant Type of Protection standard, the repairer shall document the details of tests that cannot be carried out and these shall be communicated to the user in writing before continuing the repair.

4.3.2.4 Documentation

4.3.2.4.1 General

The service facility shall seek to obtain all necessary information and data from the user or manufacturer for the repair or overhaul of the equipment. This shall include reference to the relevant Type of Protection standard, schedule drawings and information relating to previous repairs, overhauls or modifications.

The service facility shall maintain and refer to copies of any relevant Type of Protection standards with which repaired/overhauled equipment is claimed to comply.

The data necessary for the repair or overhaul to the schedule drawings and related drawings (R in square), depends upon the type of equipment and Type of Protection of the equipment being repaired. Such data can include, but is not limited to, details of the following:

- a) technical specification;
- b) drawings;
- c) relevant Type(s) of Protection standards;
- d) operating conditions (such as environment, supply (inverter), lubricants, duty, etc.);
- e) dismantling and assembly instructions;
- f) Ex Equipment Certificate and schedule drawings with Specific Conditions of Use, where specified;
- g) marking (including Ex marking);
- h) recommended methods of installation, operation, maintenance, repair or overhaul for the equipment;
- i) list of spare parts;
- j) summary of previous history of the repaired product including information as gathered under 4.2.2.

The information may be subject to amendments.

NOTE As from the fourth edition of IEC 60079-0 (2004), IEC 60079-0 requires that manufacturers prepare instructions including with regard to repair.

4.3.2.4.2 Job report to the user

At the completion of the work, a job report shall be submitted to the user for inclusion in the user's verification dossier. The job report shall contain, at least, the following:

- a) details of fault(s) detected;
- b) full details of repair and overhaul;
- c) list of replaced or reclaimed parts;
- d) results of all checks and tests (in sufficient detail to be useful, if required, by the next repairer);
- e) a comparison of the results against the criteria that have been used to determine compliance;
- f) copy of the user contract or order; and

g) a recapitulation of the marking applied in accordance with Annex A.

The job reports of repairs or overhauls shall be retained for a period of time as agreed with the user. Retained information shall be adequately controlled to ensure ease of retrieval.

For repairs undertaken without the Ex Equipment Certificate and schedule drawings as referenced in 4.3.2.4.1, the following shall be included in the repair report:

- 1) a statement that the repair is in accordance with the manufacturer's instructions or the applicable requirements of the Type of Protection standard against which the equipment was originally certified;
- 2) a statement that the repairer has insufficient evidence of full compliance with the Ex Equipment Certificate and schedule drawings;
- 3) a statement that any Specific Conditions of Use have been reviewed and any relevant conditions of use have been identified and considered in the repair or overhaul.

4.3.2.4.3 Service facility records

The following records shall be retained by the service facility:

- 1) current and past copies of relevant technical standards in addition to the explosion protection standards;
 - a) evaluation of service facility quality standard including;
 - b) details of service facility quality assessment scheme;
 - c) test instrument calibration;
 - d) competency and training records of personnel;
 - e) purchasing control system;
 - f) customer complaints system;
 - g) internal and, where appropriate, external audit documentation;
 - h) management review;
 - i) process control procedures;
 - j) register of manufacturer's drawings.
- 2) job records including:
 - a) the steps taken to obtain the Ex Certificate and schedule drawings;
 - b) mechanical inspection record for compliance with the relevant standards including traceability of instruments used and pass/fail criteria;
 - c) defect identification;
 - d) electrical test records before and after repair including traceability of instruments used and pass/fail criteria;
 - e) attestation of conformity for any part which is replaced;
 - f) recovery procedure for repaired components;
 - g) record of any assessments by the responsible person along with the justification for decisions taken;
 - h) record of mechanical inspection during assembly and upon completion;
 - i) record of work undertaken by the service facility;
 - j) record of any replacement parts manufactured by the repairer.
- 3) reclamation of repaired component records including:
 - a) identification of the component part;
 - b) name of the organization carrying out the reclamation;
 - c) a detailed justification for the work carried out;

- d) various options considered (for example welding, metal spraying);
- e) technical parameters, (for example bond strength);
- f) the reasons for selecting the chosen technique;
- g) consumables used and method of storage;
- h) base material;
- i) reclamation process manufacturers' instructions considered;
- j) procedure utilized;
- k) identity and competency of the operator;
- l) inspection procedure used, (for example ultra-sonic, dye-penetration, X-ray);
- m) maintenance and calibration details of automatic systems;
- n) detail of any dimensions which differ from those in relevant schedule drawings or the original dimensions of the component part;
- o) drawing(s) showing reclamation details including material removed and replaced;
- p) date of reclamation.

These records shall be retained for a period of at least ten years or as agreed with the user.

4.3.2.5 Spare parts

4.3.2.5.1 General

It is preferable to obtain new parts from the manufacturer. The repairer shall ensure that only appropriate spare parts are used in the repair or overhaul of certified equipment. Depending on the nature of the equipment, these spare parts may be identified by the manufacturer, the equipment standard or the relevant Ex Equipment Certificate and schedule drawings.

Where components cannot be supplied by the original manufacturer, the repairer may manufacture, or source through a subcontractor, replacement component parts provided that:

- a) the full specification for the component is available; and
- b) the service facility's quality scheme permits.

Records of such replacement component parts shall be retained and provided to the user.

4.3.2.5.2 Fasteners

Where replacement fasteners are used, they shall be the same type, material, diameter, pitch, length and tensile strength as specified for the original equipment. Where uncertainty exists for the tensile strength of fasteners, the equipment manufacturer should be consulted.

Washers, plain or lock, shall not be placed under bolt heads, screw heads or nuts unless they are specified in the original Ex Equipment Certificate and schedule drawings or in the Type of Protection standard to which the equipment was manufactured.

Where shrouds have been originally fitted, they shall remain securely attached.

4.3.2.5.3 Sealed parts

Parts, which are required by the equipment specification, the Ex Equipment Certificate or schedule drawings to be sealed, shall be replaced only by the particular spare part(s) detailed in the parts list.

Devices incorporated in equipment to indicate interference by third parties (for example security seals) as distinct from those required in the Ex Equipment Certificate and schedule drawings, do not fall within the scope of this subclause.

4.3.2.6 Identification of repaired equipment

Existing labels should be checked to ensure they are secure and legible.

The equipment shall be marked to identify the repair or overhaul and the repairer's identity. The marking for the repaired equipment is given in Annex A.

Marking may be provided on a separate label. It may be necessary to amend or remove or supplement the label in certain circumstances as follows:

- a) If after repair, overhaul or alteration, the equipment still complies with the restrictions imposed by this document, the Type of Protection standards to which it was designed and with the schedule drawings, the label should not be removed and the repair symbol "R" shall be written within a square (see Annex A).
- b) If after repair, overhaul, or alteration, the equipment still complies with the restrictions imposed by this document and the Type of Protection standards to which it was manufactured, but does not necessarily comply with the schedule drawings, the label should not normally be removed and the repair symbol "R" shall be written within an inverted triangle (see Annex A).
- c) If after repair, overhaul, alteration, or modification, the equipment is changed such that it no longer conforms with the Type of Protection standards or schedule drawings, the "Ex" marking and the mark of the certificate issuer on the label shall be removed unless a supplementary certificate has been obtained.
- d) Where the standards to which the previously certified equipment was manufactured are not known, the requirements of this document and the current edition of the relevant Type of Protection standards shall apply. An assessment, by a person competent in assessing Ex Equipment, shall be conducted to verify compliance with the relevant level of safety prior to release of the equipment by the repairer. The person performing the assessment shall not be connected to the service facility and shall be part of a recognized body competent in the examination and testing of Ex Equipment.
- e) For legacy group II and III equipment, where the schedule drawings are not available, or a nameplate is missing or not available, a fitness for purpose assessment may be carried out by the user according to IEC 60079-17. A replacement label may then be created by a competent person. The fitness for purpose assessment shall not be undertaken by the service facility.

4.3.3 Reclamations

4.3.3.1 General

Where the repair process involves reclamation work, then, in addition to the requirements of 4.3.2 for repairs and overhauls, the following also apply.

Reclamations not affecting the Type of Protection are not the subject 4.3.3. Such parts should be reclaimed using good engineering practices and be fit for purpose.

A reclamation procedure that would result in dimensions or other integral aspects affecting the Type of Protection being different from those given in relevant schedule drawings, where available, is a modification.

In the event of any uncertainty regarding the effect of an intended reclamation procedure on the Type of Protection, the advice of the manufacturer or certificate issuer should be sought. It can also be necessary to carry out tests to verify that the reclamation procedure is acceptable.

4.3.3.2 Exclusions

Some component parts are considered not to be reclaimable and are therefore excluded from the scope of this document. Examples of non-reclaimable component parts include:

- a) component parts made from the following materials: glass, plastics, or any material that is not dimensionally stable;
- b) fasteners; and
- c) component parts, for example some encapsulated assemblies, which have been stated by the manufacturer to be not repairable.

4.3.3.3 Requirements

4.3.3.3.1 General

Any reclamation shall be carried out by competent personnel, skilled in the process to be employed and using good engineering practices (see Annex B). Operators of reclamation techniques, for example welding or metal spraying, shall be required to undertake an initial and periodic practical skill test as specified in Clause B.5.

All reclamation shall be documented in accordance with 4.3.2.4.3.

If the reclamation is carried out other than by the user, the user shall be provided with a copy of the record.

If any proprietary process is used, the originator's instructions for such a process should be followed.

4.3.3.3.2 Responsibilities

If reclamations are contracted out by the service facility to a specialized industry, such reclamations shall be under the responsibility of the service facility.

4.3.3.4 Reclamation procedures

4.3.3.4.1 General

The following outlines some of the reclamation procedures which may be applicable to Ex Equipment.

It should be recognized that not all procedures are applicable to all Type(s) of Protection. Detailed instructions are given in the appropriate clauses of this document.

Metal removal shall be minimized and be just sufficient to remove the defect requiring repair and provide the minimum coating thickness recommended for the technique used.

Removal of up to 2 % of metal thickness, or 0,5 mm metal thickness, whichever is greater, for metal spraying and up to 20 % for welding shall not be significantly detrimental to the strength of the component. Removal of a greater thickness of material should only be carried out after due consultation with the manufacturer, or if the manufacturer is no longer available, by calculation.

On completion of the reclamation, the repairer shall satisfy himself that the equipment is in a fully serviceable condition and complies with the Type of Protection standard(s). Such compliance shall be recorded by the service facility and retained in the job files.

4.3.3.4.2 Metal spraying

This method shall be used only when the extent of the wear or damage, plus the machining necessary to prepare the component part for reclamation, does not weaken the part beyond safe limits. A sprayed metal inlay, whilst adding some stiffness, shall not be taken into account when strength is considered. Indeed, the machining process prior to the application of metal spray may introduce stress raisers which may further weaken the component.

Metal spraying is not recommended where peripheral speed of the shaft exceeds 90 m/s.

4.3.3.4.3 Electroplating

Electroplating is an acceptable procedure provided that the part is not weakened beyond safe limits. Detailed procedures for chromium and nickel plating shall comply with ISO 6158 and ISO 4526, respectively.

4.3.3.4.4 Sleevings

Sleeving shall be used only when the extent of the wear and damage, plus the machining necessary to prepare the part for reclamation, does not weaken the part beyond safe limits. A sleeve, whilst adding some stiffness, shall not be taken into account when strength is considered.

4.3.3.4.5 Brazing and welding

Reclamation by brazing or welding shall not be considered unless the technique employed ensures the correct penetration and fusion of braze or weld with parent metal, resulting in adequate reinforcement, the prevention of distortion, the relief of stresses and the absence of blow-holes. It should be recognized that brazing and welding raise the temperature of the component to a high level and may cause fatigue cracks to propagate.

The following welding techniques are recognized by this document and ISO 4063:

- a) manual metal arc (MMA);
- b) metal inert gas (MIG);
- c) tungsten inert gas (TIG);
- d) sub-Arc: MIG under a layer of flux;
- e) hot wire; and
- f) any other weld technique described in ISO 4063 that shields weld metals by flux or inert gas. Other techniques shall only be utilized in reclamations after due consultation with the manufacturer or, if relevant, the certifying authority.

4.3.3.4.6 Metal stitching

The cold reclamation of a fractured casting by the technique of closing the fracture with nickel alloy stitches and sealing the crack by nickel alloy chain studding may be used subject to a suitable thickness of casting.

4.3.3.4.7 Threaded holes for fasteners

All recovered threaded holes shall meet the requirements of the relevant Type of Protection standards. Threads which have been damaged such that they fail a GO–NO GO test may be reclaimed, depending upon the Type of Protection, by one of the following means:

NOTE ISO and other standards have further information on the form of threads.

- a) oversize drilling and re-tapping;
- b) oversize drilling, re-tapping and the fitting of a proprietary thread insert which passes the appropriate pull test as specified by the thread insert manufacturer;

- c) oversize drilling, plugging, re-drilling and re-tapping;
- d) oversize drilling and tapping, insert solid threaded plug, re-machine (as required);
- e) plugging, re-drilling and tapping elsewhere;
- f) plug-welding, re-drilling and tapping.

Reclaimed threaded holes for fasteners shall meet one of the following requirements:

- 1) threaded holes reclaimed using proprietary thread inserts and tested to the thread insert manufacturer's test method;
- 2) other reclaimed threads which meet a torque test equal to the bolt torque which shall not exceed 80 % of the tensile strength of the bolt and having a minimum thread engagement of 1,5 times the nominal diameter of the bolt; or
- 3) the enclosure shall be subject to an overpressure test.

Plugs shall be securely retained to avoid inadvertent removal.

4.3.3.4.8 Re-machining

Re-machining of worn or damaged surfaces may be performed only under the following circumstances, as applicable. The component part shall not be weakened beyond safe limits based upon equivalent equipment data;

- a) provided that the integrity of the enclosure is maintained; and
- b) to achieve the required surface finish.

4.3.4 Alterations and modifications

4.3.4.1 Alterations

The principal role of a service facility is to maintain, or return equipment to, its originally certified condition. A service facility cannot assume the role of a manufacturer and assemble new equipment.

Where the repair process involves alteration work, then, in addition to the requirements of 4.3.2 for repairs and overhauls, the following also apply:

- a) no alteration shall be made to the equipment unless that alteration is permitted in the Ex Equipment Certificate and schedule drawings; and
- b) if the schedule drawings are not available to the repairer, the proposed alteration shall only proceed provided the alteration is confirmed in writing by the manufacturer to be permitted by the Ex Equipment Certificate. Clauses 5 to 15 give detailed instructions regarding alterations in the context of each Type(s) of Protection.

4.3.4.2 Modifications

The user shall be informed in writing and the user shall provide written instructions on how to proceed if a modification is proposed, which results in the equipment not conforming to the schedule drawings or the standards to which the equipment was certified. If the modification is performed, the equipment is no longer suitable for use in an explosive atmosphere without additional assessment. If the modification is performed, and additional assessment not performed, the label shall be removed or altered to give a clear indication that the equipment does not conform to the Ex Equipment Certificate. In addition, the report to the user shall clearly state the engineering characteristics of the modification and that the equipment is not suitable for use in an explosive atmosphere without additional assessment. The report shall not have an attestation of compliance.

Where labels are removed, efforts should be made to maintain traceability of the product in consultation with the user, see 4.3.2.6.

4.3.5 Temporary repairs

A temporary repair intended to achieve continued short-term operation of the equipment shall only be carried out if integrity of the Type of Protection is ensured or other appropriate measures are taken until the equipment is fully restored. Certain temporary repair procedures may therefore not be allowed. Any temporary repair should be brought up to full repair standards as soon as reasonably practicable.

Temporary repairs, following good engineering practice, should only be completed on site and in consultation with the user and either the manufacturer or service facility.

Temporary repairs are to be fully documented and added to the verification dossier and in the equipment repair record. They should follow good engineering practice and be in consultation with the user of the equipment.

4.3.6 Electric machines

4.3.6.1 General

The service facility shall take into account the general industrial requirements in IEC 60034-23, which covers the procedures necessary to ensure the satisfactory overhaul and repair of all types and sizes of electric machines covered by IEC 60034 (all parts), applicable for electric machines intended to be installed in non-hazardous areas. The requirements in this document are in addition to the requirements of IEC 60034-23 for Ex Equipment installed within a hazardous area.

4.3.6.2 Removal of damaged windings

The procedure of softening the impregnating varnish of windings with solvents before stripping may be used.

The alternative procedure which uses the application of heat to facilitate the removal of windings may be used provided that the operation is carried out with caution so as not to damage the insulation between the laminations of magnetic parts.

Removal of windings by heat on equipment with Type of Protection "e" and equipment with any Type of Protection having temperature class T6, T5 or T4 requires particular caution.

Open flames shall not be applied to the core without continuous monitoring of core temperature because, dependent upon the lamination insulation type, there is a possibility of damage to the insulation between laminations and increased core losses.

The need for particular caution in those circumstances arises from the fact that an increase in core loss, which could result from degradation of inter-laminar insulation, could affect Type of Protection "e" parameters (t_E time, etc.) or result in the temperature class being exceeded.

The service facility shall confirm, as in all reclamation procedures, that on completion of the reclamation the equipment is in a fully serviceable condition and complies with the standard(s) for the relevant Type of Protection (see also 4.3.3.4.1).

4.3.6.3 Test after repair

4.3.6.3.1 Testing after repair of windings

Windings, after complete or partial repair, shall be subjected, preferably with the equipment assembled, to the following tests, as applicable:

- a) The resistance of each winding shall be measured at room temperature and verified. Replacement winding resistance should not differ from the original winding resistance by more than 5 %. In the case of polyphase windings, the resistance of each phase or between line terminals shall be balanced. Unbalance (i.e. the difference between the highest and the lowest values) shall be less than 5 % of middle value.
- b) If the winding resistance of the repaired winding differs from that of the original winding (either obtained from the original manufacturer's data, measurement from an undamaged winding, or derived by calculation from the damaged winding) by more than 5 %, additional thermal tests may be required to confirm continued conformity to the stated insulation class and temperature class.
- c) An insulation resistance test shall be applied to measure the resistance between the windings and earth, between windings where possible, between windings and auxiliaries, and between auxiliaries and earth. A minimum test voltage of 500 V DC is recommended.
- d) Minimum acceptable insulation resistance values are a function of rated voltage, temperature, type of equipment and whether the rewind is partial or complete.
- e) The insulation resistance should not be less than 20 M Ω at 20 °C on a completely rewound equipment intended for use up to 690 V AC_{RMS}.
- f) A high-voltage test in accordance with a relevant standard shall be applied between windings and earth, between windings where possible, and between windings and auxiliaries attached to the windings.
- g) A transformer or similar equipment should preferably be energized at rated supply voltage. The supply current, secondary voltage and current shall be measured. The measured value shall be compared with that derived from the manufacturer's data, where available, and in polyphase systems shall be balanced in all phases, as far as is reasonable.
- h) High-voltage (1 000 V AC_{RMS}/1 500 V DC and above) and other special equipment may require additional tests. This shall be the subject of the repair or overhaul contract.

NOTE Guidance on test voltages and additional tests for rotating machines is given in IEC 60034-1.

4.3.6.3.2 Electric machines

Electric machines, in addition to the above tests, shall be subjected to the following tests, as far as is reasonably practicable.

- a) The machine shall be run at rated speed and rated voltage, to check bearing temperature, noise or vibration and no load current values. The cause of any untoward increase in bearing temperature, noise and vibration shall be investigated and corrected. Unbalance in no load current shall be less than 5 % of middle value.

NOTE 1 When the rated speed is a range of values the test is run at the highest practicable speed within that range.

- b) The stator windings of cage machines shall be energized at an appropriate reduced voltage, with the rotor locked, to obtain between 75 % and 125 % of full-load current and to check balance on all phases. (The test, which in some respects is an alternative to a full-load test, is used to confirm the integrity of the stator winding and its connections and to indicate the presence of rotor defects.) Unbalance shall be less than 5 % of middle value.
- c) Where this test is not reasonably practical for reasons of safety, other means of verification should be used.
- d) High-voltage (1 000 V AC_{RMS}/1 500 V DC, and above) and non-cage machines may require alternative or additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 2 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034-1.

4.3.6.4 Additional requirements

Before a rewind or repaired electric machine is returned to the user, the service facility shall ensure that fan cover ventilation holes are not blocked or damaged as to impair the passage of cooling air over the machine, and that any fan clearances are in compliance with the requirements of the Type of Protection standards.

Should a fan or fan cover be damaged so as to require renewal, the replacement parts shall be obtained from the manufacturer. If not available, then they shall be of the same dimensions and at least the same quality as the original parts. They shall, where appropriate, take account of the requirements of the Type of Protection standard to avoid frictional sparking and electrostatic charging, and of the chemical environment in which the machine is used.

4.3.6.5 Lubricants and corrosion inhibitors

If any special lubricants are required on an electric machine on which they are asked to work, the service facility, should establish from the user, details of the special lubricant and the service facility is to verify the suitability for use on the electric machine. Attention is drawn to the correct selection and application of lubricants and corrosion inhibitors for example:

- a) no migration onto un-insulated electrical parts occurs;
- b) the flash-point of the lubricant or corrosion inhibitor exceeds the temperature class of equipment for which it is to be applied;
- c) the environment in which the equipment is used;
- d) the application of the lubricant shall not aid flame transmission or defeat the Type of Protection.

4.3.6.6 Inverter fed electric machine

When repairing electric machines normally supplied from an inverter, attention shall be paid to the winding insulation system including class, form and installation, and bearing selection to prevent unsafe thermal rise, turn to turn failure and arcing from circulating earth currents.

4.3.6.7 Variable speed drives

Particular attention is drawn to the need for care when adding an inverter to an Ex electric machine in ensuring that this is only done when the intended combination of inverter and electric machine is specified in the Ex Equipment Certificate or in the electric machine manufacturer's documentation.

Where a variable speed drive installed in an explosion protected housing, such as a Type of Protection "d" enclosure, is to be replaced with an alternative, the service facility shall establish the functional performance of the replacement inverter does not cause a thermal increase beyond the existing design of the explosion protected housing.

4.3.7 Control equipment

Additional guidance on overhaul and repair of control equipment is available in Annex E.

5 Additional requirements for the repair and overhaul of equipment with Type of Protection "d"

5.1 Application

Clause 5 contains additional requirements for the repair, overhaul, reclamation and alteration of equipment with Type of Protection "d". It should be read in conjunction with Clause 4, which contains general requirements, and any other appropriate clauses if relevant. The relevant equipment standards, which should be referred to when repairing or overhauling

Type of Protection "d" equipment, are those to which the equipment was originally designed (see IEC 60079-1).

5.2 Repair and overhaul

5.2.1 Enclosures

5.2.1.1 General

It is preferable to obtain new parts from the manufacturer. Enclosures shall be repaired according to the following requirements.

Particular attention shall be paid to the correct assembly of flameproof enclosures after repair or overhaul, in order to ensure that the flameproof joints comply with the requirements of the relevant standard and, where appropriate, with the schedule drawings.

Where flameproof joints are not gasketed and the manufacturer's documentation does not address joint protection then only the following shall be used:

- a) non-setting grease without evaporating solvents;
- b) anti-corrosive agents without evaporating solvents; and
- c) other methods of protection in accordance with IEC 60079-14.

Corrosion or deformation of parts shall be evaluated to ensure any original openings or gaps in the enclosure have not exceeded the limits of surface finish and the flamepath gap.

Where gaskets which are not part of the flamepath are incorporated into the flameproof joints, replacements shall be of the same materials and dimensions as the original. Any proposed change of material shall be referred to the equipment manufacturer, user or certificate issuer.

The drilling of holes into an enclosure is a modification and shall not be carried out without reference to the schedule drawings or, in exceptional circumstances, for example the manufacturer has discontinued trading, to the certificate issuer.

When changing surface finish, paint, etc. care should be taken, as this could affect the surface temperature of the enclosure and thus the temperature class.

5.2.1.2 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 or the routine pressure value as stated in equipment documentation, if available, and held for at least 10 s.

Where the reference pressure is not stated, Group I enclosures are to be tested at 1 000 kPa, IIA and IIB enclosures at 1 500 kPa and Group IIC enclosures at 2 000 kPa. Pass/fail criteria shall include assessment of structural damage, measured at the geographical centre of an enclosure panel. Following the over-pressure test, flamepath joint surfaces are to be measured to verify there is no permanent deformation.

For enclosures with threaded flameproof joints, where the thread form cannot be verified, an overpressure test shall be conducted.

Where over-pressure tests are carried out on electric machines or enclosures that are water-cooled, the tests shall be done with the water jacket dry and open to the atmosphere.

Where over-pressure tests are carried out on multi-compartment enclosures, the tests shall be done on individual compartments separately.

The responsible person shall have full documentation on how the determination has been made to pressure test or why they have chosen not to over pressure test. This shall be added to the overhaul report.

NOTE Cast iron enclosures are prone to becoming brittle over time.

5.2.2 Water jackets

The water jacket shall be descaled and the following tests performed to verify its results are within the acceptance criteria of the manufacturer's information, equipment nameplate or, schedule drawings.

- a) Measure the water jacket volumetric capacity.
- b) Measure the water jacket for flow rate.
- c) Pressure test the water jacket.
- d) Verify there is no evidence of water leaks external to and within the water-cooled electric enclosure.

5.2.3 Entries into enclosures

Entries into flameproof enclosures shall conform, after repair or overhaul, to the conditions detailed in the appropriate equipment standard and Ex Equipment Certificate and schedule drawings where applicable.

5.2.4 Terminations

Care shall be taken when repairing terminations to maintain clearance and creepage distances. Any replacement terminals, bushings or parts shall be obtained from the manufacturer or shall conform to the relevant equipment standard and schedule drawings, where applicable.

5.2.5 Insulation

A class of insulation the same as, or superior to, that originally provided shall be employed. For example, a winding insulated with class 130 (B) material may be repaired using class 155 (F) material (see IEC 60085). However, in this example, the rating and permitted temperature rise of the equipment remains that of class 130 (B).

If the equipment output is increased, the equipment shall require re-assessment.

5.2.6 Internal connections

There are no particular requirements relating to Type of Protection "d", but repairs to internal connections shall be equivalent to that of the original design.

5.2.7 Electric machines

5.2.7.1 General

The original winding data should preferably be obtained from the manufacturer. If this is not reasonably practicable (i.e. the original data is not available from the manufacturer) then use may be made of copy winding techniques, which includes determination of winding connections, conductor size, turns, coil pitch, winding projection, and may include a determination of the original coil resistance. The materials used in rewinding shall comprise an appropriate insulation system. If superior insulation is proposed compared to that of the original, the rating of the winding shall not be increased without reference to the manufacturer, as the temperature class of the equipment could then be adversely affected.

5.2.7.2 Repair of electric machine rotors

A faulty bar-wound rotor shall be replaced by a new rotor produced by the original manufacturer or repaired using materials of identical specification. Particular care shall be taken to ensure that, when replacing bars in a cage rotor, such bars are tight in the slots. The method of achieving tightness employed by the manufacturer should be adopted.

A faulty die-cast cage rotor shall be replaced by a new rotor produced by the original manufacturer.

If the original manufacturer is no longer able to supply a replacement, it is possible to produce a new rotor winding with identical characteristics to the original.

Identical characteristics include materials and dimensional characteristics of winding, shorting ring and ventilation aides.

Damage to the external surface of the shorting ring of a die-cast rotor, including ventilation aides, can be repaired.

5.2.7.3 Temperature sensors

5.2.7.3.1 Repaired windings

If embedded temperature sensors were included to monitor winding temperatures, replacements shall have the same characteristics and be embedded in the same location in the repaired winding before varnishing and curing.

5.2.7.3.2 Overhaul

It is recommended that temperature sensors be checked and if defective replaced as part of any overhaul. If replacement is required, temperature sensors shall be as specified in the schedule drawings and shall be installed as specified in that documentation. Replacement of defective embedded temperature sensors during an overhaul, which are required as part of the schedule drawings, shall necessitate a re-wind.

If the schedule drawings are not available, or the identical temperature sensors are not available, the acceptability of the replacement should be assessed and documented by the responsible person.

5.2.7.4 Flameproof brake units

Where a flameproof brake unit attached to an electric machine is also certified and is in need of repair, it is recommended that flameproof brake unit be returned to the manufacturer, together with the machine. This course is recommended because of the close construction constraints. However, such repairs are possible by service facilities other than those of the manufacturer, providing the service facility is in possession of the schedule drawings from the manufacturer or by reference to the Type of Protection standard.

5.2.7.5 Other auxiliary devices

Where auxiliary devices are based on different Type(s) of Protection, the corresponding clauses of this document shall be consulted before any repairs are undertaken.

5.2.8 Auxiliary equipment

5.2.8.1 Light-transmitting parts

Light-transmitting parts shall not be repaired or re-cemented.

Only complete replacement assemblies, as specified by the manufacturer, shall be used.

Light-transmitting or other parts made from plastics shall not be cleaned with solvents. Household detergents are recommended for this purpose.

5.2.8.2 Encapsulated parts

In general, encapsulated parts, for example switching devices, are not considered suitable for repair.

5.2.8.3 Batteries

Where batteries are used, the manufacturer's advice shall be followed.

5.2.8.4 Lamps

Lamp types specified by the manufacturer shall be used as replacements and the maximum wattage specified shall not be exceeded. The position of a reflector, if any, and the distance between the lamp and the window shall be maintained.

5.2.8.5 Lampholders

Replacements listed by the manufacturer shall be used, if obtainable. If these replacements are no longer obtainable, an equivalent verified by a person with competency in the compliance of equipment to Type(s) of Protection standards may be used.

5.2.8.6 Ballasts

Chokes, and capacitors, shall be replaced only by the manufacturer's listed parts, if obtainable. If these are no longer obtainable, an equivalent may be used, if verified by a person with competency in the compliance of the equipment or component being replaced and the Type(s) of Protection standards.

5.2.8.7 Breathing devices

Breathing devices shall be serviced to maintain the explosion protection properties of the enclosure in accordance with documentation. If this documentation is not obtainable, breathing devices shall be replaced only by those parts listed in the schedule drawings. If breathing devices carry an Ex Component Certificate, only a suitably certified and dimensioned part can be used.

5.3 Reclamation

5.3.1 General

Reclamations using the techniques detailed in 4.3.3 may be used with Type of Protection "d" equipment subject to the following restrictions of 5.3.

5.3.2 Enclosures

5.3.2.1 Components

Reclaimed component parts of flameproof enclosures shall be used only if they pass, when appropriate, the applicable over-pressure test. Metal stitching shall not be used.

Damage to components which are not an integral part of the flameproof enclosure, for example, fixing lugs, may be repaired by welding or metal stitching, but with care taken to ensure that the integrity and stability of the equipment is not impaired. It is particularly important to check that any cracks being repaired do not extend to the flameproof enclosure.

The efficacy of reclaiming or repairing by the technique of welding may be further compounded by considerations of different base materials, for example, aluminium or steel. If uncertainty exists, the repairer shall seek advice, preferably from the manufacturer, before this technique is adopted. Welding of cast-iron flameproof enclosures is not permitted without the approval of a metallurgical expert.

Where a pyramid or button-headed bolt is used, the surface around the hole shall be spot machined to ensure that the axis of the bolt head is normal to the surface unless otherwise specified by the manufacturer.

5.3.2.2 Flameproof joints

5.3.2.2.1 General

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 schedule drawings. If the schedule drawings are not available, further guidance shall be taken from Annex C. Non-metallic flameproof joints shall not be recovered.

5.3.2.2.2 Flanged joints

Welding, electroplating and re-machining flanged joint faces may be permissible, having due regard to the limitations of the technique (see Clause 4). The use of metal-spraying techniques is permissible provided the bond strength is greater than 40 MPa.

5.3.2.2.3 Spigot/cylindrical joints

Machining the parts of spigot joints requires addition of metal thus ensuring that the flamepath dimensions comply with the equipment standard, and where appropriate the schedule drawings. If only one part is damaged, that part may be restored to its original dimensions by the addition of metal and re-machining. The addition of metal may be by electroplating, sleeving or welding, but metal spraying techniques which have a bond strength less than 40 MPa are not recommended.

5.3.2.2.4 Threaded joints

For threaded joints:

- a) For cable and conduit entries it is not recommended that damaged male threaded parts be reclaimed; new components shall be used. Damaged female threads may be reclaimed using MMA, MIG and TIG welding techniques.
- b) For screwed covers the reclamation of the threaded parts of screwed covers and of the associated housings may be possible utilizing MMA, MIG and TIG welding techniques.

5.3.2.3 Threaded holes for fasteners

Threads of fasteners which have been damaged such that they fail a GO–NO GO test may be reclaimed by one of the following means:

NOTE ISO and other standards have further information on the form of threads.

- a) oversize drilling, re-tapping and the fitting of a proprietary thread insert which passes the appropriate pull test as specified by the thread insert manufacturer;
- b) oversize drilling, plugging, re-drilling and re-tapping;
- c) oversize drilling and tapping, insertion of solid threaded plug, re-machining (as required);
or
- d) plug-welding, re-drilling and tapping.

Reclaimed threaded holes for fasteners shall meet one of the following requirements.

- 1) threaded holes reclaimed using proprietary thread inserts and tested to the thread insert manufacturer's test method;
- 2) other reclaimed threads which meet a torque test equal to the bolt torque which shall not exceed 80 % of the tensile strength of the bolt and having a minimum thread engagement of 1,5 times the nominal diameter of the bolt; or,
- 3) the enclosure shall be subject to an overpressure test.

Plugs shall be securely retained to avoid inadvertent removal.

5.3.3 Sleaving

For sleaving, care should be taken not to introduce an additional effective flamepath. The sleeve shall be securely retained.

5.3.4 Shafts and housings

Shafts and bearing housings, including flameproof joints, may be reclaimed by the use of electroplating, metal spraying, sleaving or welding (except MMA) techniques. Any subsequent machining shall be to the flamepath dimensions as specified in the equipment standard or schedule drawings, as appropriate. If the schedule drawings are not available, further guidance shall be taken from Annex C. Welding may be appropriate having due regard to the limitations of this technique (see 4.3.3.4.5).

5.3.5 Sleeve bearings

Sleeve-bearing surfaces may be reclaimed by electroplating, metal spraying or welding (except MMA) techniques.

5.3.6 Rotors and stators

If rotors and stators are to be skimmed to remove eccentricities and surface damage, the resulting increased air gap between rotor and stator could produce a change in pressure-piling characteristics or higher external surface temperatures that could then exceed the temperature class of the machine. If uncertainty exists with regard to possible adverse effects on the temperature class or pressure piling; the repairer shall seek guidance, preferably from the manufacturer, before this procedure is adopted.

Skimmed or damaged stator cores shall be submitted to a "flux test" to ensure that there are no remaining hot spots which could adversely affect the temperature class or cause subsequent damage to the stator windings. The "flux test" shall be conducted at not less than 1,5 Tesla and the testing conditions and result recorded.

5.4 Alterations and modifications

5.4.1 Enclosures

No modification affecting the explosion protection shall be carried out on parts of a flameproof enclosure without reference to the schedule drawings and the manufacturer or, in exceptional circumstances, for example, the manufacturer discontinued trading, with the certifying authority.

5.4.2 Entries into enclosures

Additional entries shall not be made without reference to the schedule drawings or the manufacturer or, in exceptional circumstances, for example, the manufacturer discontinued trading, with the certificate issuer.

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, i.e. where the external conductors and cables are connected within the main enclosure.

5.4.3 Terminations

Termination assemblies containing a flameproof joint shall not be modified, for example, terminals with bushings between indirect-entry terminal box and main enclosure. Termination assemblies not containing a flameproof joint may be replaced by alternatives of adequate design and construction in terms of numbers, current-carrying capacity, creepage and clearance distances, and quality.

5.4.4 Windings

If equipment is to be rewound for another voltage, reference shall be made to the manufacturer. In such cases it shall be ensured that, for example, the magnetic loading, current densities, losses are not increased, appropriate new creepage and clearance distances are observed and the new voltage is within the limits of the schedule drawings. The rating plate shall be changed to show the new parameters.

Rewinding an electric machine for a different speed shall not be carried out without reference to the manufacturer, since the electrical and thermal characteristics of the machine could be significantly altered to the point of being outside the limits imposed by the assigned temperature class.

5.4.5 Auxiliary equipment

In cases where additional auxiliary equipment is requested, for example anti-condensation heaters or temperature sensors, the manufacturer shall be consulted to establish the feasibility of and the procedure for the proposed addition.

6 Additional requirements for the repair and overhaul of equipment with Type of Protection "i"

6.1 Application

Clause 6 contains additional requirements for the repair, overhaul, reclamation, and alteration of equipment with Type of Protection "i". It shall be read in conjunction with Clause 4, which contains general requirements, and any other appropriate clauses if relevant. The relevant equipment standards, which shall be referred to when repairing or overhauling an item of Type of Protection "i" equipment, are those to which the equipment was originally designed.

Repair and overhaul for Type of Protection "i" shall only be in accordance with the schedule drawings.

Clause 6 applies to intrinsically safe apparatus which may be installed or used in explosive atmospheres and associated apparatus which may be installed in a non-hazardous area or protected by another Type of Protection.

The component replacement requirements of Clause 6 only apply to single and double layer boards where all circuit connections are clearly visible on the surface of the board and only conventional components with leads and of a size which can be handled are used.

Multilayer circuit boards, or any board with surface mount components, shall only be repaired by the original manufacturer or by fitting a replacement circuit board supplied by the original manufacturer.

Intrinsically safe equipment can have one of three levels of protection, “ia”, “ib” and “ic”. The requirements for repair and overhaul apply to all levels of protection regardless of the hazardous area in which the equipment is installed. Furthermore, the safety of intrinsically safe systems depends upon all pieces of equipment of which they are formed, and upon the interconnecting wiring. The same consideration should be given to those parts of the Ex i system which are installed in the non-hazardous area and in the hazardous area.

Additional conformal coatings may be required as corrosion and lack of cleanliness can invalidate intrinsic safety.

6.2 Repair and overhaul

6.2.1 Enclosures

Where enclosures of intrinsically safe equipment and associated apparatus are required because intrinsic safety is dependent upon them, repair and overhaul activities shall not reduce the ingress (IP) protection offered by the enclosure.

The enclosure's external surface should be thoroughly cleaned before examination. Moisture, dirt or other pollutants should be removed from intrinsically safe components and from within enclosures.

6.2.2 Cable glands

Cable glands are used to maintain the degree of ingress protection of the enclosure. Any repairs shall not result in reduction in the degree of ingress protection.

6.2.3 Terminations

When repairing terminal compartments, any terminals replaced shall normally be of the same type that they replace. Where the same type is not available, any alternative type used shall satisfy the thermal property requirements and creepage (according to CTI) and clearance requirements specified in IEC 60079-11 for the maximum voltage of the equipment and the separation required by IEC 60079-11 to avoid inadvertent cross-connection.

Primary and redundant earth connections or earth bonds, internal and external to the intrinsically safe equipment shall be fully restored, where relevant, at the conclusion of repairs.

6.2.4 Soldered connections

When it is necessary to carry out repairs which require soldering techniques to be used, care shall be taken to ensure that the Type of Protection “i” is not invalidated.

Where it is considered possible to undertake repairs, matters that shall be considered include:

- a) compatibility of soldering method with documentation;
- b) compatibility of soldering materials with documentation;
- c) maintenance and verification of creepage and clearance;
- d) soldering processes; and
- e) clean-up and restoration of coatings to original thermal and other properties.

At the conclusion of solder work, flux residues and any solder splatter shall be removed.

Lead free soldering shall be checked for long-term stability, for example the growth of metallic whiskers that could erode creepage and clearance distances.

Any conformal coating damaged during this work shall be repaired with an original coating or with the coating of the same thermal properties as the original, providing it does not react with other materials on the board.

NOTE Basic requirements and required means of application for coatings are found in IEC 60079-11.

6.2.5 Fuses

Fuse replacement within intrinsically safe equipment shall have identical characteristics or other option identified in schedule drawings. Replacement of fuses shall only be done where the fuse is readily accessible.

In the supply-side of associated apparatus if replacement with an identical fuse is not possible, fuses may be replaced with an alternative which shall have:

- a) the same rating;
- b) the same or higher breaking capacity;
- c) the same time/current characteristic;
- d) the same type of construction; and
- e) the same physical size.

Where this is not possible, an evaluation of the effects of the chosen fuse on intrinsic safety shall be carried out by the responsible person (see 4.3.2.4.3).

Fuse replacement in encapsulated barriers or in encapsulated battery packs (or similar) is not permitted.

6.2.6 Relays

If a relay is replaced, it shall be by one which has identical characteristics as the original or as identified in the schedule drawings.

6.2.7 Shunt diode safety barriers and galvanic isolators

No repair shall be attempted to these devices. Where these devices are replaced, the replacement shall always have the same safety description and the value chosen for U_m shall be equal to, or greater than, the U_m value of the original device. All other entity parameters shall be verified as suitable. Care shall also be taken that differing physical construction does not destroy the 50 mm separation required between bare conducting parts of terminals of the intrinsically safe circuits and non-intrinsically safe circuits.

In intrinsically safe systems, replacing a barrier with an alternate type not listed in the system schedule drawings shall require re-verification of the full system parameters.

6.2.8 Printed circuit boards

These parts of the equipment often have critical distances between conducting tracks (creepage distances) which shall not be reduced. Therefore, when components are replaced, care shall be taken in positioning them on the board. When repairing printed circuit boards, matters that shall be considered include the following:

- a) damage to components and their leads during repair;
- b) alignment of components following repair to retain proper connection, creepage and clearance distances and thermal properties;
- c) damage to tracking or the base material of the printed circuit board (in particular multi-layer circuit boards);

- d) where insulation coating or conformal coating is damaged (for example during repair), coating of the type specified by the manufacturer shall be applied in the approved manner, for example, one coat if using dipping, two coats using other methods;
- e) maintenance of earth or equivalent connections to other parts of the equipment;
- f) integrity of the printed circuit board mounting; and
- g) the user shall be consulted to determine if there are any special site environmental conditions.

6.2.9 Optocouplers and piezoelectric components

Only components of the same type as listed in the schedule drawings shall be used as replacements.

NOTE Components having different part numbers can dramatically alter the segregation, performance under impact and other essential IS properties.

6.2.10 Electrical components

When replacing components such as resistors, transistors, Zener diodes, these may normally be replaced with items purchased from any source, but if components are not procured from the manufacturer or certificate issuer replacement components shall be verified by a person with competency in the compliance of equipment to Type(s) of Protection standards.

In exceptional circumstances, however, some manufacturers use a "select on test" procedure for some components. Where this is done, the documentation supplied with the equipment shall indicate that either replacements be obtained from the equipment manufacturer or selected by the method they recommend.

In intrinsically safe systems, replacing components with alternate types not listed in the system schedule drawings is a modification and shall not occur without additional assessment by a suitable competent person.

NOTE A change of component package can invalidate thermal properties.

6.2.11 Batteries

Only those battery types specified in the equipment manufacturer's instructions or schedule drawings shall be used as replacements.

NOTE Ex Equipment Certificates for modern intrinsically safe designs usually specify the manufacturer and type number of replaceable cells that have been tested and are acceptable. Different cells of the same generic type and even different types from the same manufacturer sometimes have different short circuit currents, and under short circuit conditions they have a tendency to electrolyte leakage or bursting, or produce excessive temperatures.

Where rechargeable batteries are encapsulated, the whole assembly shall be replaced.

6.2.12 Internal wiring

Certain distances between conductors and their segregation are critical. Therefore, if disturbed, internal wiring shall be re-located in its original position. Where insulation, screens, outer sheaths, or double insulation of wiring or the method of fixing are damaged, they shall be replaced by equivalent material and re-fixed in the same configuration.

Where an Ex Equipment Certificate has been prepared for the equipment, any change to wiring is a modification and shall not occur without additional assessment by a suitable competent person.

6.2.13 Transformers

If a transformer is replaced, it shall be by one which has identical characteristics as the original or as identified in schedule drawings. No attempt shall be made to repair or replace any embedded (encapsulated) thermal trip device.

6.2.14 Encapsulated components

Encapsulated components, for example, batteries with internal current-limiting resistors or fuse-Zener diode assemblies, are non-repairable and shall be replaced only with assemblies of the original design from the equipment manufacturer.

6.2.15 Non-electrical parts

Where the equipment has non-electrical parts, for example, fittings or window, that do not affect the electrical circuit or creepage and clearance distances and hence the intrinsic safety, these parts may be replaced by new parts of equivalent type.

Certain parts could have antistatic, impact, thermal and flammability requirements which affect the intrinsic safety. Where replacement of such parts is required, they shall be replaced by materials as specified in the schedule drawings.

6.2.16 Testing

After completion of the repair or overhaul the dielectric strength of the insulation between the intrinsically safe circuit and the metallic enclosure shall be checked by applying at least a 500 V AC_{RMS} (50 Hz or 60 Hz) voltage between the terminals and the enclosure for not less than 1 min. This test can be omitted if the enclosure is of insulating material or if one side of the circuit is galvanically connected to the enclosure for safety reasons or if the enclosure has not been returned for repair.

Testing of galvanic isolating components upon replacement of transformers and optocouplers shall be in accordance with the relevant equipment standard and schedule drawings.

6.3 Reclamation

No attempt shall be made to reclaim components on which intrinsic safety depends.

6.4 Modifications

Any change to the equipment in intrinsically safe systems is considered as a modification to the system from that shown in the IS system documentation which can affect the safety of the system. Reference should be made to a competent person responsible for the safety of the IS system, which may then require additional assessment. It is recommended that this assessment be carried out by a person other than the one who carried out the modification.

7 Additional requirements for the repair and overhaul of equipment with Type of Protection "p"

7.1 Application

Clause 7 contains additional requirements for the repair, overhaul, reclamation and modification of equipment with Type of Protection "p". It shall be read in conjunction with Clause 4, which contains general requirements, and any other appropriate clauses if relevant. The relevant equipment standards, which shall be referred to when repairing or overhauling Type of Protection "p" equipment, are those to which the equipment was originally designed (see IEC 60079-2 or IEC 61241-4).

When used in conjunction with explosive gas atmospheres, Type of Protection "p" equipment can be Levels of Protection "pxb" for EPL Gb, "pyb" for EPL Gb and "pzc" for EPL Gc.

When used in conjunction with explosive dust atmospheres, Type of Protection "p" or "pD" equipment can be Levels of Protection "pxb" for EPL Db, "pyb" for EPL Db or "pzc" for EPL Dc.

The requirements for repair and overhaul apply to all levels of protection regardless of the hazardous area in which the equipment is installed.

Equipment used within enclosures that are certified as complying with the requirements of IEC 61241-4, (Type of Protection "pD"), is generally unspecified with respect to that standard. Variations can therefore be made to include equipment without invalidating the Ex Equipment Certificate. However, there are general restrictions such as electrical performance and temperature rating that are taken into consideration if changes to internal equipment are made.

NOTE In contrast to Type of Protection "p", purging is not used with Type of Protection "pD". IEC 61241-4 requires internal cleaning of the enclosure before the electrical supply can be connected.

7.2 Repair and overhaul

7.2.1 Enclosures

While it is preferable to obtain new parts from the manufacturer, in principle a damaged part may be repaired or replaced with another provided that, when compared with the original, it

- a) is of at least equivalent strength;
- b) does not result in a greater leakage rate of protective gas;
- c) does not restrict the flow of protective gas into or through the enclosure;
- d) is not shaped or fitted so as to permit the explosive atmosphere to enter the enclosure;
- e) is not of a construction which would result in stagnant volumes of atmosphere inside the enclosure; and
- f) does not reduce the rate of heat dissipation from the enclosure or its content, so that it no longer complies with its temperature class.

Gaskets or other sealing devices shall be replaced with others of the same material. However, a different gasket material may be used provided that it is suitable for its purpose and is compatible with the environment.

7.2.2 Entries into enclosures

Entries shall preserve the degree of ingress protection originally provided and shall not allow increased leakage of pressurizing gas.

7.2.3 Terminations

The preservation of creepage and clearance distances as originally provided shall be ensured.

7.2.4 Insulation

Any replacement insulation used in the course of repair or overhaul shall be at least of the quality and class of that originally employed (see IEC 60085).

7.2.5 Internal connections

Internal connections shall not be electrically, thermally or mechanically inferior to those originally fitted and shall be of a standard at least equivalent to that of the original design.

7.2.6 Electric machines

7.2.6.1 General

The original winding data should preferably be obtained from the manufacturer. If this is not possible, then use may be made of copy winding techniques, which includes determination of winding connections, conductor size, turns, coil pitch, winding projection, and may include a determination of the original coil resistance. The materials used in rewinding shall comprise an appropriate insulation system. If superior insulation is proposed compared to that of the original, the rating of the winding shall not be increased without reference to the manufacturer, as the temperature class of the equipment could then be adversely affected.

7.2.6.2 Repair of electric machine rotors

A faulty bar-wound rotor shall be replaced by a new rotor produced by the original manufacturer or repaired using materials of identical specification. Particular care is necessary to ensure that, when replacing bars in a cage rotor, such bars are tight in the slots. The method of achieving tightness employed by the manufacturer should be adopted.

A faulty die-cast cage rotor shall be replaced by a new rotor produced by the original manufacturer.

If the original manufacturer is no longer able to supply a replacement, it is possible to produce a new rotor winding with identical characteristics to the original. Identical characteristics include materials and dimensional characteristics of shorting ring and ventilation aides.

Damage to the external surface of the shorting ring of a die-cast rotor including ventilation aides can be repaired.

7.2.6.3 Pressurization

Verify that the Type of Protection “p” sealing is functioning adequately, the maximum leakage rate at the maximum overpressure shall be measured to verify that the nameplate value is not exceeded.

Verify that all internal air paths and ducts are not blocked by varnish following rewind.

Where the pressurization system has not been sent to the service facility with the Type of Protection “p” equipment and the service facility does not have in house pressurization equipment, alternative test for leakage and site test of the pressurization system shall be agreed with the user before dispatch and the final repair/overhaul report cannot be completed until the site commissioning of the pressurization system has been completed.

7.2.6.4 Temperature sensors

7.2.6.4.1 Repaired windings

If embedded temperature sensors were included to monitor winding temperatures, it is recommended that replacements have the same characteristics as the original sensors and they are embedded in the same location in the repaired winding before varnishing and curing.

7.2.6.4.2 Overhaul

It is recommended that temperature sensors be checked and if defective replaced as part of any overhaul. If replacement is required, temperature sensors shall be as specified in the schedule drawings and shall be installed as specified in that documentation. Replacement of defective embedded temperature sensors during an overhaul, which are required as part of the schedule drawings, shall necessitate a stator rewind.

If the schedule drawings are not available, or the identical temperature sensors are not available, the acceptability of the replacement should be assessed and documented by the responsible person.

7.2.7 Auxiliary devices

Where auxiliary devices are based on different Type(s) of Protection, the corresponding clauses of this document shall be consulted before any repairs are undertaken.

7.2.8 Light-transmitting parts

Light-transmitting parts made from plastics shall not be cleaned with solvent. Household detergents are recommended for this purpose.

7.2.9 Encapsulated parts

Encapsulated parts (for example, switching devices in luminaires) are not considered suitable for repair.

7.2.10 Batteries

Where batteries are used, the manufacturer's advice shall be followed.

7.2.11 Lamps

Lamp types specified by the manufacturer shall be used as replacements and the maximum wattage specified shall not be exceeded.

7.2.12 Lampholders

Replacements listed by the manufacturer shall be used if obtainable. If these replacements are no longer obtainable, an equivalent lampholder verified by a person with competence in the compliance of equipment to Type(s) of Protection standards may be used.

7.2.13 Ballasts

Chokes or capacitors shall be replaced only by the manufacturer's listed parts, if obtainable. If these are no longer obtainable, an equivalent may be used, if verified by a person with competency in the compliance of the equipment or component being replaced and the Type(s) of Protection standards.

7.3 Reclamation

7.3.1 General

Reclamation using the techniques detailed in Clause 4 may be used with Type of Protection "p" equipment subject to the following restrictions of 7.3.

7.3.2 Enclosures

7.3.2.1 General

If damage to enclosures, terminal boxes and covers is to be repaired by welding or metal stitching, care shall be taken to ensure that the integrity of the equipment is not significantly impaired so as to degrade the Type of Protection, in particular, that it remains capable of withstanding the impact test and the appropriate level of overpressure.

7.3.2.2 Joints

If damaged or corroded joint faces are to be machined, the mechanical strength and operation of the component shall not be impaired, nor the degree of ingress protection affected.

Spigot joints are normally provided to achieve close tolerance location. Thus, machining the male part shall require addition of metal to, and the machining of, the female part (or vice versa) to retain the location properties of the joint. If only one part is damaged, that part may be restored to its original dimensions by the addition of metal and re-machining. The addition of metal shall be by electroplating, sleeving or welding but metal spraying techniques which have a bond strength less than 40 MPa are not recommended.

7.3.3 Shafts and housings

If shafts and bearing housings are to be reclaimed, this shall be carried out by the use of metal spraying or sleeving techniques. Welding may be appropriate with due regard to the limitations of this technique (see 4.3.3.4.5).

7.3.4 Sleeve bearings

Sleeve-bearing surfaces may be reclaimed by electroplating, metal spraying or welding (except MMA) techniques.

7.3.5 Rotors and stators

If rotors and stators are to be skimmed to remove eccentricities and surface damage, the resulting increased air gap between rotor and stator can produce a change in surface temperatures that could then exceed the temperature class of the machine. If uncertainty exists with regard to possible adverse effects on the temperature class; the repairer shall seek guidance, preferably from the manufacturer, before this procedure is adopted.

Skimmed or damaged stator cores shall be submitted to a "flux test" to ensure that there are no remaining hot spots which could adversely affect the temperature class or cause subsequent damage to the stator windings. The "flux test" shall be conducted at not less than 1,5 Tesla and the testing conditions and result recorded.

7.4 Alterations and modifications

7.4.1 Enclosures

Enclosures not containing a source of release of flammable gas can be altered. Any altered part shall meet the conditions given in 7.2. Alterations defined in the schedule drawings shall be verified by a responsible person.

Enclosures with an internal source of release of flammable gas such as analysers, chromatographs, shall not be modified in any way whatsoever without reference to the manufacturer.

The point(s) at which the level of overpressure and the rate of flow or purging gas is (are) monitored shall not be altered nor should the setting of any timer or other monitoring devices be changed.

7.4.2 Entries into enclosures

Special care shall be taken to ensure that if alteration is made to entries, the specified Type of Protection and degree of ingress protection are maintained.

7.4.3 Terminations

Modification of terminations shall be made using good engineering practices

7.4.4 Windings

Rewinding of the equipment for another voltage shall be carried out only after reference to the manufacturer provided that, for example, the magnetic loading, current densities and losses are not increased, appropriate new creepage and clearance distances are observed, and the new voltage is within the limits of the schedule drawings. The rating plate shall be changed to show the new parameters.

Rewinding an electric machine for a different speed shall not be carried out without reference to the manufacturer, since the electrical and thermal characteristics of the machine could be significantly altered to the point of being outside the limits imposed by the assigned temperature class if appropriate, and the efficacy of the pressurizing system could be jeopardized.

7.4.5 Auxiliary equipment

In cases where additional auxiliary equipment is requested, for example, anti-condensation heaters or temperature sensors, the manufacturer shall be consulted to establish the feasibility of and the procedure for the proposed addition.

7.5 Pressurization system

Functional tests for pressurization systems shall be verified for safety devices associated with equipment since the safety devices may vary depending on the Level of Protection, i.e. "pxb", "pyb", or "pzc". Therefore verify appropriately. The functional tests can include, where practicable:

- a) complete purge cycle as specified on the nameplate; this may include verifying contacts to initiate the pressurization cycle;
- b) maintenance of minimum pressure inside the enclosure as specified on the nameplate during pressurization;
- c) validation of leakage of enclosure as less than the maximum leakage capacity provided by the pressurization system;
- d) initiation of removing power or alarm signals by losing pressurization;
- e) verification of contacts and signal lights appropriate to each action as provided; and
- f) verification that the relief valve is functional when the enclosure pressure exceeds the design limit as specified by the manufacturer.

8 Additional requirements for the repair and overhaul of equipment with Type of Protection "e"

8.1 Application

Clause 8 contains additional requirements for the repair, overhaul, alteration, reclamation and modification of equipment with Type of Protection "e" or Level of Protection "eb". It shall be read in conjunction with Clause 4, which contains general requirements, and any other appropriate clauses if relevant. The relevant equipment standards, which shall be referred to when repairing or overhauling "e" or "eb" equipment, are those to which the equipment was originally designed (see IEC 60079-7).

Requirements for Level of Protection "ec" are specified in Clause 9. Level of Protection "ec" was previously Type of Protection "nA".