Repair of Ex Equipment used within Hydrogen Systems

20th Sept 2023

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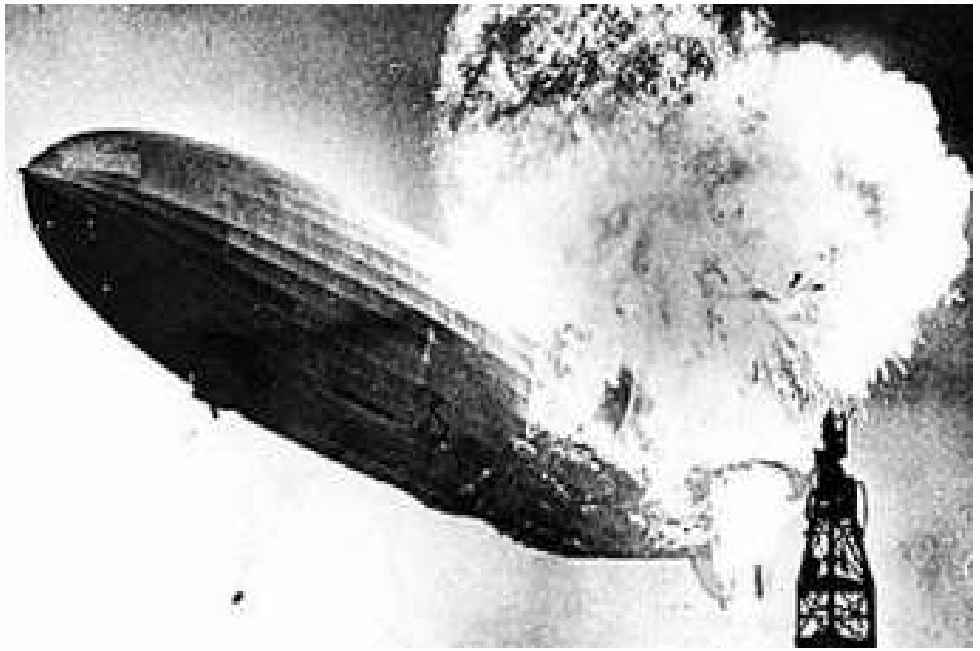
Hydrogen Ex Equipment Repair

IECEx™

There have been multiple hydrogen related incidents since the beginning of the 20th century

Standards have help reduce the occurrence of these incidents



Hindenburg Airship1937

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Ex Equipment used in the presence of hydrogen has to be manufactured, tested and certified to International Standards to ensure that the equipment is safe for use.

When Ex Equipment within a hydrogen system fails replacing the failed Ex Equipment with identical certified new equipment ensures the continued safety of the system.

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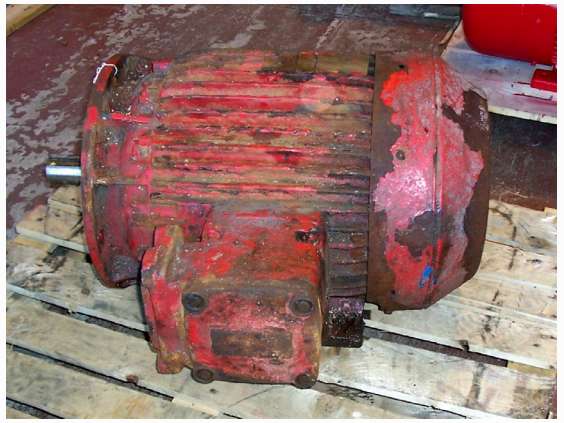
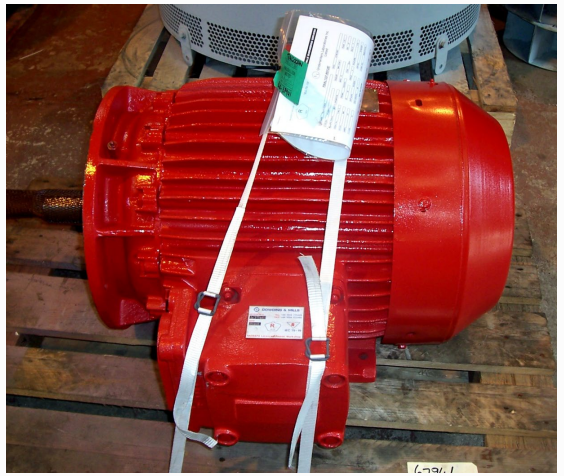
Ex Equipment for use in hydrogen systems will be manufactured to meet the Group IIC requirements in the relevant IEC Type of Protection standards or ISO standards for Ex Equipment

When Ex Equipment has to be overhauled or repaired the essential safety features incorporated to ensure that the Ex Equipment is safe to use within a hydrogen system must be maintained.



Before



After

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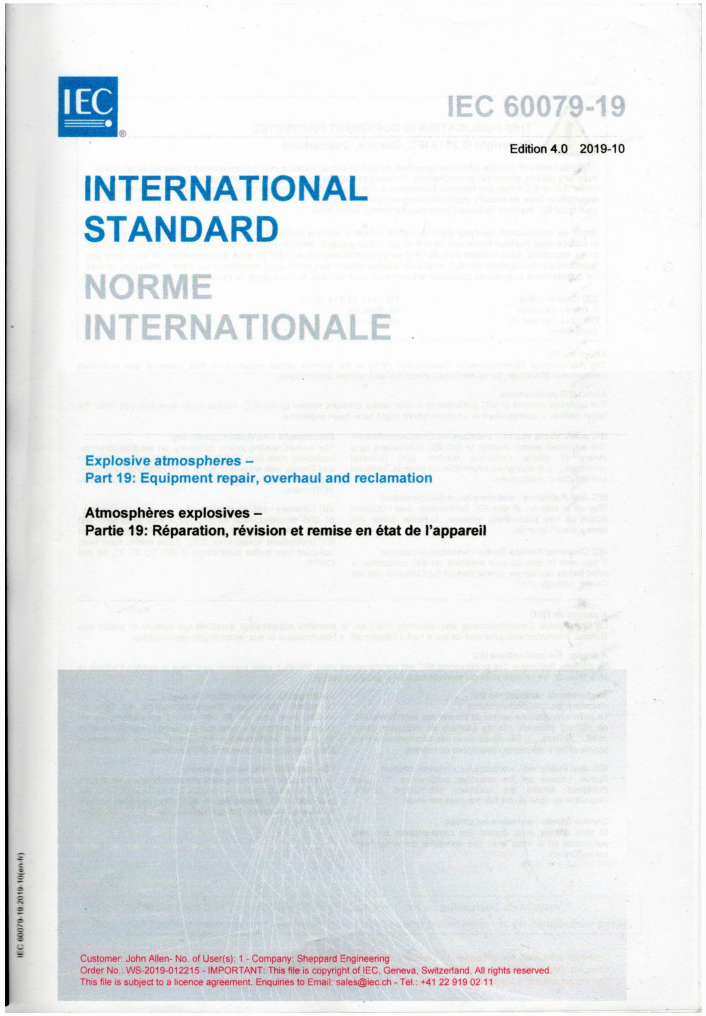
When replacement Ex Equipment is not available or not available within the timescale required to return the hydrogen system into service, Ex Equipment can be repaired to IEC 60079-19.

This standard's guidance and requirements has been proven to be effective over the last 40 years


IEC

IEC 60079-19

Edition 4.0 2019-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

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Hydrogen Ex Equipment Repair

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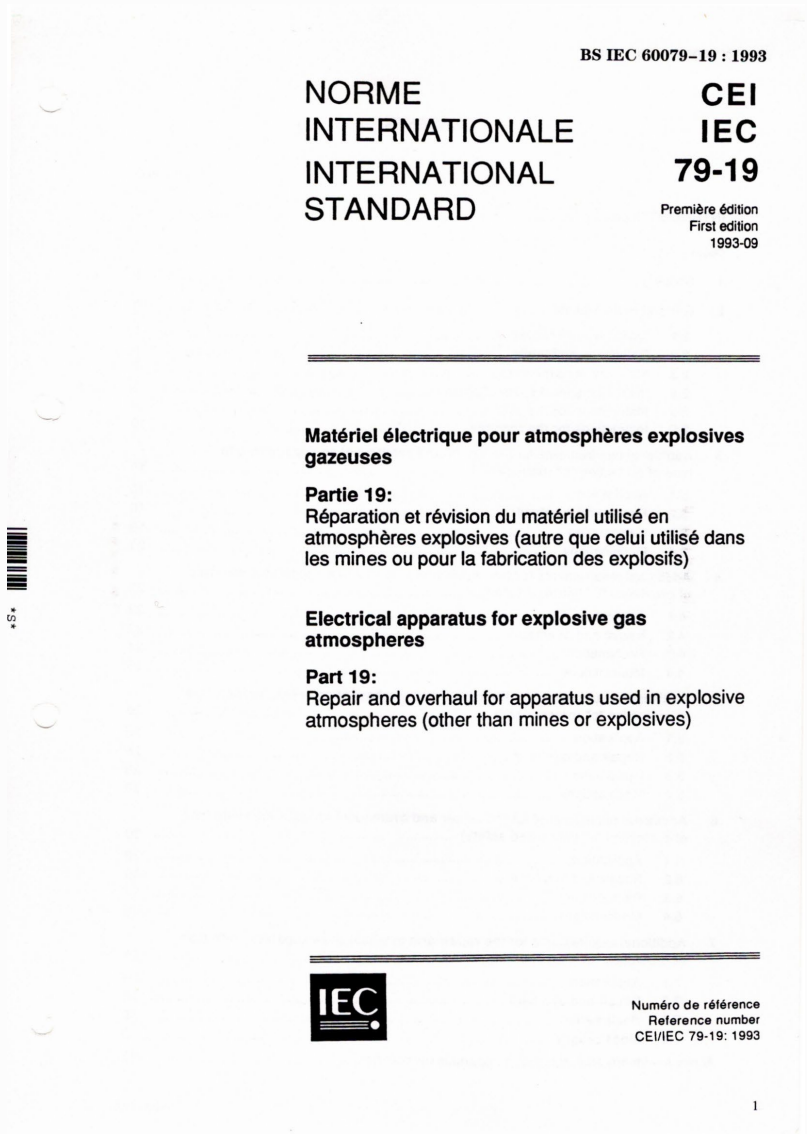
The first IEC 79-19 was published1993, this excluded its use for electrical apparatus in mines

The current 4th edition of IEC 60079-19 was published in 2019.

The next 5th edition is currently being prepared.



BS IEC 60079-19 : 1993

NORME INTERNATIONALE / INTERNATIONAL STANDARD

CEI IEC 79-19

Première édition
First edition
1993-09

Matériel électrique pour atmosphères explosives gazeuses

Partie 19:
Réparation et révision du matériel utilisé en atmosphères explosives (autre que celui utilisé dans les mines ou pour la fabrication des explosifs)

Electrical apparatus for explosive gas atmospheres

Part 19:
Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives)

IEC

Numéro de référence
Reference number
CEI/IEC 79-19: 1993

1

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Hydrogen Ex Equipment Repair

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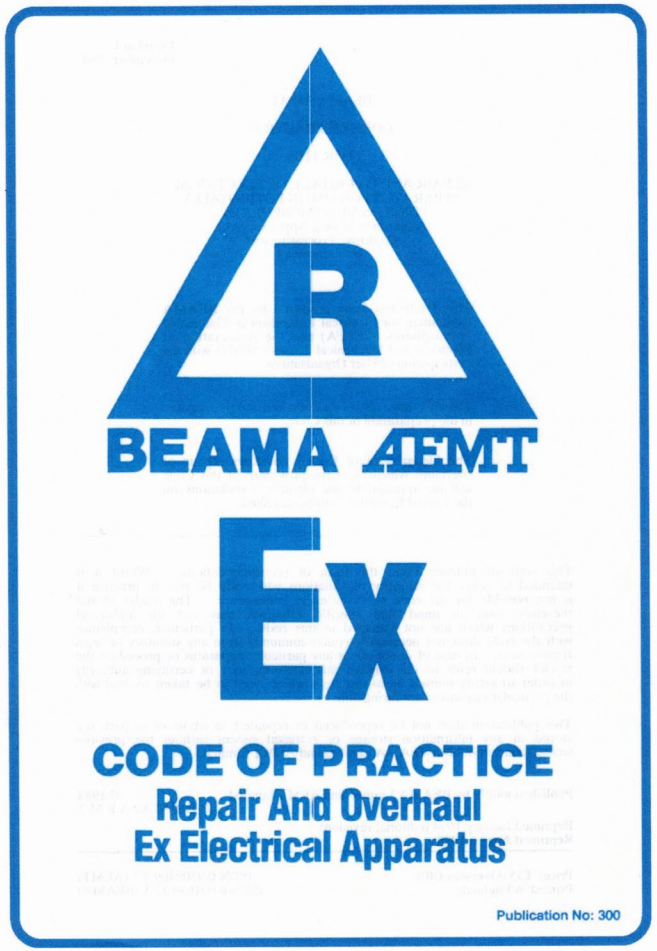
The source document for IEC 79-19 was the UK Code of Practice for Repair and Overhaul of Ex Electrical Apparatus published by BEAMA & AEMT in 1984. This document excluded repair of electrical apparatus in mines, this was controlled by the British Coal workshops



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Hydrogen Ex Equipment Repair

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The preferred method for overhaul and repair to IEC 60079-19 is with the original equipment manufacturer (OEM) documentation.

In this case the overhauled or repaired Ex Equipment is marked with an R within a square

Ex Components are not repaired they are replaced

Hydrogen Ex Equipment Repair

However when that OEM information is not available the Ex Equipment can be overhauled and repaired to IEC 60079-19 and the Type of Protection standards to which it was originally certified.

In this case the overhauled or repaired Ex Equipment is marked with an R with in an inverted triangle

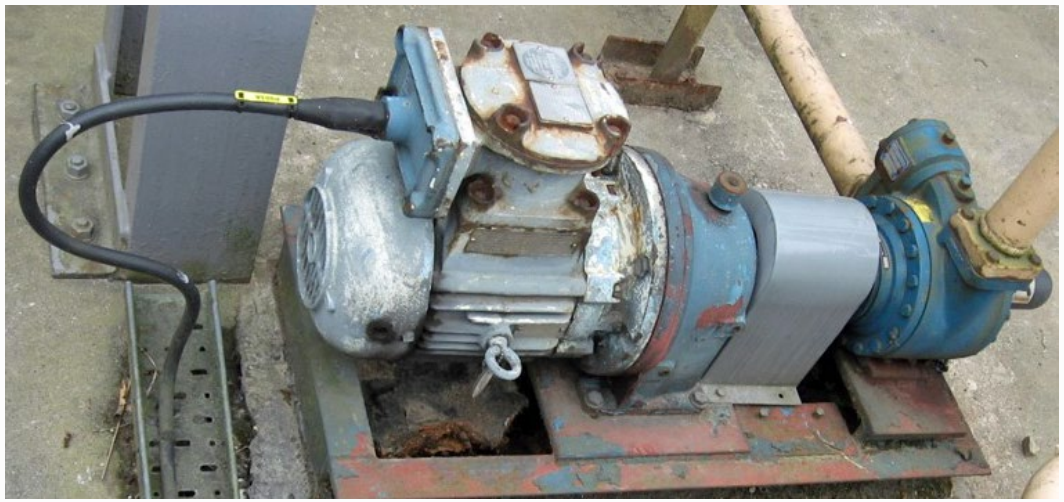
Note: The BEAMA/AEMT Code of Practice was the source of this marking system

Hydrogen Ex Equipment Repair

Many Types of Protection concepts will be used on Ex Equipment in a hydrogen system including Ex “d”, Ex “i”, Ex “p” and many others. These are examples of Ex “p” Equipment

Hydrogen Ex Equipment Repair

An example of Ex “d” Ex Equipment used within a hydrogen system is an electric machine designed to IEC 60079-1 (Flameproof) & IEC 60079-0 and other relevant standards, such as IEC 60034-2, this machine may be driving a pump, gearbox or compressor



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Hydrogen Ex Equipment Repair

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During overhaul or repair of Ex “d” Equipment verifying the integrity of the enclosure and condition of flamepaths, required to construct or connect with the Ex Equipment, are critical in ensuring the Ex Equipment is safe for continued use.

Each of these critical area have different potential failure modes

Hydrogen Ex Equipment Repair

Typical enclosure failures can be: -

- Enclosure component defect or fracture
- Enclosure threaded hole defect
- Threaded fastener missing or not as specified
- Threaded fastener clearance hole damage

- Threaded fasteners are replaced when required

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Hydrogen Ex Equipment Repair

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Corrosion can cause flamepath defects

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Hydrogen Ex Equipment Repair

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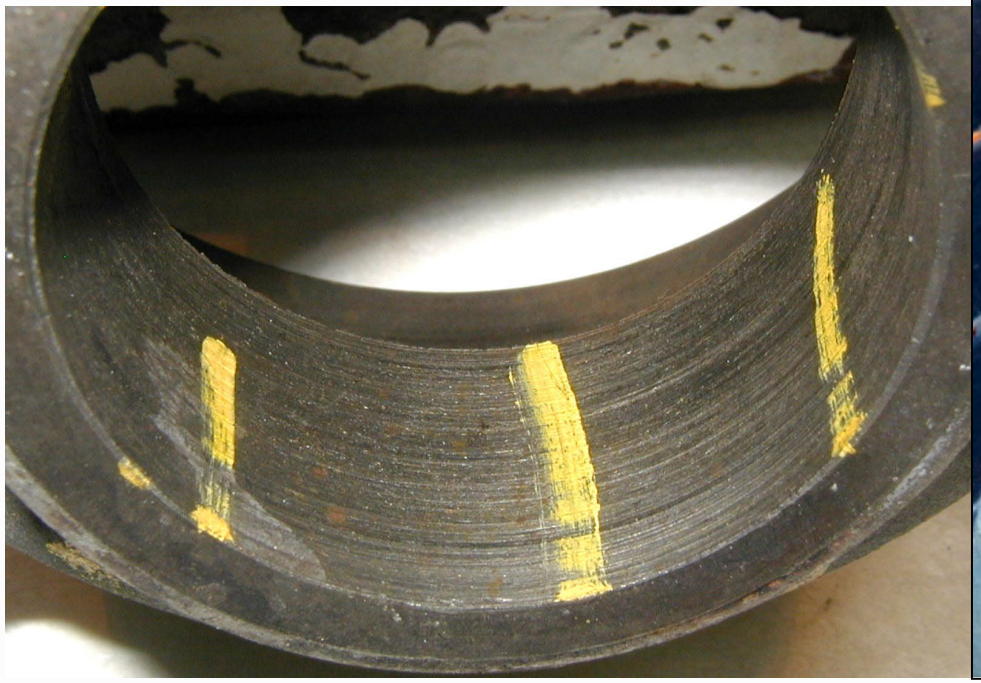
Bearing failure wear can cause flamepath defects



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Hydrogen Ex Equipment Repair

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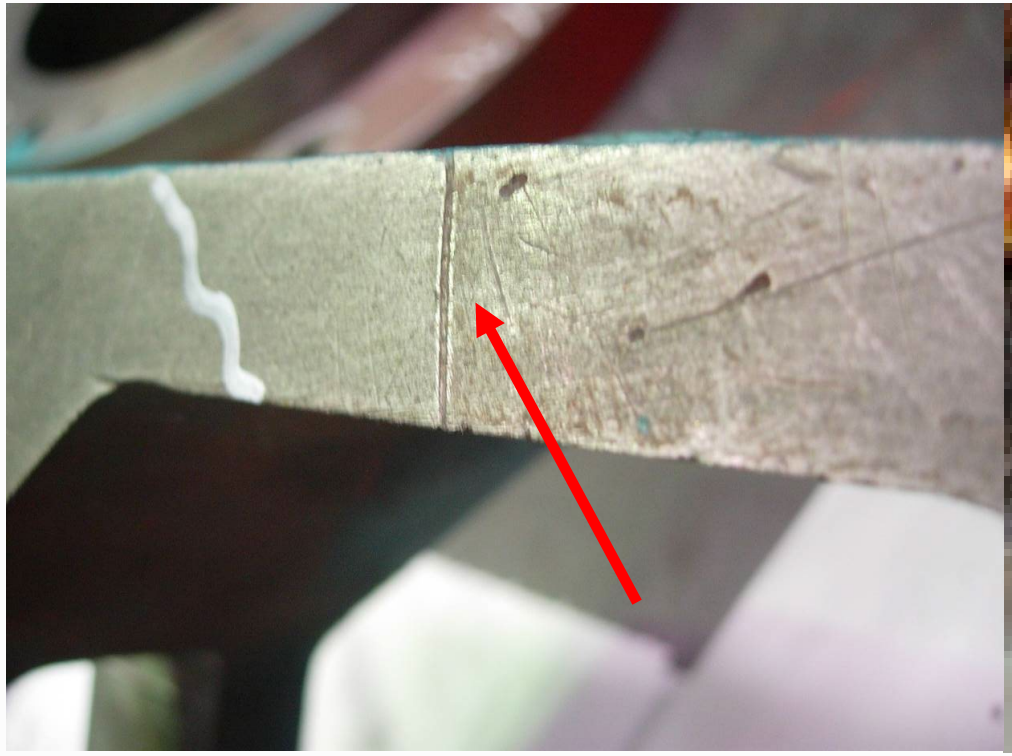
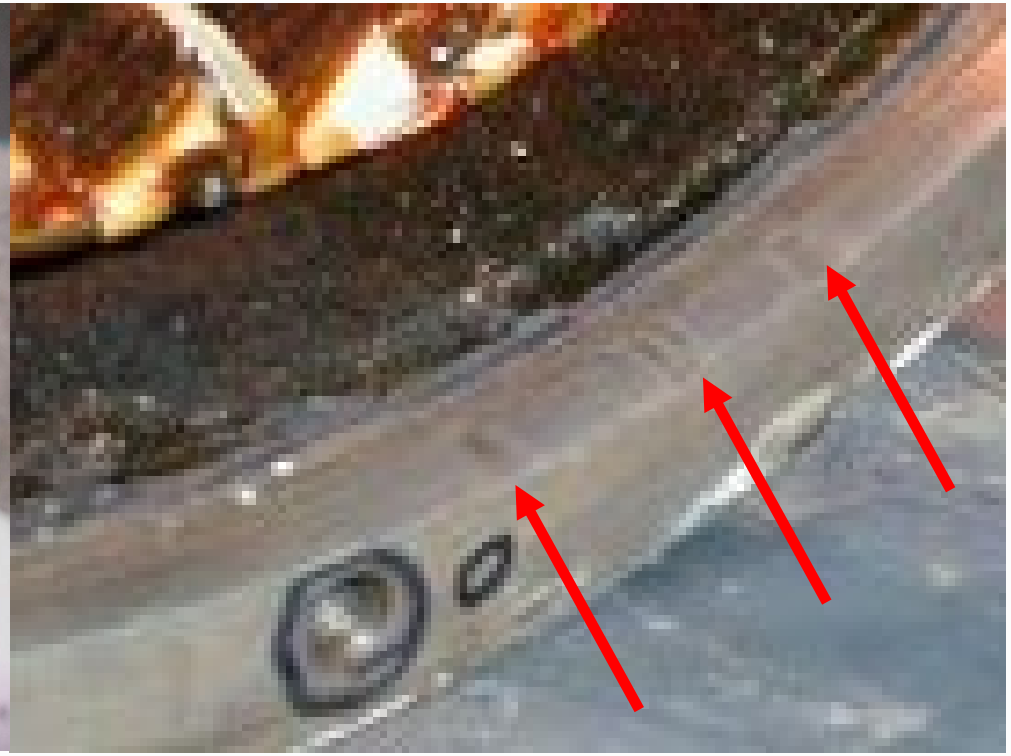
Operator Error can cause flamepath defects





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Typical cable entry failures can be: -

- Thread damage from corrosion or fitting error
- Insufficient wall thickness and threads to enable 5 full thread fit

Hydrogen Ex Equipment Repair

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Typical accessory failures can be: -

- Temperature sensor failure
- Vibration sensor failure
- Cooling fan cowl or impellor damage

Hydrogen Ex Equipment Repair

Good management controls and competent persons are key requirements within IEC 60079-19, service facilities had to have an effective QMS system to achieve these objectives

When the BEAMA/AEMT Code of Practice was introduced an unspecified additional control factor was the service facility assessment and monitoring by user inspectors, the most prestigious being the British Coal workshop inspectors

Hydrogen Ex Equipment Repair

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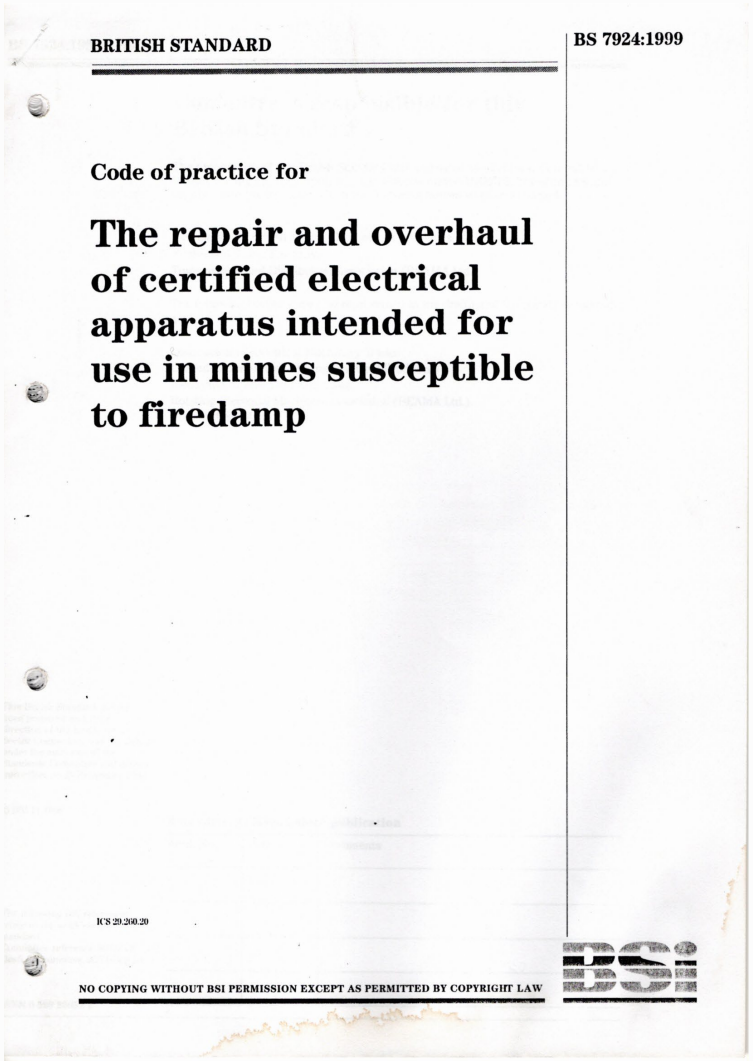
With changes in industry and demise of British Coal these expert user service facility inspectors and assessors were not available.
For electrical apparatus in UK mines this led to the development of BS 7924 which redrafted the BEAMA/AEMT Code of Practice closer to a standard which enabled independent 3rd party assessment of service facilities



BRITISH STANDARD

BS 7924:1999

Code of practice for

The repair and overhaul of certified electrical apparatus intended for use in mines susceptible to firedamp

ICS 29.260.20

BSI

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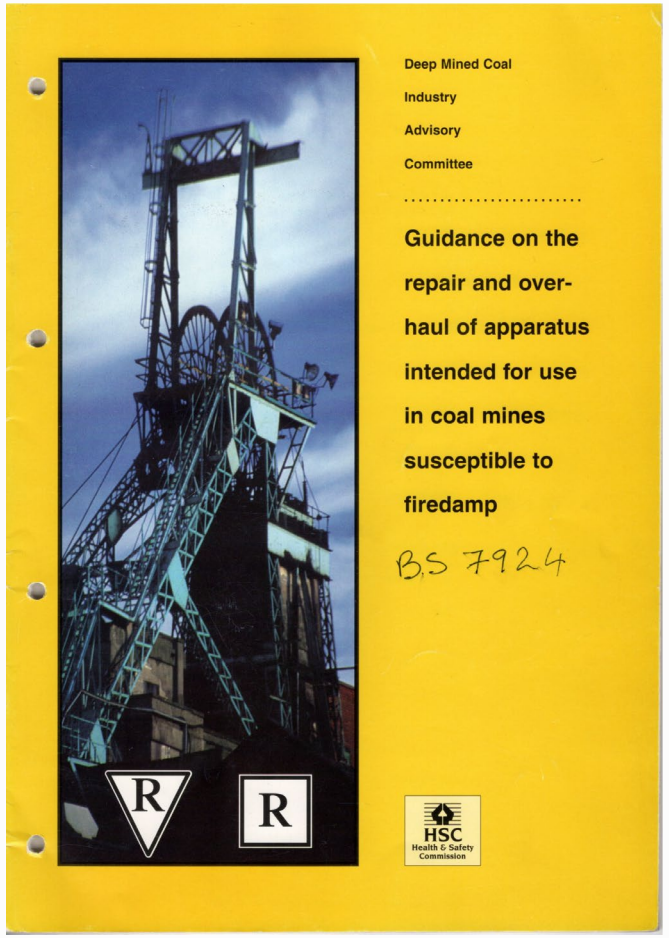
When BS 7924 was published HSE published a Guidance document to support the implementation of BS 7924

BS 7924 became the source material for the 1st revision of IEC 60079-19 which was published as the 2nd edition in 2006.

The restriction prohibiting use for mining equipment was removed



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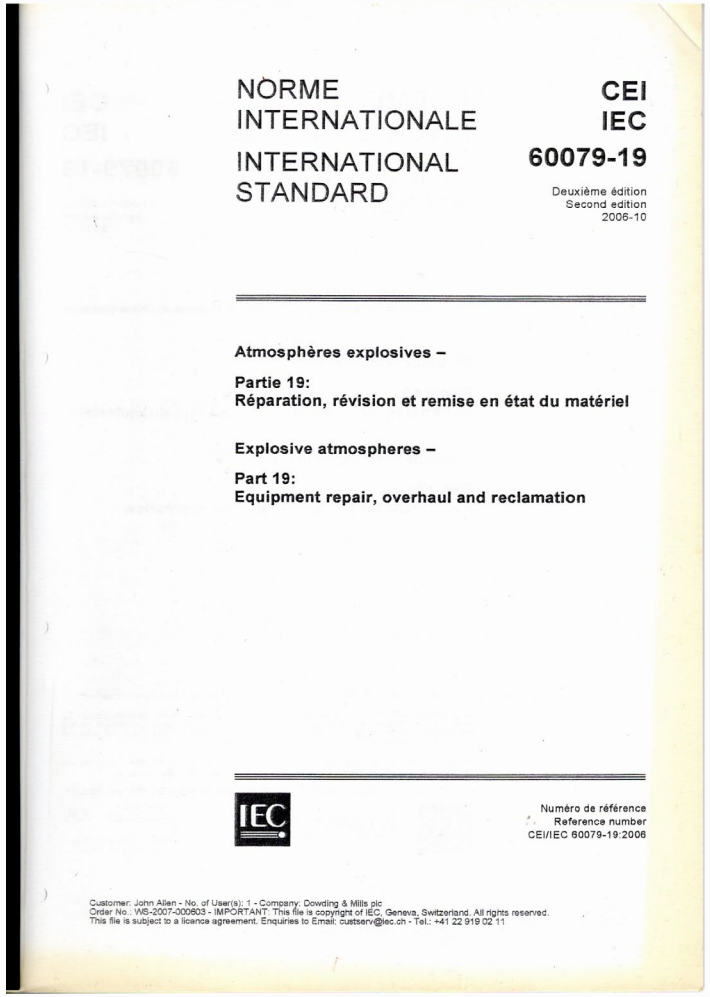
The 2nd edition of IEC 60079-19 introduced specific requirements for competence of persons working on Ex Equipment overhaul and repair.

A new requirement was that each service facility had to have a “responsible person” who had the responsibility to ensure that the repaired Ex Equipment fully met the status of the Ex Equipment after repair as agreed with the user



NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI IEC 60079-19

Deuxième édition
Second edition
2006-10

Atmosphères explosives –

Partie 19:
Réparation, révision et remise en état du matériel

Explosive atmospheres –

Part 19:
Equipment repair, overhaul and reclamation

IEC

Numéro de référence
Reference number
CEI/IEC 60079-19:2006

Hydrogen Ex Equipment Repair

The first edition of IEC 60079-19 was specifically for electrical apparatus, however following the introduction of the EU ATEX Directive in 1994 the 2nd and subsequent editions removed the electrical apparatus restriction becoming Ex Equipment and non-electrical Ex Equipment could be overhauled and repaired to IEC 60079-19 following the requirements in Clause 4

Hydrogen Ex Equipment Repair

Service facilities had been overhauling and repairing non-electrical equipment used in hazardous area long before ATEX and certification required. CE This included gearboxes, pumps, fans etc. many driven by electric machines

Hydrogen Ex Equipment Repair

The first two editions of IEC 60079-19 required quality control and quality assurance procedures to be in accordance with the ISO 9000 series of standards.

Changes in ISO 9001 necessitated the inclusion of additional QMS requirements into IEC 60079-19

Service facilities operate very differently to a manufacturer and current QMS standards specifically drafted for manufacturers do not ensure sufficient confidence of compliance for service facilities working to IEC 60079-19

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An OEM's ISO 9001 QMS system may use sampling techniques for testing product and risk assessment for where additional controls are required. This is appropriate where multiple products are manufactured to a common design with tight documentation and inspection controls

Hydrogen Ex Equipment Repair

However in a service facility every overhaul or repair will most likely be different, with different failure modes requiring individual quality plans and work programmes for each job.

Sampling and risk assessments are not appropriate, as a result some of the specific QMS requirement from older versions of ISO 9001 were included into editions 3 & 4 of IEC60079-19

Hydrogen Ex Equipment Repair

Each revision of IEC 60079-19 has included, where necessary, technical changes to the Type of Protection clauses mirroring changes in the Type of Protection standards, as well as the clarification of Clause 4 General requirements described above

Like all IEC standards the first 3 clauses are Scope, Normative References and Terms and Definitions. The 4th clause contains general requirements which applies to all Types of Protections, clauses 5 to 15 have specific requirement for each Type of Protection

Hydrogen Ex Equipment Repair

IEC 60079-19 Clause 4. general requirements, is similar to how IEC 60079-0 applies to all the other Types of Protection concepts within the IEC 60079 series of standards for Ex Equipment manufacture

IEC 60079-19 has 3 normative annexes, (marking, competence & flamepath gap verification) and 2 informative annexes (rewinding best practice & control equipment requirements)

Hydrogen Ex Equipment Repair

Requirements within standards can and have been understood differently by different users of those standards. This applies to IEC 60079-19 and much as any of the manufacturing standards in the IEC 60079 series of standards

The IECEx system was set up in 1999 to develop a common understanding of requirements and methodologies in Ex Equipment certification and manufacturing and issued it's 1st certificates in 2003

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Hydrogen Ex Equipment Repair

The IECEx Equipment Scheme recognised that to maintain the design features, which made an IECEx Ex Equipment safe to operate within a hazardous area during its operating life, the IECEx System needed to engage with service facilities to ensure a unified understanding and application of the requirements in IEC 60079-19 and the IEC Type of Protection standards used to overhaul & repair the Ex Equipment

Hydrogen Ex Equipment Repair

In 2003 IECEx started the process to set up a new IECEx Scheme for service facilities similar to that which had been setup for Ex Equipment. Initially this was a committee within the IECEx 02 Equipment Scheme for Overhaul and Repair of Ex Equipment to IEC 60079-19 but later this became the IECEx 03 Service Facility Scheme (ExSFC) with additional services to IEC 60079-14 and IEC 60079-17

This is what started my involvement with the IECEx System 21 years ago

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Hydrogen Ex Equipment Repair

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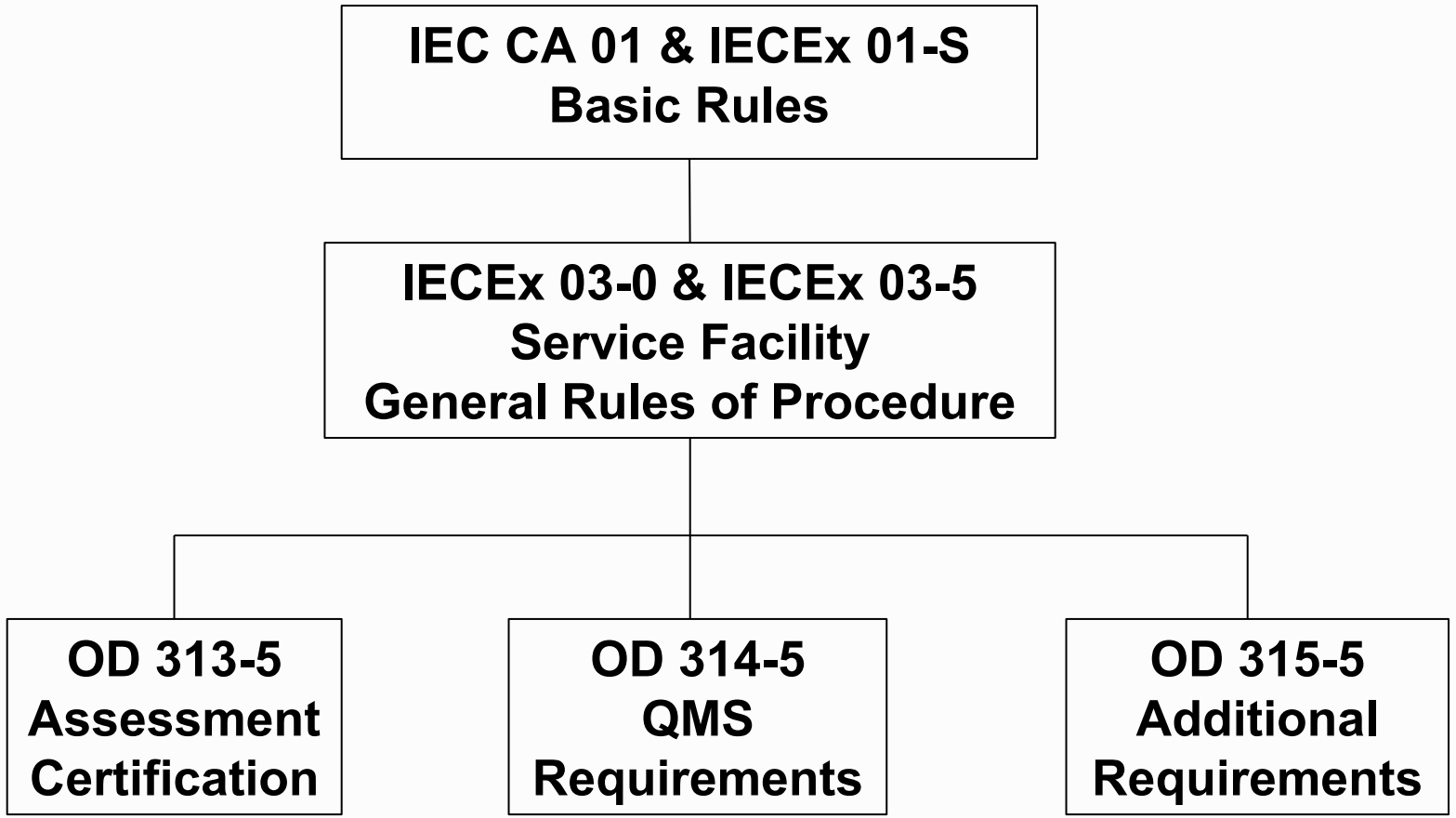
IECEx Certified Service Facility Rules & Requirements



Hydrogen Ex Equipment Repair

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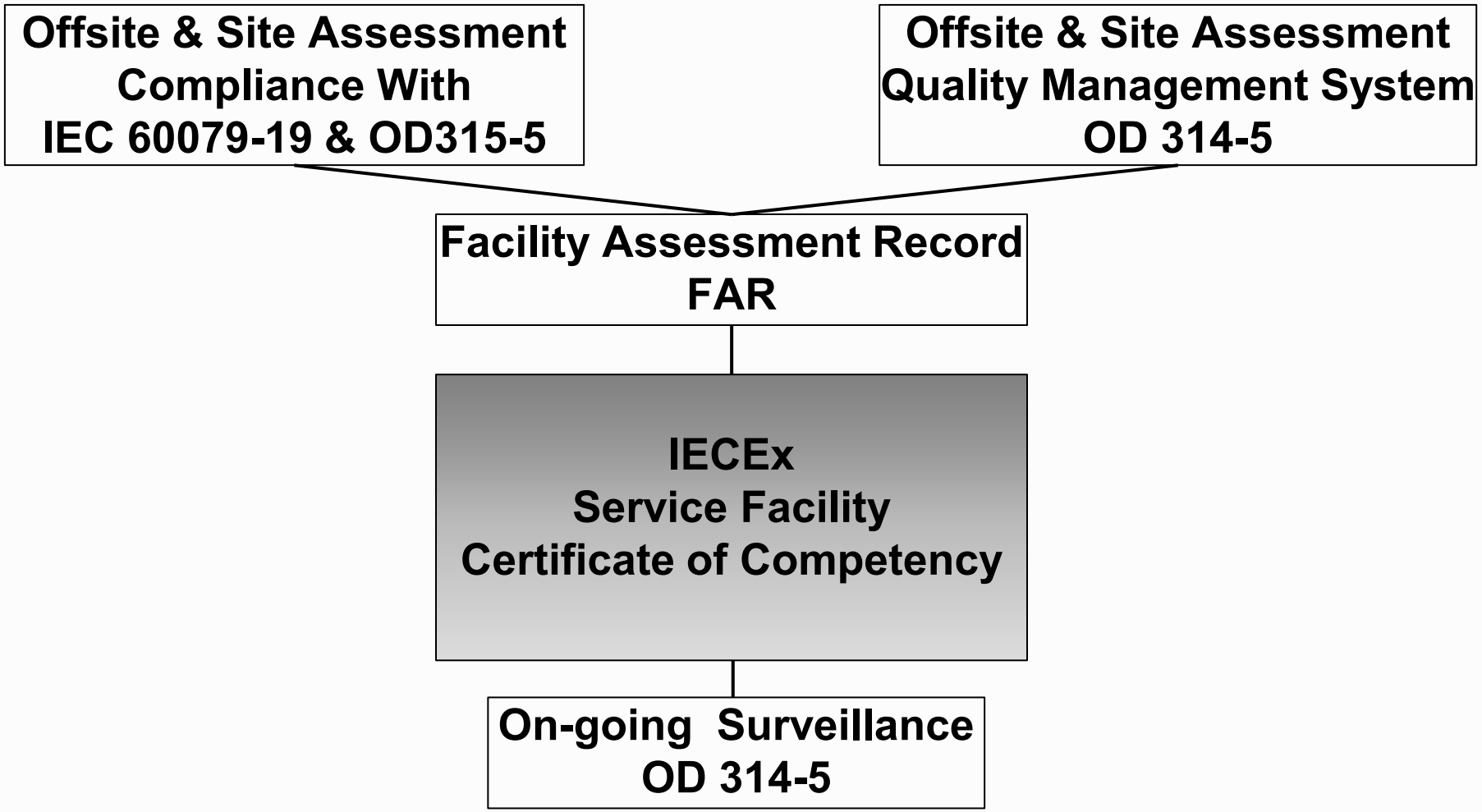
Service Facility Assessment Process



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Hydrogen Ex Equipment Repair

The IECEx Service Facility **Certificate of Conformity** enables the Ex Equipment User to have confidence that robust systems are in place and monitored, within the Service Facility, to ensure that their Ex equipment will be overhauled and repaired in conformance with IEC 60079-19, to the certification status as agreed with the Service Facility and that the equipment will be safe to return to service

The validity and status of any IECEx Service Facility Certificate of Conformity can be checked on-line at www.iecex.com

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Hydrogen Ex Equipment Repair

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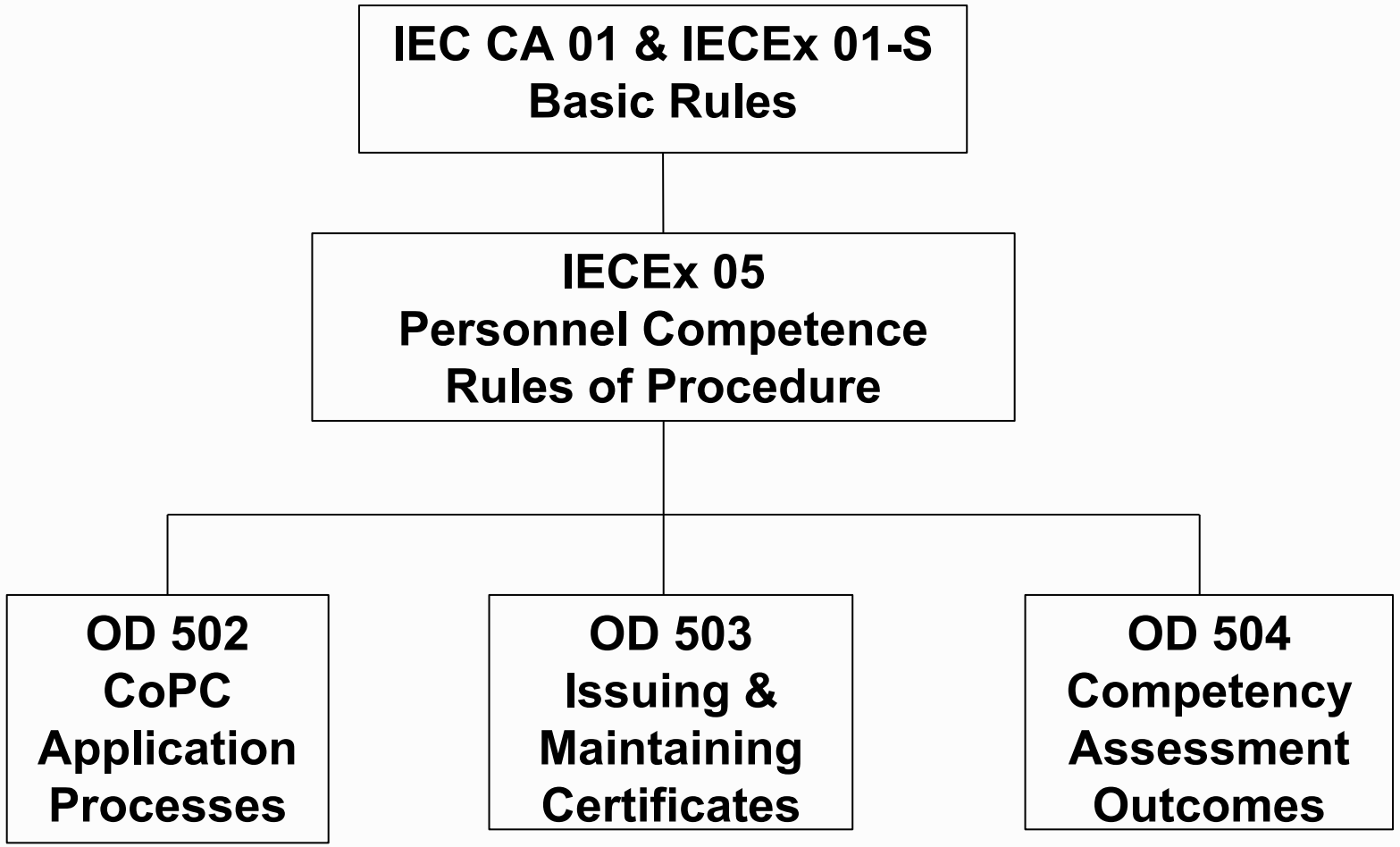
Early on when setting up the Overhaul and Repair Service Facility Scheme, it was recognised that the competence of persons overhauling and repairing Ex Equipment was critical to service facility performance and to meet this need the IECEx System started the process which lead to the development of the IECEx Competence of Persons Scheme (ExPCC)

Hydrogen Ex Equipment Repair

The IECEx Ex CoPC Scheme Rules & Requirements



Hydrogen Ex Equipment Repair

Competence of Persons Assessment Process

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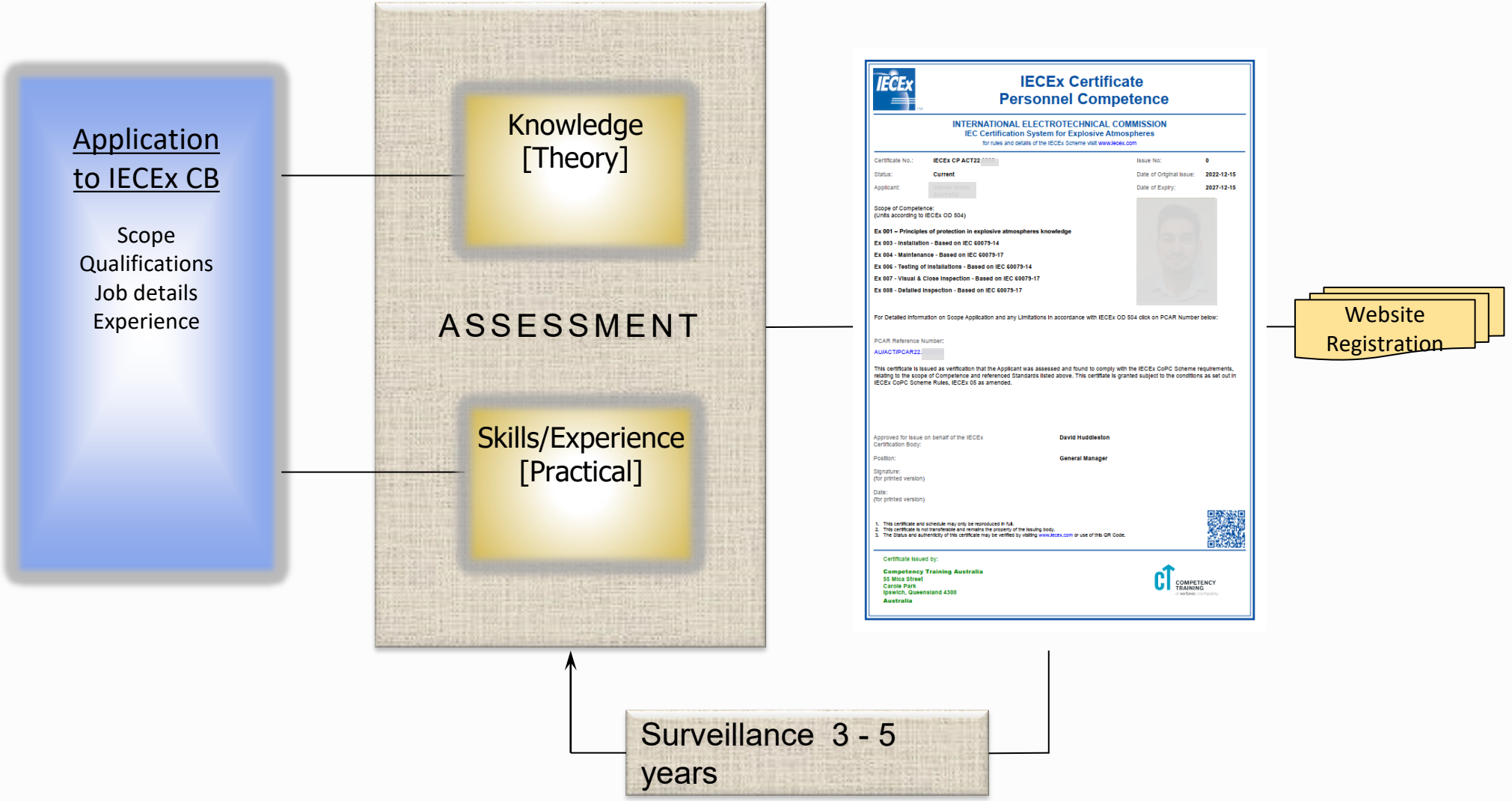

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The IECEx **Competence of Person Certificate** enables the Hazardous Area Employer to have confidence that robust systems are in place and monitored to verify the competence of the person on the certificate, for the units of competence and limitations as detailed on that certificate,

The validity and status of any IECEx Competence of Person Certificate can be checked on-line at www.iecex.com

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Hydrogen Ex Equipment Repair

The ExPCC Scheme has 9 Units of Competence, 1 Unit of Knowledge, required for the units of competence, and 2 Units of Basic Knowledge.

Unit Ex 0001	Principles of protection in explosive atmospheres **knowledge**
Unit Ex 0002	Perform classification of hazardous areas
Unit Ex 0003	Install explosion-protected equipment and wiring systems

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Unit Ex 0004	Maintain equipment in explosive atmospheres
Unit Ex 0005	Overhaul and repair of explosion-protected equipment
Unit Ex 0006	Test electrical installations in or associated with explosive atmospheres
Unit Ex 0007	Perform visual and close inspections of electrical installations in or associated with explosive atmospheres

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Unit Ex 0008	Perform detailed inspections of electrical installations in or associated with explosive atmospheres
Unit Ex 0009	Design electrical installations in or associated with explosive atmospheres
Unit Ex 0010	Perform audit inspections of electrical installations in or associated with explosive atmospheres

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The 2 Units of Basic Knowledge are.

Unit Ex 000	Basic knowledge and awareness to enter a site that includes a classified hazardous area
Unit Ex 011	Basic knowledge of the safety of hydrogen systems

Hydrogen Ex Equipment Repair

I hope that this brief introduction helps you understand the benefit of using a proven repair standard IEC 60079-19 for Ex Equipment used within a hydrogen system

The 5th edition of IEC 60079-19 will include a new Type of Protection clause for non-electrical Ex Equipment certified to ISO 80079-36 and ISO 80079-37. Clause 4 is being restructured to minimise the risk of misinterpretation of these requirements and hopefully the document will be published in 2025

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Hydrogen Ex Equipment Repair

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Overhaul and repair of Ex Equipment to IEC 60079-19 has been safe for 40 years where there are competent persons and good management controls

A 3rd party independent assessment of service facilities capability to work to IEC 60079-19 provides the user confidence that his overhauled and repaired Ex Equipment is safe to return to service.

The IECEx Service Facility Scheme Certificate of Conformity is evidence for that confidence

Hydrogen Ex Equipment Repair

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Any Questions

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Thank you!

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