

BS EN 60079-19:2011+A1:2015



BSI Standards Publication

<http://www.china-gauges.com/>

Explosive atmospheres

Part 19: Equipment repair, overhaul
and reclamation

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 60079-19:2011+A1:2015. It is identical to IEC 60079-19:2010, incorporating amendment 1:2015. It supersedes BS EN 60079-19:2011 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted by Technical Committee EXL/31, Equipment for explosive atmospheres, to Subcommittee EXL/31/3, Codes of practice.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2015.
Published by BSI Standards Limited 2015

ISBN 978 0 580 83993 1

ICS 29.260.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2011.

Amendments/corrigenda issued since publication

Date	Text affected
30 June 2015	Implementation of IEC amendment 1:2015 with CENELEC endorsement A1:2015

English version

Explosive atmospheres
Part 19: Equipment repair, overhaul and reclamation
(IEC 60079-19:2010)

Atmosphères explosives
Partie 19: Réparation, révision et remise
en état de l'appareil
(CEI 60079-19:2010)

Explosionsgefährdete Bereiche -
Teil 19: Gerätereparatur, Überholung und
Regenerierung
(IEC 60079-19:2010)

This European Standard was approved by CENELEC on 2011-01-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 31J/180/FDIS, future edition 3 of IEC 60079-19, prepared by SC 31J, Classification of hazardous areas and installation requirements, of IEC TC 31, Equipment for explosive atmospheres, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60079-19 on 2011-01-01.

This European Standard supersedes EN 60079-19:2007.

The significant technical changes with respect to EN 60079-19:2007 are as follows:

- inclusion of specific Group I requirements;
- inclusion of offshore requirements.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2011-10-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2014-01-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60079-19:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60034 series	NOTE	Harmonized in EN 60034 series (partially modified).
IEC 60079-11	NOTE	Harmonized as EN 60079-11.
IEC 60364 series	NOTE	Harmonized as HD 60364 (partially modified).
ISO 9000	NOTE	Harmonized as EN ISO 9000.
ISO 9001	NOTE	Harmonized as EN ISO 9001.

Foreword to amendment A1

The text of document 31J/249/FDIS, future IEC 60079-19:2010/A1, prepared by SC 31J "Classification of hazardous areas and installation requirements" of IEC/TC 31 "Explosive atmospheres" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60079-19:2011/A1:2015.

The following dates are fixed:

- latest date by which the document has to be (dop) 2016-01-23
implemented at national level by
publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2018-04-23
standards conflicting with the
document have to be withdrawn

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60079-19:2010/A1:2015 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60079	series	Explosive atmospheres	EN 60079	series
IEC 60079-0	-	Explosive atmospheres - Part 0: Equipment - General requirements	EN 60079-0	-
IEC 60079-1	-	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"	EN 60079-1	-
IEC 60079-2	-	Explosive atmospheres - Part 2: Equipment protection by pressurized enclosure "p"	EN 60079-2	-
IEC 60079-7	-	Explosive atmospheres - Part 7: Equipment protection by increased safety "e"	EN 60079-7	-
IEC 60079-7	1990 ¹⁾	Electrical apparatus for explosive gas atmospheres - Part 7: Increased safety "e"	-	-
IEC 60079-7	2001	Electrical apparatus for explosive gas atmospheres - Part 7: Increased safety "e"	EN 60079-7	2003 ²⁾
IEC 60079-14	-	Explosive atmospheres - Part 14: Electrical installations design, selection and erection	EN 60079-14	-
IEC 60079-15	2005	Electrical apparatus for explosive gas atmospheres - Part 15: Construction, test and marking of type of protection "n" electrical apparatus	EN 60079-15	2005 ³⁾
IEC 60079-15	2010	Explosive atmospheres - Part 15: Equipment protection by type of protection "n"	EN 60079-15	2010

¹⁾ Superseded by IEC 60079-7:2001, which is also superseded by IEC 60079-7:2006.

²⁾ Superseded by EN 60079-7:2007 (IEC 60079-7:2006).

³⁾ Superseded by EN 60079-15:2010 (IEC 60079-15:2010).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60079-19	-	Explosive atmospheres - Part 19: Equipment repair, overhaul and reclamation	EN 60079-19	-
IEC 60079-26	-	Explosive atmospheres - Part 26: Equipment with equipment protection level (EPL) Ga	EN 60079-26	-
IEC 60085	-	Electrical insulation - Thermal evaluation and designation	EN 60085	-
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	EN 60529	-
IEC 61241	series	Electrical apparatus for use in the presence of combustible dust -	EN 61241	series
IEC 61241-0	-	Electrical apparatus for use in the presence of combustible dust - Part 0: General requirements	EN 61241-1	-
IEC 61241-4	-	Electrical apparatus for use in the presence of combustible dust - Part 4: Type of protection 'pD'	EN 61241-4	-
ISO 4526	-	Metallic coatings - Electroplated coatings of nickel for engineering purposes	EN ISO 4526	-
ISO 6158	-	Metallic coatings - Electrodeposited coatings of chromium for engineering purposes	EN ISO 6158	-

<http://www.china-gauges.com/>

CONTENTS

INTRODUCTION	12
1 Scope	13
2 Normative references	13
3 Terms and definitions	14
4 General	16
4.1 General principles	16
4.2 Statutory requirements for repair facility	17
4.3 Instructions for the user	17
4.3.1 Certificates and documents	17
4.3.2 Records and work instructions	17
4.3.3 Re-installation of repaired equipment	17
4.3.4 Repair facilities	17
4.4 Instructions for the repair facility	17
4.4.1 Repair and overhaul	17
4.4.2 Reclamations	22
4.4.3 Alterations and modifications	24
4.4.4 Temporary repairs	24
4.4.5 Rotating machinery	25
4.4.6 Inverters	25
5 Additional requirements for the repair and overhaul of equipment with type of protection "d" (flameproof)	26
5.1 Application	26
5.2 Repair and overhaul	26
5.2.1 Enclosures	26
5.2.2 Cable and conduit entries	27
5.2.3 Terminations	27
5.2.4 Insulation	27
5.2.5 Internal connections	27
5.2.6 Windings	27
5.2.7 Auxiliary equipment	29
5.2.8 Light-transmitting parts	29
5.2.9 Encapsulated parts	29
5.2.10 Batteries	29
5.2.11 Lamps	29
5.2.12 Lampholders	30
5.2.13 Ballasts	30
5.2.14 Breathing devices	30
5.3 Reclamation	30
5.3.1 General	30
5.3.2 Enclosures	30
5.3.3 Sleeving	31
5.3.4 Shafts and housings	31
5.3.5 Sleeve bearings	31
5.3.6 Rotors and stators	31
5.4 Alterations and modifications	32

5.4.1	Enclosures	32
5.4.2	Cable or conduit entries	32
5.4.3	Terminations	32
5.4.4	Windings	32
5.4.5	Auxiliary equipment	32
6	Additional requirements for the repair and overhaul of equipment with type of protection "i" (intrinsic safety)	32
6.1	Application	32
6.2	Repair and overhaul	33
6.2.1	Enclosures	33
6.2.2	Cable glands	33
6.2.3	Terminations	33
6.2.4	Soldered connections	33
6.2.5	Fuses	34
6.2.6	Relays	34
6.2.7	Shunt diode safety barriers and galvanic isolators	34
6.2.8	Printed circuit boards	34
6.2.9	Optocouplers and piezoelectric components	34
6.2.10	Electrical components	35
6.2.11	Batteries	35
6.2.12	Internal wiring	35
6.2.13	Transformers	35
6.2.14	Encapsulated components	35
6.2.15	Non-electrical parts	36
6.2.16	Testing	36
6.3	Reclamation	36
6.4	Modifications	36
7	Additional requirements for the repair and overhaul of equipment with type of protection "p" (pressurized)	36
7.1	Application	36
7.2	Repair and overhaul	36
7.2.1	Enclosures	36
7.2.2	Cable and conduit entries	37
7.2.3	Terminations	37
7.2.4	Insulation	37
7.2.5	Internal connections	37
7.2.6	Windings	37
7.2.7	Auxiliary devices	39
7.2.8	Light-transmitting parts	39
7.2.9	Encapsulated parts	39
7.2.10	Batteries	39
7.2.11	Lamps	39
7.2.12	Lampholders	39
7.2.13	Ballasts	40
7.3	Reclamation	40
7.3.1	General	40
7.3.2	Enclosures	40
7.3.3	Shafts and housings	40
7.3.4	Sleeve bearings	40

7.3.5	Rotors and stators.....	40
7.4	Alterations and modifications.....	41
7.4.1	Enclosures.....	41
7.4.2	Cable and conduit entries.....	41
7.4.3	Terminations.....	41
7.4.4	Windings.....	41
7.4.5	Auxiliary equipment.....	41
8	Additional requirements for the repair and overhaul of equipment with type of protection "e" (increased safety).....	41
8.1	Application.....	41
8.2	Repair and overhaul.....	42
8.2.1	Enclosures.....	42
8.2.2	Cable or conduit entries.....	42
8.2.3	Terminations.....	42
8.2.4	Insulation.....	42
8.2.5	Internal connections.....	42
8.2.6	Windings.....	43
8.2.7	Light-transmitting parts.....	46
8.2.8	Encapsulated parts.....	46
8.2.9	Batteries.....	46
8.2.10	Lamps.....	46
8.2.11	Lampholders.....	46
8.2.12	Ballasts.....	46
8.2.13	Breathing devices.....	47
8.3	Reclamation.....	47
8.3.1	Enclosures.....	47
8.3.2	Sleeve bearings.....	47
8.3.3	Rotors and stators.....	47
8.4	Modifications.....	48
8.4.1	Enclosures.....	48
8.4.2	Cable and conduit entries.....	48
8.4.3	Terminations.....	48
8.4.4	Windings.....	48
8.4.5	Auxiliary equipment.....	48
9	Additional requirements for the repair and overhaul of equipment with type of protection "n".....	48
9.1	Application.....	48
9.2	Repair and overhaul.....	48
9.2.1	Enclosures.....	48
9.2.2	Cable and conduit entries.....	49
9.2.3	Terminations.....	49
9.2.4	Insulation.....	49
9.2.5	Internal connections.....	49
9.2.6	Windings.....	49
9.2.7	Light-transmitting parts.....	53
9.2.8	Encapsulated parts.....	53
9.2.9	Batteries.....	53
9.2.10	Lamps.....	53
9.2.11	Lamp holders.....	53

9.2.12	Ballasts	53
9.2.13	Enclosed break devices	53
9.2.14	Breathing devices	54
9.3	Reclamation	54
9.3.1	General	54
9.3.2	Enclosures	54
9.3.3	Joints	54
9.3.4	Shafts and housings	54
9.3.5	Sleeve bearings	54
9.3.6	Rotors and stators	54
9.4	Alterations and modifications	55
9.4.1	Enclosures	55
9.4.2	Cable and conduit entries	55
9.4.3	Terminations	55
9.4.4	Windings	55
9.4.5	Auxiliary equipment	55
10	Additional requirements for the repair and overhaul of equipment covered by IEC 60079-26	55
11	Additional requirements for the repair and overhaul of equipment with type of protection Group III 't' (formerly known as 'tD' or DIP)	55
11.1	Application	55
11.2	Repair and overhaul	56
11.2.1	Enclosures	56
11.2.2	Cable and conduit entries	56
11.2.3	Terminations	56
11.2.4	Insulation	57
11.2.5	Internal connections	57
11.2.6	Windings	57
11.2.7	Light-transmitting parts	59
11.2.8	Batteries	59
11.2.9	Lamps	59
11.2.10	Lamp holders	59
11.2.11	Ballasts	59
11.2.12	Breathing devices	59
11.3	Reclamation	60
11.3.1	Enclosures	60
11.3.2	Joints	60
11.3.3	Shafts and housings	60
11.3.4	Sleeve bearings	60
11.3.5	Rotors and stators	60
11.4	Alterations and modifications	60
11.4.1	Enclosures	60
11.4.2	Cable and conduit entries	60
11.4.3	Windings	61
11.4.4	Auxiliary equipment	61
12	Additional requirements for the repair and overhaul of equipment with type of protection pressurization 'pD'	61
12.1	Application	61
12.2	Repair and overhaul	61

12.3 Reclamation	61
12.4 Modifications	61
Annex A (normative) Identification of repaired equipment by marking.....	62
Annex B (normative) Knowledge, skills and competencies of “responsible persons” and “operatives”	64
Annex C (normative) Requirements for measurements in flameproof equipment during overhaul, repair and reclamation (including guidance on tolerances).....	66
Annex D (informative).....	69
Bibliography.....	70
Figure C.1 – Determination of maximum gap of reclaimed parts	68
Table C.1 – Determination of maximum gap of reclaimed parts	66

<http://www.china-gauges.com/>

INTRODUCTION

When electrical equipment is installed in areas where dangerous concentrations and quantities of flammable gases, vapours, mists or dusts may be present in the atmosphere, protective measures are to be 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 IEC 60364 series, as regards installation requirements, and also refers to IEC 60079 series and its appropriate parts for the design requirements of suitable electrical equipment.

Clause 4 of this part of IEC 60079 contains general requirements for the repair and overhaul of equipment and should be read in conjunction with the other relevant clauses of this standard dealing with the detailed requirements for individual types of protection.

In cases where protected equipment incorporates more than one type of protection, reference should be made to all clauses involved.

This part not only gives guidance on the practical means of maintaining the electrical safety and performance requirements of repaired equipment, but also defines procedures for maintaining, after repair, overhaul or reclamation, compliance of the equipment with the provisions of the certificate of conformity or with the provisions of the appropriate explosion protection standard where a certificate is not available.

The nature of the explosion protection offered by each type of protection varies according to its unique features. Reference should be made to the appropriate standard(s) for details.

Users will utilize the most appropriate repair facilities for any particular item of equipment, whether they be the facilities of the manufacturer or a suitably competent and equipped repairer (see Note).

This part 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.

In the case of the repair, overhaul or reclamation of equipment which has been the subject of design certification, it may be necessary to clarify the position of the continued conformity of the equipment with the certificate.

NOTE Whilst some manufacturers recommend that certain equipment be returned to them for repair or reclamation, there are also competent independent repair organizations who have the facilities to carry out repair work on equipment employing some or all of the types of protection covered by IEC 60079 series. For repaired equipment to retain the integrity of the type(s) of protection employed in its design and construction, detailed knowledge of the original manufacturer's design (which may only be obtainable from design and manufacturing drawings) and any certificate documentation may be necessary. Where equipment is not being returned to the original manufacturer for repair or reclamation, the use of repair organizations that are recommended by the original manufacturer should be considered.

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 equipment designed for use in explosive atmospheres;
- is not applicable to maintenance, other than when repair and overhaul cannot be disassociated from maintenance, neither does it give advice on cable entry systems which may require a renewal when the equipment is re-installed;
- is not applicable to type of protection “m”, “o” and “q”;
- assumes that good engineering practices are adopted throughout.

NOTE Much of the content of this standard is concerned with the repair and overhaul of electrical machines. This is not because they are the most important items of explosion-protected equipment, but rather because they are often major items of repairable capital equipment in which, whatever type of protection is involved, sufficient commonality of construction exists as to make possible more detailed instructions for their repair, overhaul, reclamation or modification.

2 Normative references

The following referenced documents are indispensable for the application 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 60079 (all parts), *Explosive atmospheres*

IEC 60079-0, *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 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety “e”*

^{A1} IEC 60079-7:1990, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety “e”*

IEC 60079-7:2001, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety “e”* ^{A1}

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

^{A1} IEC 60079-15:2005, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, test and marking of type of protection “n” electrical apparatus*

IEC 60079-15:2010, *Explosive atmospheres – Part 15: Equipment protection by type of protection “n”* ^{A1}

IEC 60079-19, *Explosive atmospheres – Part 19: Equipment repair, overhaul and reclamation*

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

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

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

IEC 61241 (all parts), *Electrical apparatus for use in the presence of combustible dust*

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

IEC 61241-4, *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.

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

3.1

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 requirements of the certificate documentation as applicable, in which such a component part is used

3.2

repair

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

NOTE The relevant standard means the standard to which the equipment was originally designed.

3.3

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

3.4

maintenance

routine actions taken to preserve the fully serviceable condition of the installed equipment (see Clause 1)

3.5

component part

an indivisible item

NOTE The assembly of such items may form equipment.

3.6

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 The relevant standard means the standard to which the individual parts were originally manufactured.

**3.7
modification**

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

NOTE As the certificate describes specific construction of the equipment, a modification of the equipment would no longer comply with the construction described in the certificate documentation.

**3.8
manufacturer**

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

**3.9
alteration**

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

**3.10
user**

user of the equipment

**3.11
repair facility**

facility providing a service that consists of repairs, overhauls, or reclamations of explosion-protected equipment who may be the manufacturer, the user or a third party (repair agency)

**3.12
certificate**

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

NOTE The certificate may 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.

**3.13
certificate references**

a certificate reference number may refer to a single design or a range of equipment of similar design

**3.14
symbol "X"**

symbol used to denote specific conditions of use

NOTE The symbol "X" is used to provide a means of identifying that essential information for the installation, use, and maintenance of the equipment is contained within the certificate. Therefore, the certificate documents should be studied before such equipment is installed, repaired, overhauled, reclaimed, altered or modified.

**3.15
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

**3.16
flameproof enclosure "d"**

enclosure in which parts which can ignite an explosive atmosphere are placed and 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 atmosphere surrounding the enclosure

3.17

type of protection "i"

type of protection based on the restriction of electrical energy within apparatus and of interconnecting wiring exposed to the potentially explosive gas atmosphere to a level below that which can cause ignition by either sparking or heating effects

3.18

type of protection "p"

technique of 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

3.19

type of protection "e"

type of protection applied to electrical apparatus in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks in normal service or under specified abnormal conditions

3.20

type of protection "n"

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

3.21

type of protection "tD" or Group III "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

3.22

type of protection "pD"

technique of applying a protective gas 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

4 General

4.1 General principles

This clause covers those aspects of repair, overhaul, reclamation, alteration, and modification which are common to all explosion-protected equipment. Subsequent clauses provide instructions for the additional requirements relevant to specific types of protection. When equipment incorporates more than one type of protection, reference shall be made to the appropriate clauses.

NOTE 1 Additional requirements for types of protection "m", "o" and "q" have not been defined.

Assuming that repairs and overhauls are carried out using good engineering practices, then repairs and overhauls impacting the type of protection shall be presumed as being in conformity with the certificate when manufacturer's parts or parts specified in 4.4.1 are used and repairs or alterations are carried out specifically as detailed in this standard, the certificate documentation under 4.4.1.5, and when performed by competent persons as provided in 4.4.1.3.

In circumstances where the relevant documentation in accordance with 4.4.1.5.1 is not available, then the repair or overhaul shall be carried out on the equipment in accordance with this standard and other relevant standard(s). The steps taken to obtain the relevant documentation shall be recorded in the repair facility records (see 4.4.1.5.3).

If the equipment has been modified, it shall comply with the requirements of 4.4.3 where a new certificate is required to be prepared or the equipment is no longer suitable for use in a hazardous area.

NOTE 2 In some countries, legal requirements do not permit repair without relevant documentation for Group 1 equipment unless subjected to complete retesting and a new certificate issued.

If other repair or alteration techniques are used which are not in accordance with this standard, then it will be necessary to ascertain, from the manufacturers, and/or the certification authority, the suitability of the equipment for continued use in an explosive atmosphere.

NOTE 3 Repair of equipment which has no marking plate should be avoided.

4.2 Statutory requirements for repair facility

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

4.3 Instructions for the user

4.3.1 Certificates and documents

The equipment design certificate and other related documents (see 4.4.1.5) should have been obtained as part of the original purchase contract.

4.3.2 Records and work instructions

The relevant documentation (4.3.1), along with the records of any repairs, overhauls, alterations or modifications, should be kept by the user and made available to the repairer.

NOTE 1 The documentation and records are normally retained in the users verification dossier for the lifetime of the equipment.

NOTE 2 It will be in the interests of the user that the repairer is notified, whenever possible, of the fault and/or nature of the work to be done and any special application information, e.g. a motor supplied by an inverter.

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

4.3.3 Re-installation of repaired equipment

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

NOTE Before the repaired equipment is re-commissioned, cable/conduit entry systems should be checked to ensure that they are undamaged and are appropriate to the equipment type of protection.

4.3.4 Repair facilities

It is the responsibility of the user to ascertain that the repair facility concerned can demonstrate compliance with the relevant stipulations of this standard.

4.4 Instructions for the repair facility

4.4.1 Repair and overhaul

4.4.1.1 General

Repair facilities shall operate a Quality Management System.

NOTE Overhaul of explosion-protected equipment involves special techniques. The Quality Management System should include documented procedures to ensure work is performed within an agreed refurbishment quality programme. For additional information, see ISO 9001.

The repair facility shall appoint a person ('responsible person') with the required competency (see Annex B), within the management organization, to accept responsibility and authority for ensuring that the overhauled/repaired equipment complies with the certification status agreed with the user. The person so appointed shall have a working knowledge of the appropriate explosion protection standards and an understanding of this standard.

The repair facility must have adequate repair and overhaul facilities as well as the appropriate equipment necessary and trained Operatives with the required competency (see Annex B) and authority to carry out the activities, taking into account the specific type of protection.

The repair facility shall conduct an assessment of the status of the equipment to be repaired, agree with the user the expected certification status of the equipment after repair and the scope of work to be done. The assessment should include the justification for omission of any tests mentioned within this document that the user could reasonably assume to be included. The assessment shall be documented and shall address the relevant clauses of the appropriate equipment standard and this standard 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 explosion protection techniques for which they have demonstrated his competence.

The repair facility shall include additional procedures and systems to carry out overhaul/repair work at sites external to the repair facility, where appropriate.

4.4.1.2 Certificates and standards

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

4.4.1.3 Competency

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

Training and competency assessments are specified in Annex B.

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

4.4.1.4 Repair of components

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

NOTE In some countries, legal consequences may depend upon the extent to which the carrying out or not of certain actions or tests is practicable.

4.4.1.5 Documentation

4.4.1.5.1 General

The repair facility shall seek to obtain all necessary information/data from the user or manufacturer for the repair and/or overhaul of the equipment. This may include information

relating to previous repairs, overhauls or modifications. The repair facility shall also have available and refer to the relevant explosion-protection standard.

NOTE As from the fourth edition of IEC 60079-0, manufacturers are required to prepare instructions including repair.

The data necessary for the repair and/or overhaul includes, but is not limited to details of the:

- technical specification;
- drawings;
- type(s) of explosion-protection;
- operating conditions (such as environment, supply (inverter), lubricants, duty, etc.)
- dismantling and assembly instructions;
- certificate documentation with certificate limitations (specific conditions of use), where specified;
- marking (including Ex marking);
- recommended methods of installation/operation/maintenance/repair/overhaul for the equipment;
- list of spare parts;
- summary of previous history of the repaired product including information as gathered under 4.3.2.

The information may be subject to amendments.

The repair facility shall maintain copies of any relevant explosion-protection standards with which repaired/overhauled equipment is claimed to comply.

4.4.1.5.2 Job report to the user

At the completion of the work, job reports shall be submitted to the user (see 4.3.2), for inclusion in the user's verification dossier, containing, at least, the following:

- details of fault(s) detected;
- full details of repair and overhaul;
- list of replaced or reclaimed parts;
- results of all checks and tests (in sufficient detail to be useful if required by the next repairer, see 4.3.2);
- a comparison of the results against the criteria that have been used to determine compliance;
- copy of the user contract or order;
- a recapitulation of the marking applied in accordance with Annex A.

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

For repairs undertaken without documentation in accordance with 4.4.1.5.1, the following shall be included in the repair report:

- a statement that the repair is in accordance with the manufacturer's instructions or applicable requirements of the Ex standard for the particular type of protection against which the equipment was originally manufactured;
- a statement that the repairer has insufficient evidence of full compliance with the certificate documents;

- a statement that any specific conditions of use have not been identified or considered in the repair or overhaul.

4.4.1.5.3 Repair facility records

The following records shall be retained by the repair facility:

- current and past copies of relevant technical standards in addition to the explosion protection standards;
- certification of Facility Quality Standard including:
 - details of Repair provider's Quality Assessment Scheme;
 - test instrument calibration;
 - competency and training records of personnel;
 - purchasing control system;
 - customer complaints system;
 - internal and, where appropriate, external audit documentation;
 - management review;
 - process control procedures;
 - register of manufacturer's drawings.
- job records including:
 - the steps taken to obtain the certificate documentation;
 - mechanical inspection record for compliance with relevant standards;
 - defect identification;
 - electrical test records before and after repair including traceability of instruments used and pass/fail criteria;
 - attestation of conformity for replacement components;
 - recovery procedure for repaired components;
 - record of any assessments by the responsible person along with the justification for decisions taken;
 - record of mechanical inspection during assembly and upon completion;
 - record of work undertaken by the repair facility;
 - record of any replacement parts manufactured by the repairer.

The record of the reclamation of repaired components (4.4.2.2.2) shall, at least, identify the following:

- 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 (e.g., welding, metal spraying);
- e) technical parameters, e.g., 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, e.g., 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 certificate documents or the original dimensions of the component part;
- o) drawing 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.

4.4.1.6 Spare parts

4.4.1.6.1 General

It is preferable to obtain new parts from the manufacturer, and the repairer shall ensure that only appropriate spare parts be 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 certificate documentation.

Where components cannot be supplied by the original manufacturer, where the full specification for the component is available, and where the repairer's quality scheme permits, the repairer may manufacture replacement component parts. Records of such replacement shall be retained and provided to the user.

4.4.1.6.2 Fasteners

Where replacement bolts are used, they shall be the same type, diameter, pitch and length and at least the same tensile strength as specified for the original equipment.

Washers, plain or lock, shall not be placed under bolt heads, screw heads or nuts unless they are specified in the original certificate documentation or in the type of protection standard to which the equipment was manufactured.

4.4.1.6.3 Sealed parts

Parts, which are required by the equipment specification and certificate documents to be sealed, shall be replaced only by the particular spare part(s) detailed in the parts list.

NOTE Devices incorporated in equipment to indicate interference by third parties (e.g., security seals) as distinct from those required in the certificate documentation, are not intended to fall within the scope of this subclause.

4.4.1.7 Identification of repaired equipment

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 standard and the type of protection standards to which it was manufactured, but does not necessarily comply with the certificate documentation, the label should not normally be removed and the repair symbol "R" shall be written within an inverted triangle (see Annex A).
- b) If after repair, overhaul, alteration, or modification, the equipment is changed such that it no longer conforms with the type of protection standards or certificate documentation, the "Ex" marking and the mark of the certificate issuer on the certification label shall be removed unless a supplementary certificate has been obtained.

- c) Where the standards to which the previously certified equipment was manufactured are not known, the requirements of this standard and the current edition of the relevant type of protection standards shall apply. An assessment, by a person competent in assessing explosion protected equipment, shall be conducted to verify compliance with the relevant level of safety prior to release of the equipment by the repairer.

4.4.2 Reclamations

4.4.2.1 General

Where the repair process involves reclamation work, then, in addition to the requirements of 4.4.1 for repairs and overhauls, the requirements of 4.4.2 also apply.

4.4.2.2 Exclusions

Some component parts are considered not to be reclaimable and are therefore excluded from the scope of this standard. Such parts:

- component parts made from the following materials: glass, plastics, or any material that is not dimensionally stable;
- fasteners;
- component parts, e.g., some encapsulated assemblies, which have been stated by the manufacturer to be not subject to repair.

4.4.2.2.1 Requirements

4.4.2.2.2 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). If any proprietary process is used, the instructions of the originator of such a process should be followed.

All reclamation shall be documented in accordance with 4.4.1.5.3.

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

4.4.2.2.3 Responsibilities

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

4.4.2.2.4 Reclamation procedures

4.4.2.2.5 General

The following outlines some of the reclamation procedures which may be applicable to explosion-protected equipment.

It should be recognized that not all procedures are applicable to all types of protection. Detailed instructions are given in the appropriate clauses of this standard.

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.

NOTE 1 Industry guidance would suggest that the 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 will not be significantly detrimental to the strength of the component.

NOTE 2 Removal of a greater thickness of material should only be carried out after due consultation with the manufacturer or by calculation where the manufacturer is no longer available.

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

4.4.2.2.6 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.

NOTE Metal spraying is not recommended where peripheral speed exceeds 90 m/s.

4.4.2.2.7 Electroplating

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

4.4.2.2.8 Sleaving

This method 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, should not be taken into account when strength is considered.

4.4.2.2.9 Brazing and welding

Reclamation by brazing or welding shall be considered only if 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 standard:

- MMA: Manual metal arc
- MIG: Metal inert gas
- TIG: Tungsten inert gas
- Sub-Arc: MIG under a layer of flux
- Hot wire

Other techniques shall only be utilized in reclamations after due consultation with the manufacturer or, if relevant, the certifying authority.

4.4.2.2.10 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 admissible subject to a suitable thickness of casting.

4.4.2.2.11 Threaded holes for fasteners

Threads which have been damaged beyond an acceptable extent may be reclaimed, depending upon the type of protection, by the following means:

- oversize drilling and re-tapping;
- 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;
- oversize drilling, plugging¹, re-drilling and re-tapping;
- plugging², re-drilling and tapping elsewhere;
- plug-welding, re-drilling and tapping.

4.4.2.2.12 Re-machining

Re-machining worn or damaged surfaces shall be considered only if

- the component part is not weakened beyond safe limits;
- provided that the integrity of the enclosure is maintained;
- the required surface finish is achieved.

4.4.3 Alterations and modifications

4.4.3.1 Alterations

Where the repair process involves alteration work, then, in addition to the requirements of 4.4.1 for repairs and overhauls, the requirements of 4.4.3 also apply.

No alteration shall be made to the equipment unless that alteration is permitted in the certificate documentation. If the certificate documentation is not available to the repairer, the proposed alteration is confirmed in writing by the manufacturer to be permitted by the certificate. Subsequent clauses of this standard give detailed instructions regarding alterations in the context of different types of protection.

4.4.3.2 Modifications

The user shall be informed in writing and his written instructions obtained if a modification is proposed, which results in the equipment not conforming to the certificate documentation. If the modification is performed, the equipment is no longer suitable for use in an explosive atmosphere without additional assessment. If the repair 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 original 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.

NOTE 1 The "assessment" may include third party certification of the modified equipment, but this may not be practical in all situations. When not practical, assessments by competent persons may be accepted by the user.

NOTE 2 Where labels are removed, efforts should be made to maintain traceability of the product in consultation with the user.

4.4.4 Temporary repairs

A temporary repair intended to achieve continued short-term operation of the equipment shall only be carried out if retention of explosion-protection aspects 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 shall be brought up to full repair standards as soon as reasonably practicable.

¹ Plugs shall be securely retained.

4.4.5 Rotating machinery

4.4.5.1 Removal of damaged windings

The procedure of softening the impregnating varnish of windings with solvents before stripping is acceptable.

The alternative procedure which uses the application of heat to facilitate the removal of windings is acceptable 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 T₂, T₃ or T₄ requires particular caution.

NOTE The advice of the manufacturer should be sought, regarding the construction of the core and the inter-laminar insulation material, if necessary.

The application of open flames to the core is not acceptable because it may damage the insulation between laminations.

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 significantly affect type "e" parameters (t_E -time, etc.) or result in the temperature classification being exceeded.

The repairer shall satisfy himself, 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 explosion concept (see also 4.4.2.2.4).

4.4.5.2 Additional requirements

Before a rewind or repaired rotating machine is returned to the user, the repair 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 equipment standards, if appropriate. 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 equipment standard to avoid frictional sparking and electrostatic charging, and of the chemical environment in which the machine is used.

4.4.5.3 Lubricants and corrosion inhibitors

Third-party repairers should establish from the user that on any rotating machine, on which they are asked to work, if any special lubricants are required. Attention is drawn to the correct selection and application of lubricants and corrosion inhibitors for example:

- no migration onto un-insulated electrical parts occurs;
- the flash-point of the lubricant or corrosion inhibitor exceeds the temperature class of equipment for which it is to be applied;
- the environment in which the equipment is used;
- its application will not aid flame transmission or defect the type of protection technique.

4.4.6 Inverters

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

Third-party repairers should establish from the user that if any rotating machine, on which they are asked to work, are fed by an inverter.

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

5.1 Application

This clause 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 an Ex "d" equipment are those to which the equipment was originally manufactured (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. 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 certificate documentation. Where flameproof joints are not gasketed and the manufacturer's documentation does not address joint protection but for ingress protection, then only non-setting grease or anti-corrosive agents without evaporating solvents shall be used or 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 certification authority.

The drilling of holes into an enclosure is a modification and shall not be carried out without reference to the manufacturer's certified drawings, or, in exceptional circumstances, e.g., manufacturer discontinued trading, to the certifying authority.

NOTE Care should be taken when changing surface finish, paint, etc., as this may affect the surface temperature of the enclosure and thus the temperature classification.

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 nominated in certificate documentation and held at least 10 s. Where reference pressure is not stated, Group I 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 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 threadform cannot be verified, an overpressure test shall be conducted.

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

5.2.2 Cable and conduit entries

Entries into flameproof enclosures shall conform, after repair or overhaul, to the conditions detailed in the appropriate equipment standard and/or certificate documentation where applicable.

5.2.3 Terminations

Care shall be taken when refurbishing terminations to maintain clearance and creepage distances. Any replacement terminals, bushes or parts should be obtained from the manufacturer or shall conform to the relevant equipment standard and/or certificate documentation, where applicable.

5.2.4 Insulation

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

NOTE If the motor output is increased, the motor will require recertification.

5.2.5 Internal connections

There are no particular requirements relating to this type of protection but repairs to internal connections shall be of a standard at least equivalent to that of the original design.

5.2.6 Windings

5.2.6.1 General

The original winding data shall 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 classification of the equipment could then be adversely affected.

5.2.6.2 Repair of rotating 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.

NOTE Identical characteristics includes 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.

5.2.6.3 Testing after repair of windings

5.2.6.3.1 General

Windings, after complete or partial repair, shall be subjected, preferably with the equipment assembled, to the following tests, as far as is reasonably practicable.

- 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.

NOTE 1 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.

NOTE 2 In the event that the winding resistance is unbalanced, it should be verified by a competent person that the specific motor is suitable for the intended application.

- b) 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 d.c. is recommended.

Minimum acceptable insulation resistance values are a function of rated voltage, temperature, type of equipment and whether the rewind is partial or complete.

NOTE 3 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.

- c) 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.
- d) The transformer or similar equipment shall 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.
- e) High-voltage (e.g., 1 000 V a.c./1 500 V d.c. and above) and other special equipment may require additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 4 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034, or the manufacturer's recommendation may be obtained for special circumstances.

5.2.6.3.2 Rotating machines

Rotating 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/or 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 should be 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.

NOTE 2 Where this test is not reasonably practical other means of verification should be used.

- c) High-voltage (e.g., 1 000 V a.c./1 500 V d.c., and above) and non-cage machines may require alternative and/or additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 3 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034, or the manufacturer's recommendation may be obtained for special circumstances.

5.2.6.4 Temperature sensors

5.2.6.4.1 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.

5.2.6.4.2 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 documentation prepared in accordance with IEC 60079-0, 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 certificate documentation, will necessitate a re-wind.

NOTE If the documentation is 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 Auxiliary equipment

5.2.7.1 Flameproof brake units

Where a flameproof brake unit attached to a rotating machine is also certified and is in need of repair, it is recommended that it 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 repair facilities other than those of the manufacturer providing the repair facility is in possession of the necessary drawings and information from the manufacturer or by reference to the type of protection standard.

5.2.7.2 Other auxiliary devices

Where auxiliary devices are based on different types of protection, the corresponding clauses of this standard shall be consulted before any repairs are undertaken.

5.2.8 Light-transmitting parts

No attempt shall be made to re-cement or repair light-transmitting parts, and 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.

5.2.9 Encapsulated parts

In general, encapsulated parts (e.g. switching devices) are not considered suitable for repair.

5.2.10 Batteries

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

5.2.11 Lamps

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

NOTE The position of a reflector, if any, or the distance between the lamp and the window should be maintained.

5.2.12 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.

5.2.13 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.

5.2.14 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 a certificate documentation. 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 4.4.2 may be used with type of protection "d" equipment subject to the following restrictions of this clause.

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

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

- a) 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.
- b) Spigoted/cylindrical joints: Machining the male part will require addition of metal to it, and also machining of, the female part (or vice versa), thus ensuring that the flamepath dimensions comply with the equipment standard, and where appropriate the certificate documentation. 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.
- c) Threaded joints:
 - 1) 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.
 - 2) Screwed covers: 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

Reclamation of damaged threaded holes shall be carried out using the techniques described in 4.4.2.2.11.

5.3.3 Sleeving

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, sleeving or welding (except MMA) techniques. Any subsequent machining shall be to the flamepath dimensions as specified in the equipment standard and/or certificate documents, as appropriate. If the certificate documents 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 4.4.2.2.9).

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 may 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 classification or cause subsequent damage to the stator windings. The "flux test" shall be conducted at 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 certificate documentation and/or the manufacturer. In exceptional circumstances, for example, the manufacturer discontinued trading, with the certifying authority.

5.4.2 Cable or conduit entries

Additional entries shall not be made without reference to the certificate documentation and/or the manufacturer or, in exceptional circumstances, for example, the manufacturer discontinued trading, with the certifying authority.

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 certificate documentation. The rating plate shall be changed to show the new parameters.

Rewinding a rotating 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" (intrinsic safety)

6.1 Application

This clause contains additional requirements for the repair, overhaul, reclamation, alteration and modification 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 Ex "i" equipment are those to which the equipment was originally manufactured.

NOTE 1 Intrinsically safe equipment may have one of three levels of protection, Ex ia, Ex ib and Ex ic. However, the requirements for repair and overhaul apply to all levels of protection regardless of the hazardous area (i.e. zone 0, zone 1 or zone 2), 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 system which are installed in the non-hazardous area and in the hazardous area.

NOTE 2 Due to the critical nature of circuit design and component specific requirements associated with type of protection 'i' repair without certificate documentation may be inappropriate (refer Clause 4.1). Where the safety components are not clearly defined in the certificate documentation, electrical repairs could affect intrinsic safety.

NOTE 3 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.

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 refurbishing 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 creepage (according to CTI) and clearance requirements specified in the standard for the maximum voltage of the equipment and the separation required by the standard to avoid inadvertent cross-connection.

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

NOTE Earthing is a very important consideration for intrinsic safety, and a duplicated or triplicated earth connection may be a requirement of the intrinsic safety equipment certificate documentation.

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 basis of certification is not invalidated; e.g.,

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

- Compatibility of soldering method with documentation;
- Compatibility of soldering materials with documentation;
- Maintenance and verification of creepage and clearance;
- Soldering processes;
- 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.

NOTE 1 Additional conformal coatings may be required as corrosion and lack of cleanliness can invalidate intrinsic safety.

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 2 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 certificate documentation. 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:

- the same rating;
- the same or higher breaking capacity;
- the same time/current characteristic;
- the same type of construction;
- 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 4.4.1.5.3.

NOTE Fuse replacement in encapsulated barriers or in encapsulated battery packs (or similar) is inappropriate.

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 certificate documentation.

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 the intrinsically safe circuits and non-intrinsically safe circuits.

NOTE In intrinsically safe systems, replacing shunt diode safety barriers or galvanic isolators with an alternate type to that shown in the IS system documentation may affect the safety of the system. Reference should be made to a competent person responsible for the safety of the IS system.

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. Where coating is damaged during repair, coating of the type prescribed by the manufacturer shall be applied in the approved manner, for example, one coat if using dipping, two coats using other methods.

NOTE 1 Coating may be an insulation coating or a conformal coating for environmental protection

NOTE 2 Creepage and clearance between individual components can also be critical. In modern surface-mounted boards, the components are positioned to fractions of a millimetre, and this can be an essential feature of the certified segregation between different parts of the overall circuit. This makes it very difficult to attempt board-level repair to the 'as supplied state' on modern, compact, surface mounted designs. In such cases, exchange of entire printed circuit assemblies is the recommended repair.

6.2.9 Optocouplers and piezoelectric components

Only components of the same type as listed in the certificate documentation 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, etc., these may normally be replaced with items purchased from any source, but if components are not procured from the manufacturer or certificate holder, 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 certificate documentation is a modification and shall not occur without additional certification.

6.2.11 Batteries

Only those battery types specified in the equipment manufacturer's instructions or certificate documentation shall be used as replacements. The use of different cell types (such as "equivalent" generic types from the same or other manufacturers) will invalidate intrinsic safety.

NOTE Certificates for modern intrinsically safe designs will 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 may have different short circuit currents, and under short circuit conditions may be prone to electrolyte leakage or bursting, or produce excessive temperatures.

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

The use of alternative encapsulated battery packs to those supplied by the manufacturer or certificate holder is a modification and shall not occur without additional certification.

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. If insulation, screens, outer sheaths, and/or double insulation of wiring or the method of fixing are damaged, they shall be replaced by equivalent material and/or re-fixed in the same configuration.

Where equipment is subject to an overall certification, any change to wiring is a modification and shall not occur without additional certification.

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 certificate documentation. 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 may have antistatic, impact, thermal and flammability requirements which affect the intrinsic safety. Where replacement of such parts is required they should be replaced by materials as specified in the certificate documentation.

6.2.16 Testing

After completion of the repair or overhaul the electric strength of the insulation between the intrinsically safe circuit and the metallic enclosure shall be checked by applying a 500 V a.c. (50 Hz or 60 Hz) voltage between the terminals and the enclosure for 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 opto-couplers shall be in accordance with the relevant equipment standard.

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 may 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 certification. 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" (pressurized)

7.1 Application

This clause 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 an Ex "p" equipment are those to which the equipment was originally manufactured (see IEC 60079-2).

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 given that, when compared with the original, it

- is of at least equivalent strength;
- does not result in a greater leakage rate of protective gas;
- does not restrict the flow of protective gas into or through the enclosure;
- is not shaped or fitted so as to permit the explosive atmosphere to enter the enclosure;

- is not of a construction which would result in stagnant volumes of atmosphere inside the enclosure;
- 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.

NOTE The "pressurisation" sealing requires verification either at the repair facility (if possible) or on site.

7.2.2 Cable and conduit entries

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 Windings

7.2.6.1 General

The original winding data shall 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 classification of the equipment could then be adversely affected.

7.2.6.2 Repair of rotating 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.

NOTE Identical characteristics includes 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 Testing after repair of windings

7.2.6.3.1 General

Windings, after complete or partial repair, shall be subjected, with the equipment assembled, to the following tests, as far as reasonably practicable.

- 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.

NOTE 1 If the winding resistance (either obtained from the original manufacturer's data, measurement from an undamaged winding, or derived by calculation from the damaged winding) of the repaired winding differs from that of the original winding by more than 5 %, additional thermal tests may be required to confirm continued conformity to the stated insulation class and temperature class.

NOTE 2 In the event that the winding resistance is unbalanced, it should be verified by a competent person that the specific motor is suitable for the intended application.

- b) 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 d.c. is recommended. Minimum acceptable insulation resistance values are a function of rated voltage, temperature, type of equipment and whether the rewind is partial or complete.

NOTE 3 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.

- c) A high-voltage test, in accordance with a relevant equipment standard, shall be applied between windings and earth, between windings where possible, and between windings and auxiliaries attached to the windings.
- d) The transformer or similar equipment shall 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.
- e) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and other special equipment may require additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 4 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034, or the manufacturer's recommendation may be obtained for special circumstances.

7.2.6.3.2 Rotating machines

Rotating 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/or 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 should be 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 ensure 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 of less than 5 % of the middle value is acceptable.

NOTE 2 Where this test is not reasonably practical other means of verification should be used.

- c) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and non-cage machines may require alternative and/or additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 3 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034, or the manufacturer's recommendation may be obtained for special circumstances.

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 documentation prepared in accordance with IEC 60079-0, 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 certificate documentation, will necessitate a stator rewind.

NOTE If the documentation is 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 types of protection, the corresponding clauses of this standard 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

In general, 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 verified by a person with competency 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 this clause.

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.

Spigoted joints are normally provided to achieve close tolerance location. Thus, machining the male part will 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 4.4.2.2.9).

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 may 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 classification or cause subsequent damage to the stator windings. The "flux test" shall be conducted at 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 may be modified. Any modified part shall meet the conditions given in 7.2.

Enclosures with an internal source of release of flammable gas such as analysers, chromatographs, etc. 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 Cable and conduit entries

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 certificate documents. The rating plate shall be changed to show the new parameters.

Rewinding a rotating 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.

8 Additional requirements for the repair and overhaul of equipment with type of protection "e" (increased safety)

8.1 Application

This clause contains additional requirements for the repair, overhaul, reclamation and modification of equipment with type of protection "e". 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 Ex "e" equipment are those to which the equipment was originally manufactured (see IEC 60079-7).

8.2 Repair and overhaul

8.2.1 Enclosures

While it is preferable to obtain new parts from the manufacturer, in principle, damaged parts may be repaired or replaced with others, given that the degree of ingress protection and temperature classification as stipulated on the certification label are preserved.

NOTE The specific IP rating is integral to type of protection "e". The performance of gaskets and seals is critical to maintaining that IP rating and has been subjected to special conditioning and testing and should only be replaced with gaskets and seals of identical materials and identical construction.

A more stringent degree of ingress protection than that specified in the equipment standard may have been provided to cater for environmental conditions in which case any repair shall not jeopardize such higher degree of ingress protection.

Particular attention is drawn to impact test requirements of all parts of the enclosure and also the degree of ingress protection to be provided for air inlet and outlet openings, as given in the equipment standard.

Adequate clearance shall be maintained between stationary and rotating parts in accordance with the equipment standard. Adequate clearance shall mean the clearance required by the manufacturer's certified drawings or in the absence of drawings, minimum clearance as specified in IEC 60079-7.

Attention is drawn to the effects of surface finishes, paint, etc. on the temperature classification of enclosures. Only finishes specified by the manufacturer or equivalent shall be applied.

8.2.2 Cable or conduit entries

Entries shall preserve a minimum IP54 degree of ingress protection, in accordance with the requirements of IEC 60529, and at least the same IP rating as the equipment was originally designed for.

8.2.3 Terminations

The design of terminations in terms of the materials and construction used, the creepage and clearance distances and the comparative tracking indices of termination insulation will normally be fully specified in the certificate documents. Replacement parts shall be obtained from the manufacturer or his advice sought regarding acceptable alternatives.

Where terminations are loose leads, the methods of termination including insulation shall be in accordance with the certificate documentation.

8.2.4 Insulation

^{A1} Comprehensive details of the insulation system of windings, including the type of impregnation varnish, are normally included in the certificate documentation. Where this does not apply, full information shall be sought from the manufacturer or determined by detailed inspection of the original winding. ^{A1}

8.2.5 Internal connections

If internal connections are to be renewed, the insulation on such connections shall not be electrically, thermally or mechanically inferior to that originally supplied.

The cross-sectional area of any replacement connection shall not be less than that originally fitted. The permitted methods of connecting conductors are given in the relevant standards.

8.2.6 Windings

8.2.6.1 General

- A1** The electrical construction of Type of Protection "e" equipment decisively influences the explosion safety and the repairer shall be in full possession of the necessary information and equipment. The whole of the winding shall be restored to the original condition, except that a partial winding replacement may be possible on larger equipment where this may be practicable.

8.2.6.1.1 For machines with a rated voltage of 1 000 V or less; machines evaluated to IEC 60079-7:1969, 1990 or 2001:

The following repair techniques are acceptable:

- stator windings replaced with those provided by the manufacturer;
- stator windings replaced based on manufacturer's winding data;
- copy winding techniques;

The following winding data are required to be able to repair the stator winding and maintain the original t_E :

- a) type of winding – for example, single-layer, double-layer, etc.;
- b) winding diagram;
- c) number of turns/conductors/slot, parallel paths per phase;
- d) interphase connections;
- e) conductor size;
- f) insulation system, including slot insulation and the generic varnish system or process such as VPI or trickle;
- g) measurement or calculation of resistance/phase or between terminals.
- h) coil pitch
- i) winding projection, including clearance between coils and enclosure

NOTE 1 Converter-fed motors are not protected using the concept of t_E , but are protected either with embedded temperature sensors or by the inherent design of the converter.

Where copy rewind techniques are being used, all of the following are required:

- a) Where there is a risk of damaging the core when stripping out the old winding, a core flux test shall be conducted, at an appropriate value, such as 1,5 T (50 Hz) or 1,32 T (60 Hz), before and after stripping winding to verify condition of core. The core losses after stripping shall be no greater than 110 % of the core losses before stripping.
- b) Removal of stator winding shall be by use of chemical stripping, controlled pyrolysis (temperature controlled burn out) where the stator temperature does not exceed 370 °C or cold stripping process.
- c) The cross section area of the conductor shall be no less than the cross section area of the original winding and not greater than 103 % of the cross section area of the original winding.
- d) The type of winding used on the original winding shall be used for the rewind – for example, single-layer, double-layer, lap, concentric, etc.
- e) The number of conductors/slot, and parallel paths per phase shall be as in the original winding. **A1**

- A1** f) The mean length turn of the coil shall be no greater than the original winding coil or preferably reduced.
- g) The stator winding projection shall be the same as the original winding.
- h) Embedded temperature sensors shall be fitted in the same location as the temperature sensors in the original winding.
- i) The generic varnish system process shall be the same as used in the original winding, such as trickle epoxy resin, solvent free resin using VPI, or triple dip with pre-heating and cure in resin with solvent
- j) After impregnation but before curing, the stator bore shall be cleaned. This is in order to minimise the need for stator bore cleaning after the stator winding is cured, which can increase stray losses.
- k) The resistance/phase or between terminals shall be within $\pm 5\%$ of the original winding.

NOTE 2 The EASA/AEMT Rewind Guid titled *The Effects of Repair/Rewinding on Motor Efficiency* published by EASA & AEMT provides additional information on Best Practice during rewinding & repair. This document is available as a free download from www.easa.com or www.iecex.com.

8.2.6.1.2 For machines with a rated voltage of greater than 1 000 V; machines evaluated to IEC 60079-7:1990 or 2001:

In addition to the revised requirements of 8.2.6.1.1:

Unless the insulation system has been previously subjected to the stator incendivity tests of IEC 60079-7:1990 or 2001, the complete motor windings shall be subjected to the stator incendivity tests of IEC 60079-7:1990 or 2001, as applicable.

NOTE 1 Equipment evaluated against the requirements of IEC 60079-7:1969 or 1990 was not subjected to additional requirements for high-voltage machines. These machines, if returned to original condition, will likely only comply with the requirements of the standard to which they were originally evaluated.

NOTE 2 Additional information on the evaluation of stator windings and insulation systems based on the IECEx Decision Sheet DS2013/006 (available from www.iecex.com) can be found in Annex D. **A1**

8.2.6.2 Repair of rotating 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.

NOTE Identical characteristics includes 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 stirres can be repaired

8.2.6.3 Testing after repair of windings

8.2.6.3.1 General

After complete or partial repair, windings shall be subjected, with the equipment assembled, to the following tests so far as is reasonably practicable.

- 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.

NOTE 1 If the winding resistance of the repaired winding differs from that of the original winding, whether 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.

NOTE 2 In the event that the winding resistance is unbalanced, it should be verified by a competent person that the specific motor is suitable for the intended application.

- b) 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. The minimum test voltage of 500 V d.c. is recommended. Minimum acceptable insulation resistance values are a function of rated voltage, temperature and type of equipment and whether the rewind is partial or complete.

NOTE 3 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.

- c) A high-voltage test, in accordance with a relevant equipment standard, shall be applied between windings and earth, between windings where possible, and between windings and auxiliaries attached to the windings.
- d) The transformer or similar equipment shall 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 should be balanced in all phases, as far as is reasonable.
- e) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and other special equipment may require additional tests. This shall be the subject of the repair or overhaul contract.

8.2.6.3.2 Rotating machines

In addition to the above tests, rotating machines shall be subjected to the following tests so 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/or 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 should be run at the highest practicable speed within that range.

- b) The stator windings of cage machines shall be energized at nominal voltage, with the rotor locked to verify the current I_A and the resulting ratio I_A/I_N within the tolerances of ± 10 %. If the voltage needs to be reduced due to the test equipment the current and current ratio shall be calculated in accordance with common engineering rules. Current unbalance of less than 5 % of the middle value is acceptable. (The test is used to confirm the integrity of the stator winding and its connections and to indicate the presence of rotor defects.)

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 ensure 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 of less than 5 % of the middle value is acceptable.

NOTE 2 Where this test is not reasonably practical other means of verification should be used.

- c) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and non-cage machines may require alternative and/or additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 3 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034, or the manufacturer's recommendation may be obtained for special circumstances.

8.2.6.4 Temperature sensors

8.2.6.4.1 Repaired windings

If embedded temperature sensors were included to monitor winding temperatures, it is recommended that an identical replacement be embedded in the same location in the repaired winding before varnishing and curing.

8.2.6.4.2 Overhaul

It is recommended that temperature sensors be checked and if defective replaced as part of any overhaul. If replacements are required, temperature sensors shall be as specified in the documentation prepared in accordance with IEC 60079-0, 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 certificate documentation, will necessitate a stator rewind.

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

8.2.7 Light-transmitting parts

No attempt shall be made to repair light-transmitting parts and only replacement components provided by the manufacturer shall be used. Light-transmitting parts or other parts made of plastic shall not be cleaned with solvents. Household detergents may be used.

8.2.8 Encapsulated parts

In general, encapsulated parts (for example, switching devices in luminaires) are not considered suitable for repair or reclamation.

8.2.9 Batteries

Where batteries are used, reference shall be made to the manufacturer's instructions before carrying out any repair or replacement.

8.2.10 Lamps

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

Special care shall be taken with single-pin tubular fluorescent tubes. The single pin, when inserted in the lampholder, forms a flameproof enclosure and distortion or misalignment may affect the designed explosion protection.

8.2.11 Lampholders

Only replacements specified by the manufacturer shall be used. In those cases where the wiring to the lampholder is factory-made (crimps, etc.), rewiring shall not be undertaken unless the repairer has the equipment to make up the wiring to the same standard.

NOTE Lampholders for type of protection "e" luminaires are invariably of specific types, either single-pin for tubular fluorescent lamps or screw for other types.

8.2.12 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.

8.2.13 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 a certificate documentation. If breathing devices carry an Ex component certificate, only a suitably certified and dimensioned part can be used.

8.3 Reclamation

Reclamation using the techniques detailed in Clause 4 may be used with the type of protection "e" equipment subject to the following restrictions of this clause.

8.3.1 Enclosures

8.3.1.1 General

If minor 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 as to degrade the type of protection, in particular, that it remains capable of withstanding the impact test and maintains the degree of ingress protection.

8.3.1.2 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.

Where joints are provided to achieve close tolerance location, machining the male part may require addition of metal to it and also 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 is not recommended.

8.3.1.3 Shafts and housings

If shafts and bearing housings are to be reclaimed, this may be carried out by use of metal spraying or sleeving techniques. Welding may be appropriate with due regard to the limitations of this technique (see 4.4.2.2.9).

8.3.2 Sleeve bearings

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

8.3.3 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 may 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 adversely affect the temperature classification or cause subsequent damage to the stator windings.

The repairer shall seek and follow advice from the manufacturer before this procedure is adopted or the equipment is re-tested in accordance with the type of protection standard.

8.4 Modifications

8.4.1 Enclosures

Enclosures may be modified provided that the specified temperature classification, degree of ingress protection and impact test requirements of the appropriate standards are met.

8.4.2 Cable and conduit entries

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.

8.4.3 Terminations

No modification of terminations shall be made without reference to the manufacturer.

8.4.4 Windings

Rewinding of the equipment for another voltage or connection shall not be carried out without guidance from the manufacturer and provided that, for example, the magnetic loading, current densities and losses are not increased, new appropriate creepage and clearance distances are observed, and the new voltage, t_E time and I_A/I_N ratio are within the limits of the certificate documentation. The rating plate shall be changed to show the new parameters.

Rewinding a rotating machine for a different speed shall not be carried out without guidance from the manufacturer, since the electrical and thermal characteristics of the machine could be significantly altered to the point of being outside the limits of the certificate documentation. The rating plate shall be changed to show the new parameters.

8.4.5 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 modification.

9 Additional requirements for the repair and overhaul of equipment with type of protection "n"

9.1 Application

This clause contains additional requirements for the repair, overhaul, reclamation and modification of equipment with type of protection "n". 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 Ex "n" equipment are those to which the equipment was originally manufactured (see IEC 60079-15).

9.2 Repair and overhaul

9.2.1 Enclosures

Whilst it is preferable to obtain new parts from the manufacturer, in principle, damaged parts may be repaired or replaced with others, given that the degree of ingress protection and temperature classification as stipulated on the label is preserved.

NOTE The specific IP rating is integral to type of protection "n". The performance of gaskets and seals is critical to maintaining that IP rating and has been subjected to special conditioning and testing and should only be replaced with gaskets and seals of identical materials and identical construction.

A more stringent degree of ingress protection than that specified in the equipment standard may have been provided to cater for environmental conditions, in which case any repair shall not jeopardize such higher degree of ingress protection.

Particular attention is drawn to the impact test requirements of all parts of the enclosure as given in the equipment standard.

Adequate clearance shall be maintained between stationary and rotating parts in accordance with the equipment standard.

Restricted breathing enclosures depend for their explosion protection on gaskets and other means of sealing. The condition of the sealing arrangements may adversely affect the type of protection.

Attention is drawn to the effect of surface finish, paint, etc. on the temperature classification of enclosures.

9.2.2 Cable and conduit entries

Entries shall preserve a minimum IP54 degree of protection in accordance with the requirements of IEC 60529.

9.2.3 Terminations

Care shall be taken when refurbishing terminal compartments to maintain clearances and creepages in accordance with the equipment standard. Where non-metallic screws are used for fixing, only replacement screws of similar materials shall be used.

Where terminations are loose leads, the method of termination including insulation shall be in accordance with the certificate documentation.

9.2.4 Insulation

A class of insulation the same as or superior to that originally provided shall be employed, for example, a winding insulated with class E material may be repaired using class F material (see IEC 60085).

9.2.5 Internal connections

If internal connections are to be renewed, the insulation on such connections shall not be electrically, thermally or mechanically inferior to that originally supplied.

The cross-sectional area of any replacement connection shall not be less than that originally fitted.

9.2.6 Windings

9.2.6.1 General

A1 The electrical construction of type of protection "n" equipment decisively influences the explosion safety and the repairer shall be in full possession of the necessary information and equipment. The whole of the winding shall be restored to the original condition except that a partial winding replacement may be possible on larger equipment where this may be practicable. **A1**

A1) For machines evaluated to IEC 60079-15:1987 or 2001, one of the following repair options shall be employed:

- stator windings replaced with those provided by the manufacturer;
- repair based on manufacturer's winding data;
- copy winding technique, which includes determination of winding connections, conductor size, turns, coil pitch, winding projection, and may include a determination of the original coil resistance.

For machines with a rated voltage of 1 000 V or less evaluated to IEC 60079-15:2005 or 2010, one of the following repair options shall be employed:

- stator windings replaced with those provided by the manufacturer;
- repair based on manufacturer's winding data;
- copy winding technique, which includes determination of winding connections, conductor size, turns, coil pitch, winding projection, and may include a determination of the original coil resistance.

For machines with a rated voltage of greater than 1 000 V, one of the following repair options shall be employed, ensuring that, unless the insulation system has been previously subjected to the stator incendivity tests of IEC 60079-15:2005 or 2010, the motor windings shall be subjected to the stator incendivity tests of IEC 60079-15:2005 or 2010. For IEC 60079-15:2005, the end user has the option of advising that the risk factors used for the original assessment against IEC 60079-15:2005 indicated a low potential for stator winding discharge, and therefore the stator incendivity tests were not performed:

- stator windings replaced with those provided by the manufacturer;
- stator windings replaced based on manufacturer's winding data;
- copy winding techniques.

The following winding data are required to be able to repair the stator winding and maintain the original t_E :

- a) type of winding – for example, single-layer, double-layer, etc.;
- b) winding diagram;
- c) number of turns/conductors/slot, parallel paths per phase;
- d) interphase connections;
- e) conductor size;
- f) insulation system, including slot insulation and the generic varnish system or process such as VPI or trickle;
- g) measurement or calculation of resistance/phase or between terminals;
- h) coil pitch;
- i) winding projection, including clearance between coils and enclosure.

NOTE 1 Converter-fed motors are not protected using the concept of t_E , but are protected either with embedded temperature sensors or by the inherent design of the converter.

Where copy rewind techniques are being used, all of the following are required:

- a) A core flux test shall be conducted at an appropriate value, such as 1,5 T (50 Hz) or 1,32 T (60 Hz), before and after stripping winding to verify condition of core. The core losses after stripping shall be no greater than 110 % of the core losses before stripping. **A1**

- A1** b) Removal of stator winding shall be by use of chemical stripping, controlled pyrolysis (temperature controlled burn out) where the stator temperature does not exceed 370 °C or cold stripping process.
- c) The cross section area of the conductor shall be no less than the cross section area of the original winding and not greater than 103 % of the cross section area of the original winding.
- d) The type of winding used on the original winding shall be used in the rewind – for example, single-layer, double-layer, lap, concentric, etc.
- e) The number of conductors/slot, and parallel paths per phase shall be as in the original winding.
- f) The mean length turn of the coil shall be no greater than the original winding coil or preferably reduced.
- g) The stator winding projection shall be the same as the original winding.
- h) Embedded temperature sensors shall be fitted in the same location as the temperature sensors in the original winding.
- i) The generic varnish system process shall be the same as used in the original winding, such as trickle epoxy resin, solvent free resin using VPI, or triple dip with pre-heating and cure in resin with solvent
- j) After impregnation but before curing, the stator bore shall be cleaned. This is in order to minimise the need for stator bore cleaning after the stator winding is cured, which can increase stray losses.
- k) The resistance/phase or between terminals shall be within ± 5 % of the original winding.

NOTE 2 Additional information on the 'Evaluation of Best Practice During Rewinding & Repair' can be found in Annex D. **A1**

9.2.6.2 Repair of rotating 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.

NOTE Identical characteristics includes 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 stirres can be repaired.

9.2.6.3 Testing after repair of windings

9.2.6.3.1 General

Windings, after complete or partial repair, shall be subjected, with the equipment assembled, to the following tests as far as is reasonably practicable.

- 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.

NOTE 1 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.

NOTE 2 In the event that the winding resistance is unbalanced, it should be verified by a competent person that the specific motor is suitable for the intended application.

- b) 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 d.c. is recommended.

Minimum acceptable insulation resistance values are a function of rated voltage, temperature, type of equipment and whether the repair is partial or complete.

NOTE 3 The insulation resistance should not be less than 20 M Ω at 20 °C, on a completely rewound equipment intended for use at up to 690 V.

- c) A high-voltage test in accordance with a relevant equipment standard shall be applied between windings and earth, between windings where possible, and between windings and auxiliaries attached to the windings.
- d) The transformer or similar equipment shall preferably be energized at rated supply voltage. The supply current, secondary voltage and current shall be measured. The measured value should 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.
- e) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and other special equipment may require additional tests. This shall be the subject of the repair and overhaul contract.

9.2.6.3.2 Rotating machines

Rotating machines, in addition to the above tests, shall be subjected to the following tests so 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/or 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 should be 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 rated current and to ensure 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 of less than 5 % of the middle value is acceptable.

NOTE 2 Where this test is not reasonably practical other means of verification should be used.

- c) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and non-cage machines may require alternative and/or additional tests. This shall be the subject of the repair or overhaul contract.

NOTE 3 Guidance on test voltages and additional tests for rotating machines is given in IEC 60034, or the manufacturer's recommendation may be obtained for special circumstances.

9.2.6.4 Temperature sensors

9.2.6.4.1 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.

9.2.6.4.2 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 documentation prepared in accordance with IEC 60079-0, 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 certificate documentation, will necessitate a stator rewind.

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

9.2.7 Light-transmitting parts

Light-transmitting or other parts made of plastic shall not be cleaned with solvents. Household detergents may be used.

9.2.8 Encapsulated parts

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

9.2.9 Batteries

Where batteries are used, reference shall be made to the manufacturer's instructions before carrying out any repair or replacement.

9.2.10 Lamps

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

9.2.11 Lamp holders

Lamp holders 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.

NOTE The position of a reflector, if any, or the distance between the lamp and the window should be maintained.

9.2.12 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.

9.2.13 Enclosed break devices

In general, enclosed break devices are not considered to be suitable for repair. Replacement parts listed by the manufacturer shall be used.

9.2.14 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 a certificate of documentation. If breathing devices carry an Ex component certificate, only a suitably certified and dimensioned part can be used.

9.3 Reclamation

9.3.1 General

Reclamations using the techniques detailed in 4.4.2.4 may be used with type of protection "n" equipment subject to the following restrictions of this subclause.

9.3.2 Enclosures

If minor 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 impaired, in particular, that it remains capable of withstanding the impact test and maintains the degree of ingress protection.

9.3.3 Joints

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

Spigoted joints are normally provided to achieve close tolerance location. Thus, machining the male part will require addition of metal to and 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 is not recommended.

9.3.4 Shafts and housings

Shafts and bearing housings may be reclaimed, preferably by use of metal spraying or sleeving techniques. Welding may be appropriate having due regard to the limitations of this technique (see 4.4.2.2.9).

9.3.5 Sleeve bearings

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

9.3.6 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 may produce 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, 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 classification or cause subsequent damage to the stator windings.

9.4 Alterations and modifications

9.4.1 Enclosures

Enclosures may be modified provided that the specified temperature classification, degree of ingress protection and impact test requirements of the appropriate standard are met.

9.4.2 Cable and conduit entries

Care shall be taken to ensure that the specified type of protection and degree of ingress protection are maintained.

9.4.3 Terminations

Terminations shall be modified only if compliance with the equipment standard is maintained.

9.4.4 Windings

It is permissible to rewind the equipment for another voltage after reference to the manufacturer provided that, for example, the magnetic loading, current densities and losses are not increased, appropriate new clearances and creepage distances are observed and the new voltage is within the limits of the certificate. The rating plate shall be changed to show the new parameters.

Rewinding a rotating machine for a different speed is not permissible 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 of the certificate documentation.

9.4.5 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 procedure for the proposed modification.

10 Additional requirements for the repair and overhaul of equipment covered by IEC 60079-26

No repair or overhaul shall be carried out without availability of manufacturer information. In addition to meeting the requirements of IEC 60079-26, the applicable requirements of Clauses 5 to 8 of this standard still apply.

If the certificate documentation is not available, the equipment shall be subjected to re-testing in accordance with the appropriate equipment standard.

11 Additional requirements for the repair and overhaul of equipment with type of protection Group III 't' (formerly known as 'tD' or DIP)

11.1 Application

This clause contains additional requirements for the repair, overhaul, reclamation and modification of equipment with type of protection Group III 't' (formerly known as 'tD' or DIP). 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 Group III 't' equipment are those to which the equipment was originally manufactured.

NOTE The highest temperature which is attained by any part of the external surface of electrical equipment when tested under the defined dust-free or dust-layer conditions at the specified maximum ambient temperature (normally 40 °C) is marked on the equipment as a temperature value *T*. Practice A equipment with the zone prefixed "A" had been type-tested under dust-free conditions. Practice B equipment with the zone prefixed "B" had been type-tested under dust-layer conditions.

11.2 Repair and overhaul

11.2.1 Enclosures

Whilst it is preferable to obtain new parts from the manufacturer, in principle, damaged parts may be repaired or replaced with others, given that the degree of ingress protection and temperature classification as stipulated on the certification label is preserved.

NOTE The specific IP rating is integral to type of protection Group III 't' (formerly known as 'tD' or DIP). The performance of gaskets and seals is critical in maintaining that IP rating and has been subjected to special conditioning and testing and should only be replaced with gaskets and seals of identical materials and identical construction.

If visual inspection (for example, ingress of dust or water) indicates that the effectiveness of sealing elements of the enclosure suffered from damage or ageing, such elements shall be replaced, preferably by using original spare parts supplied by the equipment manufacturer or by gasket parts of equivalent quality. Particular attention shall be given to ensuring the characteristics such as method of retention, uninterrupted periphery, durometer hardness, percentage recovery etc of the equivalent material.

If there are any signs that the specified temperature has been exceeded, or, in case of doubt, actual measurements according to relevant equipment type(s) of protection standards shall be made. If necessary, active parts such as windings, cores, cooling systems shall be replaced using manufacturer's spare parts and/or advice.

A more stringent degree of ingress protection than that specified in the equipment standard may have been provided to cater for environmental conditions, in which case any repair shall not jeopardize such higher degree of ingress protection.

Particular attention is drawn to the impact test requirements of all parts of the enclosure as given in the equipment standard.

Adequate clearance shall be maintained between stationary and rotating parts in accordance with the equipment standard.

Attention is drawn to the effect of surface finish, paint, etc. on the temperature classification of enclosures. Only finishes specified by the manufacturer or equivalent should be applied.

Plastic material for enclosures, parts of enclosures or parts of the external ventilation system of rotating electrical machines are designed so that the danger of ignition due to propagating brush discharges is avoided. Spare parts, in addition to dimensional compliance, shall have the electrostatic discharge properties as specified in IEC 61241-0.

11.2.2 Cable and conduit entries

Entries shall preserve a minimum IP5X or IP6X degree of ingress protection as appropriate in accordance with the requirements of IEC 60529.

11.2.3 Terminations

Care shall be taken when refurbishing terminal compartments to maintain clearances and creepages and ingress protection in accordance with the equipment standard. Where non-metallic screws are used for fixing, only replacement screws of similar materials shall be used.

Where terminations are loose leads, the method of termination including insulation shall be in accordance with the certificate documentation.

11.2.4 Insulation

A superior class of insulation compared with that originally used does not permit an increase in equipment rating without reference to the manufacturer.

11.2.5 Internal connections

The cross-sectional area of any replacement connection shall not be less than that originally fitted.

11.2.6 Windings

11.2.6.1 General

Where rewinding is carried out, it is essential that the original winding data are determined and that the new winding conforms to the original. 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 classification of the equipment could then be adversely affected.

The original winding data should preferably be obtained from the manufacturer. If this is not reasonably practicable, 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.

It is not recommended to have a partial winding replacement, except on a larger equipment where this may be practicable, unless reference has been made to the manufacturer or certifying authority.

11.2.6.2 Repair of 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.

NOTE Identical characteristics includes 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 stirres can be repaired.

11.2.6.3 Testing after repair of windings

11.2.6.3.1 General

Windings, after complete or partial repair, shall be subjected, with the equipment assembled, to the following tests as far as is reasonably practicable:

- 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.

NOTE 1 If the winding resistance of the repaired winding differs from that of the original winding by more than 5 %, additional thermal tests may be required to confirm continued conformity to the stated insulation class and temperature class.

NOTE 2 In the event that the winding resistance is unbalanced, it should be verified by a competent person that the specific motor is suitable for the intended application.

- b) 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 d.c. is recommended.

Minimum acceptable insulation resistance values are a function of rated voltage, temperature, type of equipment and whether the rewind is partial or complete.

NOTE The insulation resistance should not be less than 20 M Ω at 20 °C, on a completely rewound equipment intended for use at up to 690 V.

- c) A high-voltage test in accordance with a relevant equipment standard shall be applied between windings and earth, between windings where possible, and between windings and auxiliaries attached to the windings.
- d) The transformer or similar equipment shall preferably be energized at rated supply voltage. The supply current, secondary voltage and current shall be measured. The measured value should 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.
- e) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and other special equipment may require additional tests. This shall be the subject of the repair and overhaul contract.

11.2.6.3.2 Rotating machines

Rotating machines, in addition to the above tests, shall be subjected to the following tests so 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/or vibration shall be investigated and corrected. Unbalance in no load current shall be less than 5 % of middle value.

NOTE When the rated speed is a range of values, the test should be 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 rated current and to ensure 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.

NOTE Where this test is not reasonably practical other means of verification should be used.

- c) High-voltage (for example, 1 000 V a.c./1 500 V d.c. and above) and non-cage machines may require alternative and/or 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, or the manufacturer's recommendation may be obtained for special circumstances.

11.2.6.4 Temperature sensors

11.2.6.4.1 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.

11.2.6.4.2 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 documentation prepared in accordance with IEC 60079-0, 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 certificate documentation, will necessitate a stator rewind.

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

11.2.7 Light-transmitting parts

Light-transmitting or other parts made of plastic shall not be cleaned with solvents. Household detergents may be used.

11.2.8 Batteries

Where batteries are used, reference shall be made to the manufacturer's instructions before carrying out any repair or replacement.

11.2.9 Lamps

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

11.2.10 Lamp holders

Lamp holders 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.

NOTE The position of a reflector, if any, or the distance between the lamp and the window should be maintained.

11.2.11 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.

11.2.12 Breathing devices

Breathing devices shall be replaced only by the manufacturer's listed parts. Alternatively a suitably certified and dimensioned part can be used.

NOTE Suitably certified includes protection type, gas group and ingress protection rating (if applicable).

11.3 Reclamation

Reclamations using the techniques detailed in 4.4.2.4 may be used with type of protection 't' equipment subject to the following restrictions of this subclause.

11.3.1 Enclosures

If minor 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 impaired, in particular, that it remains capable of withstanding the impact test and maintains the degree of ingress protection.

11.3.2 Joints

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

Spigoted joints are normally provided to achieve close tolerance location. Thus, machining the male part will require addition of metal to, and 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 is not recommended.

11.3.3 Shafts and housings

Shafts and bearing housings may be reclaimed, preferably by use of metal spraying or sleeving techniques. Welding (except MMA) may be appropriate having due regard to the limitations of this technique (see 4.4.2.2.9).

11.3.4 Sleeve bearings

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

11.3.5 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 may produce a change in 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, 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 classification or cause subsequent damage to the stator windings.

11.4 Alterations and modifications

11.4.1 Enclosures

Enclosures may be modified provided that the specified temperature classification, degree of ingress protection and impact test requirements of the appropriate standard are met.

11.4.2 Cable and conduit entries

Care shall be taken to ensure that the specified type of protection and degree of ingress protection are maintained.

11.4.3 Windings

It is permissible to rewind the equipment for another voltage after reference to the manufacturer provided that, for example, the magnetic loading, current densities and losses are not increased, appropriate new clearances and creepage distances are observed and the new voltage is within the limits of the certificate. The rating plate shall be changed to show the new parameters.

Rewinding a rotating machine for a different speed is not permissible 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 of the certificate documentation.

11.4.4 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 procedure for the proposed modification.

12 Additional requirements for the repair and overhaul of equipment with type of protection pressurization 'pD'

12.1 Application

This clause contains additional requirements for the repair, overhaul, reclamation, alteration and modification of equipment with protection type 'pD'. 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 a 'pD' equipment are those to which the equipment was originally manufactured.

Equipment used within enclosures that are certified as complying with the requirements of IEC 61241-4, 'pD' is generally unspecified with respect to that standard. Variations can therefore be made to include equipment without invalidating the 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 allowed with type of protection 'pD'. Internal cleaning of the enclosure is necessary before the electrical supply can be connected as per IEC 61241-4.

12.2 Repair and overhaul

The requirements for repair and overhaul are identical with those of protection 'p' as specified in Clause 7.

12.3 Reclamation

The requirements for reclamations are identical with those of protection 'p' as specified in Clause 7.

12.4 Modifications

The requirements for modifications are identical with those of protection 'p' as specified in Clause 7.

Annex A (normative)

Identification of repaired equipment by marking

A.1 Marking information

Repaired and overhauled equipment shall be marked in the main part in a visible place. This marking shall be legible and durable taking into account all relevant environmental conditions. The marking shall include

- the relevant symbol (see Clause A.2 below);
- the standard number "IEC 60079-19" or national equivalent;
- the name of the repairer or his registered trade mark and repair facility certification, if any;
- the repairer's reference number relating to the repair;
- the date of the overhaul/repair.

The marking may be on a plate permanently attached to the repaired equipment.

In the event of subsequent repairs, the earlier repair/overhaul plate shall be removed, and a record being made of all the markings on it.

If an earlier plate has been removed and it had the triangular symbol as shown in A.2.2, then the symbol on subsequent plates should also be triangular unless the repairer restores the whole equipment to full conformity with the certificate documentation.

Equipment which, after repair or overhaul, conforms neither to the certificate documentation nor to the type of protection standard(s) shall have all the marking details relating to the explosion-protection removed with the agreement of the user.

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

A.2 Symbols

A.2.1 In accordance with certificate documentation and/or manufacturer's specification

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



A.2.2 In accordance with the type of protection standards but not the certificate documentation

This mark is to be used when either

- a) the equipment is changed during repair or reclamation so that it still complies with the restrictions imposed by this standard and the explosion-protection standards to which it was manufactured, but repairer has insufficient evidence of full compliance with the certificate documentation; or
- b) the standards to which the equipment was manufactured are not known, but the requirements of this standard and the current edition of the relevant explosion-protection

standards have been applied but repairer has insufficient evidence of full compliance with the certificate documentation. An assessment, by a person competent in assessing explosion-protected equipment has been conducted to verify compliance with the relevant level of safety prior to release of the equipment by the repairer.

In these situations the certification labels should not be removed.



NOTE These marking are required for the benefit of subsequent repairers and the only difference between the markings is the method of compliance.

A.2.3 Other situations

Equipment which, after repair or reclamation, does not conform to A.2.1 or A.2.2 should have its original manufacturer's label removed or altered to give a clear indication that the equipment is not in compliance with the certificate documentation until a supplementary certificate is obtained to cover the repair or overhaul.

If the equipment is returned to its owner before such a supplementary certificate is obtained, the record described in 4.4.1.5 should indicate that the equipment is not in serviceable condition and is not to be used in an explosive atmosphere.

Annex B (normative)

Knowledge, skills and competencies of “responsible persons” and “operatives”

B.1 Scope

This annex specifies the knowledge, skills and competencies of persons referred to in this standard.

B.2 Knowledge and skills

B.2.1 Responsible persons

“Responsible persons” who are responsible for the processes involved in the overhaul, repair and reclamation of specific types of explosion protection of explosion protected equipment, shall possess, at least, the following:

- a) general understanding of relevant electrical and mechanical engineering at the craftsperson level or above;
- b) practical understanding of explosion-protection principles and techniques;
- c) understanding and ability to read and assess engineering drawings;
- d) familiarity with measurement functions, including practical metrology skills, to measure known quantities;
- e) working knowledge and understanding of relevant standards in the explosion protection field;
- f) basic knowledge of quality assurance, including the principles of traceability of measurement and instrument calibration.

Such persons shall confine their involvement to overhaul, repair and reclamation in the nominated areas of competence and not engage themselves in modifications of explosion-protected equipment without expert guidance.

B.2.2 Operatives

Operatives shall possess, to the extent necessary to perform their tasks, the following:

- a) understanding of the general principles of types of protection and marking;
- b) understanding of those aspects of equipment design which affect the protection concept;
- c) understanding of examination and testing as related to relevant parts of this standard;
- d) ability to identify replacement parts and components authorized by the manufacturer;
- e) familiarity with the particular techniques to be employed in repairs referred to in this standard.

B.3 Competencies

B.3.1 General

Competencies shall apply to each of the explosion-protection techniques for which the person is involved. For example: it is possible for a person to be competent in the field of repair and overhaul of Ex 'd' motors only and not be fully competent in repair of Ex 'd' switchgear or Ex

'e' motors. In such cases, the repair facility management shall define this in their documentation system.

B.3.2 Responsible persons

Responsible persons shall be able to demonstrate their competency and provide evidence of attaining the knowledge and skill requirements specified in B.2.1 relevant to the types of protection and/or types of equipment involved.

B.3.3 Operatives

Operatives shall be able to demonstrate their competency and provide evidence of attaining the knowledge and skill requirements specified in B.2.2 relevant to the types of protection and/or types of equipment involved.

They shall also be able to demonstrate their competency in the

- use and availability of documentation specified in 4.4.1.5.1;
- production of job reports to the user as specified in 4.4.1.5.2;
- use and production of repair facility records as specified in 4.4.1.5.3.

B.4 Assessment

The competency of responsible persons and operatives shall be verified and attributed, at intervals in accordance with 4.4.1.3 , on the basis of sufficient evidence that the person

- a) has the necessary skills required for the scope of work;
- b) can act competently across the specified range of activities; and
- c) has the relevant knowledge and understanding underpinning competency.

Annex C
(normative)

Requirements for measurements in flameproof equipment during overhaul, repair and reclamation (including guidance on tolerances)

C.1 General

Evidence has come to light that there have been instances where equipment passed the Ex d flame transmission test with the gaps set to the maximum specified by the manufacturer but failed the test when set to the larger gaps permitted by the Ex d standard. As such equipment has not necessarily been marked with an 'X' on the certificate, there is no way of knowing whether the equipment can be safely repaired to the values allowed by the standard or whether it needs to be repaired to the smaller gaps specified by the manufacturer. Therefore, in the absence of drawings showing the manufacturer's gaps, repairers shall use the guidance given in Table C.1.

NOTE Figure C.1 is equivalent to Table C.1.

Table C.1 – Determination of maximum gap of reclaimed parts

Ref.	Condition		Maximum gap
1.	Dimensions are available in certificate documentation.		Use the values specified in that documentation.
2.	Original national standard ^a required that the test gap be set at the value in that standard.		Use the values specified in the standard used.
3.a)	Original standard or certification body policy required that suffix 'X' is marked where the test gap is less than the values in the standard used.	Certificate has suffix 'X'.	Use values specified in the 'conditions of use' with the certificate.
3.b)		Certificate has no suffix.	Use the values specified in the standard used.
4.	Relevant dimensions accurately determined: <ul style="list-style-type: none"> – by measurement of the equipment in 'as new' condition; or – from identical undamaged equipment; or – from undamaged parts of the equipment; or – from partially damaged parts of the equipment. 		Use the values determined by measurement.
5.	Other method by which the original dimensions are accurately determined.		Use the values so determined.
6.a)	Other conditions ^{b,c,d}	Cylindrical joints for shaft glands of rotating electrical machines with rolling-element bearings.	Use 80 % of the value specified in the current edition of IEC 60079-1.
6.b)		Other joints	Use the smallest credible manufacturing gap.
6.c)			40 % of the appropriate value in the current edition of IEC 60079-1 is greater than the credible manufacturing gap.

- a The 'original standard' is the edition of the standard to which the equipment was certified.
- b The reduced gap (80 % or 40 %) is only applicable to damaged parts subject to reclamation.
- c Where the reduced gap contravenes the requirements for the minimum radial gap ' k ' and/or the maximal radial gap ' m ', the required gap shall be the smallest that meets the ' k ' and ' m ' requirements.
- d Damaged gaps on equipment in environments requiring Group IIC equipment cannot be reclaimed.

<http://www.china-gauges.com/>

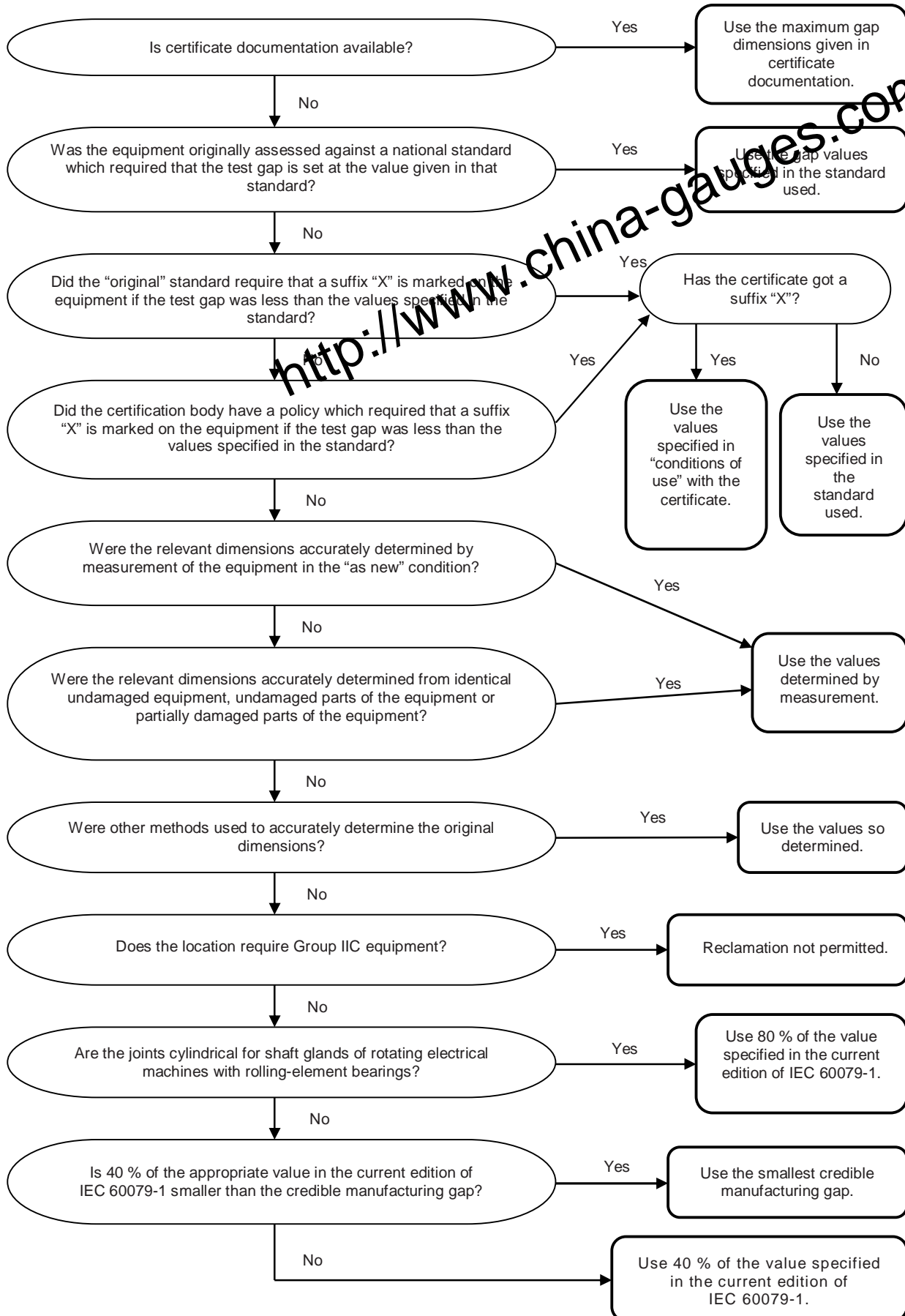


Figure C.1 – Determination of maximum gap of reclaimed parts

Annex D
(informative)

When rewinding electric motors, it is important to maintain the original efficiency of the machine to prevent an increase in losses, which may affect the Ex temperature classification.

Information on the effect of rewinding on the efficiency of motors, together with guidance on best practice during repair and rewinding, is available from the EASA/AEMT Rewind Study titled:-

'The Effect of Repair/Rewind on Motor Efficiency' published by EASA & AEMT.

This is available as a free download from the IECEx web site:

(<http://www.iecex.com/operational.htm>, Operating Document OD 301)

or from the EASA web site:

(<http://www.easa.com/energy>)

Guidance on the data a service facility will need to obtain from the original stator winding, to make a successful copy rewind, is available in IECEx ExTAG Decision Sheet 2013/006 (available as a free download from the IECEx web site:- http://www.iecex.com/extag_decisions.htm)

Bibliography

IEC 60050-426, *International Electrotechnical Vocabulary – Part 426: Equipment for explosive atmospheres*

IEC 60034 (all parts), *Rotating electrical machines*

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

IEC 60364 (all parts), *Low-voltage electrical installations*

ISO 9000, *Quality management and systems – Fundamentals and vocabulary*

ISO 9001, *Quality management systems – Requirements*

ISO 17000, *Conformity assessment – Vocabulary and general principles*

<http://www.china-gauges.com/>

<http://www.china-gauges.com/>

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards-based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

All the data, software and documentation set out in all British Standards and other BSI publications are the property of and copyrighted by BSI, or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI. Details and advice can be obtained from the Copyright & Licensing Department.

Useful Contacts:

Customer Services

Tel: +44 845 086 9001

Email (orders): orders@bsigroup.com

Email (enquiries): cservices@bsigroup.com

Subscriptions

Tel: +44 845 086 9001

Email: subscriptions@bsigroup.com

Knowledge Centre

Tel: +44 20 8996 7004

Email: knowledgecentre@bsigroup.com

Copyright & Licensing

Tel: +44 20 8996 7070

Email: copyright@bsigroup.com