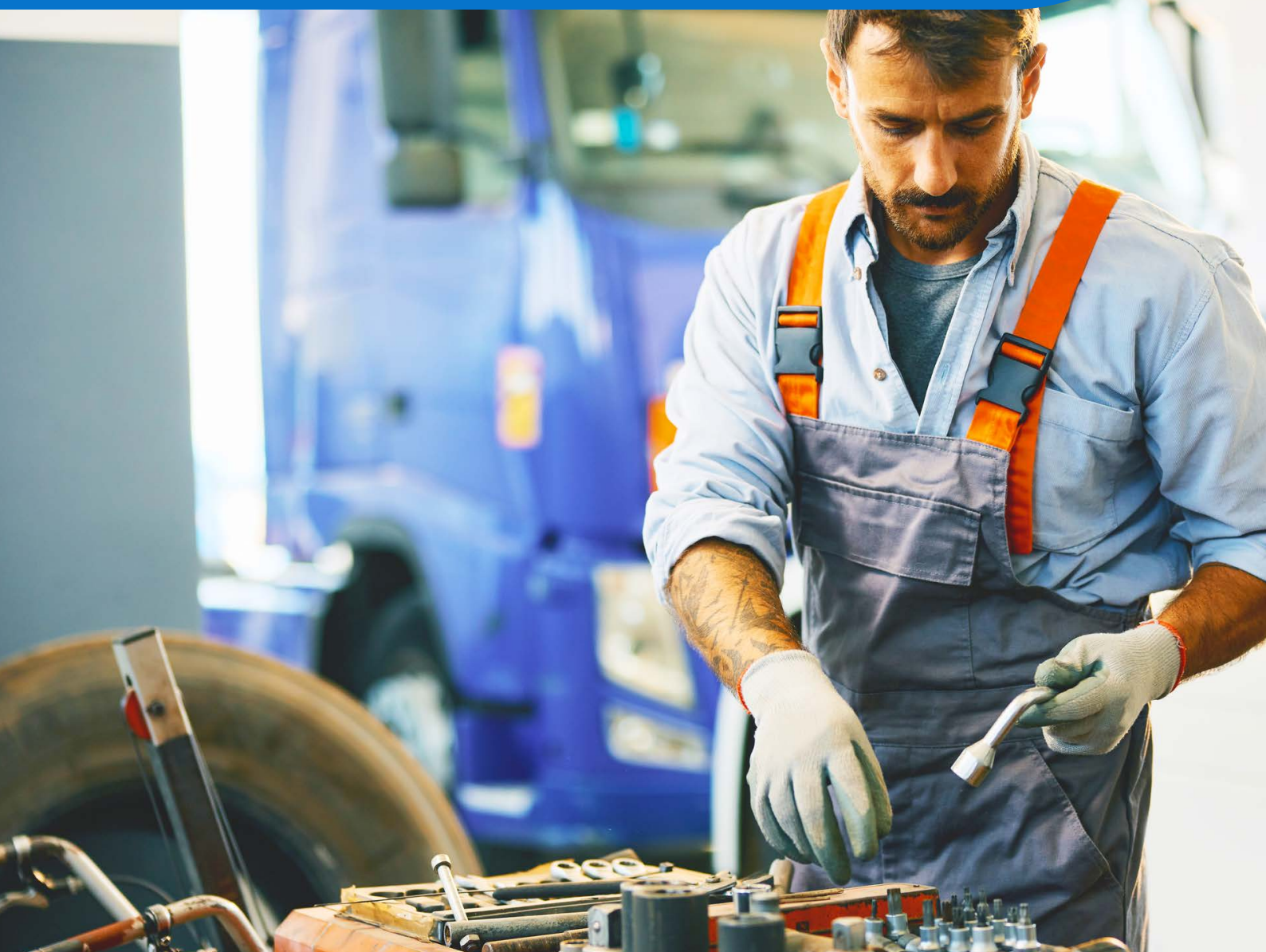


Battery electric and hydrogen-fuelled heavy-duty vehicles – Workshops and protocols for maintenance and inspection – Specification

Version 2 March 2025



BSI Flex 2072 v2.0:2025-03



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Foreword

This BSI Flex was sponsored by Connected Places Catapult (CPC). Its development was facilitated by BSI Standards Limited and it was released under licence from The British Standards Institution. It came into effect on 31 March 2025.

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The content in this version is part of an iterative process. It is likely to change from time to time with subsequent iterations.

Supersession

This version of BSI Flex 2072 supersedes BSI Flex 2072 v1.0:2024-08, which is withdrawn.

Relationship with other publications

This BSI Flex is part of the zero emission HGV and infrastructure demonstrator programme, alongside:

- BSI Flex 2071, *Design and implementation of publicly accessible charging sites for battery electric HGVs – Code of practice*
- BSI Flex 2073, *Design and implementation of mobile and static hydrogen dispensing sites – Code of practice*

Information about this document

This is Version 2.0 of BSI Flex 2072, which is the last planned version of the document. All comments received will be reviewed to inform the future direction of this document. Interested parties are encouraged to check the BSI website for updates regarding any future plans.

This is a partial update of the document, and introduces the following principal changes:

- additional references to existing standards, legislation, regulations, and guidance literature;
- amendments and refinements to some clauses to reflect in-practice operation of workshops for zero emission heavy duty vehicles;
- removal of some information related to vehicle design and manufacture;
- addition of information in some clauses to make the clauses more measurable and verifiable;
- cross-references to information sources (e.g. vehicle original equipment manufacturer's operating manual) where relevant.

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Presentational conventions

The provisions of this document are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the *Shorter Oxford English Dictionary* is used (e.g. "organization" rather than "organisation").

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Introduction

This BSI Flex covers both battery electric and gaseous hydrogen-fuelled heavy-duty vehicles (HDVs). The requirements within this BSI Flex are therefore divided by fuel type, with three sets of annexes pertaining to each fuel type as follows:

- workshops;
- management of vehicles; and
- management of the vehicles’ fuel source.

The structure of each of the three annexes is repeated. Table 1 shows how to navigate for each fuel type covered by this BSI Flex. Battery electric HDVs and hydrogen fuel cell HDVs have battery-related considerations, whilst hydrogen-fuelled HDVs and hydrogen fuel cell electric HDVs have hydrogen-related considerations. To enable the user to access the most relevant information, this BSI Flex is structured as shown in Table 1.

Table 1 – Navigation of BSI Flex 2072 based on fuel source for HDVs

	Battery electric HDVs	Hydrogen-fuelled HDVs	Hydrogen fuel cell electric HDVs
Workshops	Annex A	Annex D	Annex G
Management of vehicles	Annex B	Annex E	Annex H
Management of fuel source	Annex C	Annex F	Annex I

1 Scope

This BSI Flex specifies requirements for the operation of battery electric and hydrogen-fuelled heavy-duty vehicles (HDVs), including various aspects of workshop activities, risk management, planning, personnel, layout, systems and operations.

This BSI Flex also provides requirements for the management of battery electric and hydrogen-fuelled HDVs, including use, parking, fuelling for commissioning, inspection, diagnostics, installation, repair and maintenance, disposal, transportation and documentation.

This BSI Flex covers the additionality of batteries and hydrogen gas as fuel sources in the context of workshops and protocols for maintenance and inspection. Where other fuels are used in combination with these fuel sources (e.g. diesel fuel for either plug-in hybrid electric vehicles or hydrogen internal combustion engine vehicles), additional requirements for safety and inspection, diagnostics, maintenance and repair for those fuel sources apply.

NOTE 1 *This BSI Flex acknowledges the work undertaken in the development of BS EN 13423, the structure of which was used as the basis for this BSI Flex.*

This BSI Flex is intended for use by fleet managers in identifying and embedding the appropriate safety principles in the development of inspection and maintenance protocols for battery electric and hydrogen-fuelled HDVs. It is also applicable to those responsible for planning/design of storage, maintenance and inspection facilities such as workshops and warehouses. This BSI Flex is of use to workshop architects, workshop owners, workshop staff, original equipment manufacturers (OEM), system manufacturers, owners and users, fleet managers, dealers and local authorities.

NOTE 2 *This BSI Flex might also be of use to workshops servicing electric or hydrogen retrofit vehicles, i.e. internal combustion engine HDVs that have been modified or retrofitted with electric or hydrogen systems.*

The scope of a workshop for this BSI Flex covers standard inspection, diagnostics, maintenance and repair facilities for battery electric and hydrogen-fuelled HDVs, in addition to larger workshops, depots, and warehouses, such as those used by vehicle OEMs.

NOTE 3 *This BSI Flex might also be applicable to authorized testing facilities used for MOT testing of battery electric and hydrogen-fuelled HDVs.*

This BSI Flex does not cover:

- battery assembly and disassembly;
- hydrogen tank manufacture;
- fuelling protocols for hydrogen refuelling stations or fuel quality for hydrogen gas;
- liquid hydrogen as a fuel source for vehicles; and
- vehicle manufacture.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 50110-1, *Operation of electrical installations – Part 1: General requirements*

BS EN 50402, *Electrical apparatus for the detection and measurement of combustible or toxic gases or vapours or of oxygen – Requirements on the functional safety of gas detection systems*

BS EN IEC 60079-29-2, *Explosive atmospheres – Part 29-2: Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen*

BS EN IEC 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*²⁾

BS EN ISO 10012, *Measurement management systems – Requirements for measurement processes and measuring equipment*

BS ISO 19881, *Gaseous hydrogen – Land vehicle fuel containers*

BS ISO 19882, *Gaseous hydrogen – Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers*

BS ISO 31000, *Risk management – Guidelines*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

²⁾ This document also gives an informative reference to BS EN IEC 60079-10-1:2021.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1 awarding organization

body, independent of the battery electric or hydrogen-fuelled HDV workshop, authorized by a certification body to prepare and administer qualification practice assessments and knowledge examinations

3.1.2 battery electric HDV

vehicle with a maximum permitted weight of more than 4.25 t in UN(ECE) category M2, M3, N2 or N3

NOTE Examples can include heavy goods vehicles, buses, and coaches, powered by a traction battery as a fuel source.

3.1.3 battery electrical system

assembly of components, including the traction battery, and connecting parts, including electrical connections, fitted on motor vehicles using a traction battery in their propulsion system

3.1.4 cleanroom

environment free from dust and other contaminants used for the manufacture of electronic components and battery assembly or repair

3.1.5 combustible material

substance that can burn (i.e. sustain a flame) in air under certain conditions

3.1.6 dangerous goods

substances, materials or articles capable of posing a significant risk to people, health, property or the environment

3.1.7 designated responsible person

qualified person who takes responsibility for decisions relating to installation, maintenance and repair of the battery electric system or hydrogen system

NOTE 1 This role can also be called the “operational designated person”.

NOTE 2 An example of a designated responsible person is the technical manager of the workshop.

NOTE 3 The designated responsible person is the qualified person for either the battery electrical system or the hydrogen tank system, whichever is applicable in the context of the fuel source.

[SOURCE: BS EN 13423:2021, 3.27, modified – “an NGV system” changed to “the battery electric system or hydrogen system”, term changed from “technical manager” to “designated responsible person”]

3.1.8 disposal

any operation which is not recovery even where the operation has a secondary consequence of the reclamation of substances or energy

3.1.9 fire protection systems

systems used to reduce damage to expensive equipment, documents and inventory whilst keeping building occupants safe

NOTE This includes systems to extinguish, control, or in some cases, entirely prevent fires from spreading or occurring.

3.1.10 fuel cell

stack and associated balance of plant located in the housing of the fuel cell module

3.1.11 fuel cell electric vehicle (FCEV)

vehicle powered with a battery or supercapacitor as a fuel source, in combination with electricity generated using oxygen and compressed hydrogen through an electrochemical cell

NOTE For some smaller vehicles, the vehicle can also be powered directly from the fuel cell as well as the high voltage battery.

3.1.12 gas detection

system or device that detects the presence of gases in an area, often as part of a safety system

3.1.13 hazardous area

area in which an explosive gas atmosphere is present, or can be expected to be present, in quantities such that special precautions for the construction, installation and use of equipment are required due to increased risk of fire or explosion

[SOURCE: BS EN IEC 60079-10-1:2021, 3.3.1, modified – “due to increased risk of fire or explosion” added]

3.1.14 hazardous area classification (HAC)

technique for assessing the probability of formation of a flammable atmosphere and its likely duration, with areas classified into zones based on an assessment of the frequency of the occurrence and duration of an explosive gas atmosphere

3.1.15 hazard identification (HAZID)

process of finding and recording possible hazards that might be present in the workplace, as part of a risk assessment

3.1.16 heavy duty vehicle (HDV)

classification for a vehicle with a maximum permitted weight of more than 4.25 t in UN(ECE) category M2, M3, N2 or N3

NOTE Examples can include heavy goods vehicles, buses, and coaches.

3.1.17 heavy goods vehicle (HGV)

goods vehicle with a maximum permitted weight of more than 4.25 t in UN(ECE) category N2 or N3

3.1.18 hot work

use of open fires, flames and work involving the application of heat by means of tools and equipment

3.1.19 HV electrical safety pole/hook

safety tool used to pull an injured person from high voltage systems or batteries

NOTE This can also be called a rescue hook, fisher's hook or shepherd's hook.

3.1.20 hydrogen gas

colourless, odourless, tasteless, flammable gaseous substance used as a fuel source for vehicle propulsion within hydrogen-fuelled vehicles

3.1.21 hydrogen fuel cell

electrochemical cell that converts the chemical energy of hydrogen to electricity

NOTE This type of cell can be used in motor vehicles for vehicle propulsion and high voltage battery charging.

3.1.22 hydrogen-fuelled HDV

heavy vehicle powered by hydrogen gas as a fuel source

NOTE This can include hydrogen internal combustion engine hybrid vehicles.

3.1.23 hydrogen internal combustion engine vehicle

vehicle powered by an internal combustion engine and compressed hydrogen gas as a fuel source

3.1.24 hydrogen tank

pressure vessel used for the storage of hydrogen gas

3.1.25 hydrogen tank system

assembly of components fitted on motor vehicles using hydrogen gas in their propulsion system

NOTE This includes hydrogen tanks, valves, fuel lines, and connecting parts, including pipes and pipework.

3.1.26 ignition source

source of energy sufficient to ignite a flammable atmosphere

NOTE Ignition sources include naked flames, exposed incandescent material, sparks, electric welding arcs, and electrical or mechanical equipment not approved for use in hazardous locations.

[SOURCE: BS EN 13423:2021, 3.9]

3.1.27 incident

unplanned event or occurrence that has been assessed as having an actual or potentially adverse effect

NOTE An incident can be classified as a "major incident" or "minor incident". A major incident has an effect on the vehicle's integrity or structural support (vehicle chassis) whereas a minor incident does not. An example of a major incident is damage to the bonnet/wing, which is designed to crumple to absorb the impact rather than continue to transfer the momentum to the vehicle's passengers; a damaged hood can imply a damage to the vehicle chassis. An example of a minor incident is damage to a door panel that can be minor when limited to the skin (outer panel).

[SOURCE: BS ISO 28007-1:2015, 3.21, modified – "event" changed to "unplanned event or occurrence"]

3.1.28 inspection

process of measuring, examining, testing, gauging or otherwise comparing the product with the applicable requirements

[SOURCE: BS EN ISO 11961:2018+A1, 3.1.19]

3.1.29 internal combustion engine (ICE)

assembly of components that generate motive power for vehicles through the burning of petrol, oil, or other fuel with air

3.1.30 lower flammability limit (LFL)

concentration of flammable gas or vapour in air, below which an explosive gas atmosphere does not form

NOTE Lower flammability limit can also be called lower explosive limit (LEL).

[SOURCE: BS EN IEC 60079-10-1:2021, 3.6.12]

3.1.31 multimeter

instrument designed to measure electric current, voltage, and usually resistance, typically over several ranges of value

3.1.32 original equipment manufacturer (OEM)

person or body responsible to the approval authority for all aspects of the type approval or authorization process and for ensuring conformity of production of the vehicle

NOTE 1 It is not essential that the person or body be directly involved in all stages of the construction of the vehicle, system, component or separate technical unit which is the subject of the approval process.

NOTE 2 Vehicle manufacturer can also mean vehicle importer where the manufacturer is not represented in the European Union.

[SOURCE: BS EN ISO 18542-1:2012, 3.1.17, modified, term changed from “vehicle manufacturer (VH)” to “original equipment manufacturer”]

3.1.33 parking area

site or proportion of a site where the surface is prepared for and is used, or is intended to be used, primarily for the parking or storage of motor vehicles

3.1.34 personal emergency evacuation plan (PEEP)

document for how people will be evacuated when they have difficulty responding to a fire alarm or escaping from a building unaided, in the event of an emergency

3.1.35 personal protective equipment (PPE)

device worn or held by an individual for protection against one or more health and safety hazards

3.1.36 powertrain

mechanism that transmits the drive from the power source of a vehicle to its axle

3.1.37 proving unit

device used to verify the correct function of a voltage detector

3.1.38 purging

displacing hydrogen gas with a non-flammable gas, steam, air or water

[SOURCE: BS EN 13423:2021, 3.18]

3.1.39 qualification

formal outcome of an assessment and validation process which is obtained when an awarding organization determines that an individual has achieved learning outcomes to given standards

3.1.40 qualified person

individual subjected to a qualification process who has successfully completed a qualification or accreditation process

NOTE The qualified person has been certificated by an awarding organization.

3.1.41 quarantine zone

safe area for a battery electric vehicle with a fault or with suspected or detected damage to the battery, which is separate from the workshop and other vehicles, in case an incident occurs

3.1.42 recycling

recovery operation by which waste minerals are reprocessed into products, materials or substances whether for the original or other purposes

3.1.43 service pit

hole in the ground providing standing access to the underside of a vehicle

[SOURCE: BS EN 13423:2021, 3.23]

3.1.44 system manufacturer

company which assumes technical responsibility for the manufacturing or retrofitting of a battery electrical system or hydrogen tank system, and demonstrates that it possesses the features and the necessary means to provide quality assessment and conformity of production of the battery electrical system or hydrogen tank system

NOTE 1 The system manufacturer is either the battery electrical system supplier or the hydrogen tank system supplier, whichever is applicable in the context of the fuel source.

NOTE 2 The system manufacturer can also be referred to as the system supplier.

[SOURCE: BS EN 13423:2021, 3.26, modified – “CHG” changed to “battery electrical” and “or hydrogen tank system” added]

3.1.45 traction battery

rechargeable battery pack(s) used to power electric motors of a battery electric vehicle

3.1.46 vehicle manual

instructional book or booklet that is supplied with technologically advanced consumer products

3.1.47 ventilation

movement of air and its replacement with fresh air, due to the effect of wind, temperature gradients, or artificial means (for example fans or extractors)

[SOURCE: BS EN ISO 16923:2018, 3.54]

3.1.48 venting

controlled release of hydrogen gas to atmosphere

[SOURCE: BS EN ISO 16923:2018, 3.55, modified – “natural gas” changed to “hydrogen gas”]

3.1.49 voltage detector

device which checks for the presence or absence of voltage

NOTE A voltage detector can also be called an approved voltage indicator (AVI).

3.1.50 workshop

dedicated servicing facility, where work on battery electric, hydrogen-fuelled and/or hydrogen FCEV HDVs is carried out, including inspection, diagnostics, repair and maintenance, that can have both indoor and outdoor areas

3.1.51 workshop owner

legal entity responsible for the procedures and activities on battery electric, hydrogen-fuelled and/or hydrogen FCEV HDVs

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

AO	awarding organization
CPD	continuing professional development
DC	direct current
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
FCEV	fuel cell electric vehicle
HAC	hazardous area classification
HAZID	hazard identification
HDV	heavy-duty vehicle
HGV	heavy goods vehicle
HV	high voltage
ICE	internal combustion engine
LFL	lower flammability limit
NOS	National Occupational Standards
OEM	original equipment manufacturer
PEEP	personal emergency evacuation plan
PPE	personal protective equipment
PPM	parts per million

4 General provisions

COMMENTARY ON CLAUSE 4

This BSI Flex covers both battery electric and gaseous hydrogen-fuelled heavy-duty vehicles (HDVs). The requirements within this BSI Flex are therefore divided by fuel type, with three normative annexes pertaining to each fuel type. The three sets of annexes cover each of workshops, management of vehicles, and management of the fuel source of the vehicles, for each fuel type. The structure of each of the three annexes is repeated.

4.1 General

COMMENTARY ON 4.1

This BSI Flex is limited to the additionality of batteries and hydrogen gas as fuel sources, in the context of workshops and protocols for inspection, diagnostics, maintenance and repair. Other areas of any workshop should be assessed based on the expected hazardous substances within the workshop and of other fuel types within the depot, e.g. diesel, petroleum, and natural gas.

Where other fuel sources are present in a workshop, or where other fuels are used in combination with either batteries or hydrogen gas to fuel HDVs (e.g. diesel fuel for either plug-in hybrid electric vehicles or hydrogen internal combustion engine vehicles), all safety measures relevant to other fuel types shall be used in combination with the requirements of this document.

NOTE 1 *Attention is drawn to local regulations to be used alongside this BSI Flex. Attention is also drawn to the Health and Safety Executive's Health and safety in motor vehicle repair and associated industries [1] guidelines.*

NOTE 2 *Other fuel sources can include but are not limited to diesel, petroleum or natural gas.*

Where other fuel sources are present in a workshop, or where other fuels are used in combination with either batteries or hydrogen gas to fuel HDVs, a suitably qualified person shall undertake a risk assessment related to these other fuel sources.

4.2 Requirements for battery electric HDVs

Workshops intended to service battery electric HDVs shall conform to the requirements specified in Annex A.

The management of battery electric HDVs shall conform to the requirements specified in Annex B.

The management of traction batteries used to power battery electric HDVs shall conform to the requirements specified in Annex C.

NOTE *The requirements within Annex B and Annex C are also intended to apply to the user of the battery electric HDV, whether they are the owner, operator or dealer responsible for the sale or maintenance of the vehicle.*

4.3 Requirements for hydrogen-fuelled HDVs

Workshops intended to service hydrogen-fuelled HDVs shall conform to the requirements specified in Annex D.

The management of hydrogen-fuelled HDVs shall conform to the requirements specified in Annex E.

The management of hydrogen tanks used to fuel hydrogen-fuelled HDVs shall conform to the requirements specified in Annex F.

***NOTE** The requirements within Annex E and Annex F are also intended to apply to the user of the hydrogen-fuelled HDV, whether they are the owner, operator or dealer responsible for the sale or maintenance of the vehicle.*

4.4 Requirements for hydrogen fuel cell electric HDVs

Workshops intended to service hydrogen fuel cell electric vehicle (FCEV) HDVs shall conform to the requirements specified in Annex G.

The management of hydrogen FCEV HDVs shall conform to the requirements specified in Annex H.

The management of system components used to fuel FCEV HDVs, such as hydrogen tanks, fuel cells and batteries, shall conform to the requirements specified in Annex I.

***NOTE** The requirements within Annex H and Annex I are also intended to apply to the user of the hydrogen FCEV HDV, whether they are the owner, operator or dealer responsible for the sale or maintenance of the vehicle.*

Annex A (normative)

Workshops with battery electric HDVs

A.1 Battery electric HDV workshop activities

Workshops intended to service or maintain battery electric HDVs and battery electric systems shall be designed to accommodate one or more of the following activities:

- a) system inspection;
- b) system installation;
- c) system diagnostics;
- d) system repair;
- e) system maintenance;
- f) system requalification;
- g) system removal; and
- h) system disposal.

A.2 Battery electric HDV workshop risk management

A.2.1 Risk management procedure

Risks in relation to the battery electric HDV workshop, and of any battery electric HDVs that are handled by it, shall be managed in accordance with the principles outlined in BS ISO 31000.

A.2.2 Risk context

Risks in relation to the battery electric HDV workshop, and of any battery electric HDVs that are handled by it, shall be assessed in respect of the various key stakeholders and their respective roles and operations, including but not limited to:

- a) health and safety organizations;
- b) awarding organizations;
- c) the local authority;
- d) fire and emergency response providers;
- e) environmental agencies;
- f) system manufacturers;
- g) vehicle manufacturers;
- h) battery electric HDV workshop owners;
- i) battery electric HDV workshop personnel;
- j) battery electric HDV workshop neighbours;
- k) battery electric HDV users; and
- l) the general public.

A.2.3 Risk assessment

A.2.3.1 General risk assessment

Risks in relation to the battery electric HDV workshop, and of any battery electric HDVs that are handled by it, shall be assessed using risk assessment techniques.

***NOTE 1** Attention is drawn to BS EN IEC 31010 for general guidance on selection and application of systematic techniques for a risk assessment. Guidance from the vehicle OEM should also be included in the risk assessment.*

The risk assessment shall as a minimum include the following aspects of the battery electric HDV workshop:

- a) organization;
- b) layout;
- c) systems; and
- d) operations.

***NOTE 2** Some research indicates that charging infrastructure might interfere with personal health measures that emit electromagnetic fields (EMF), such as pacemakers, insulin pumps and implants. This should be included in any risk assessment. Any staff with personal health measures should refer to the guidelines accompanying their medical devices. Attention is drawn to the Control of Electromagnetic Fields at Work Regulations 2016 [2].*

A.2.3.2 Risk assessment for batteries

COMMENTARY ON A.2.3.2

For shipping and transportation, lithium-ion batteries are classified as dangerous goods, as per UN3480 [3].

Prior to deciding whether handling and storage of batteries are able to take place in a workshop, a risk assessment shall be completed and documented in accordance with C.2 and C.4.

The risk assessment shall, as a minimum, include:

- a) the quantity, size(s) and type(s) of batteries;
- b) location of the batteries;
- c) battery classification (e.g. defective and severely damaged batteries);
***NOTE 1** See C.2.2 for battery classification information.*
- d) types of activity/handling;
- e) characteristics of facilities/utilities, infrastructure, installations, safety measures (including tools and equipment, e.g. HV electrical safety poles/hooks), fire detectors and extinguishing systems in place;
- f) other risks/hazards/threats in the facility's and operation's surroundings (i.e. besides those in the facility and the operations);
- g) objects in the surrounding areas exposed to the risk (e.g. production located nearby, environmental factors);
- h) battery manufacturer/supplier recommendations; and

***NOTE 2** Battery manufacturer/supplier recommendations can be found in the documentation accompanying the battery, including safety sheets.*

- i) the facility's criticality (i.e. how critical the facility is), disruption/property damage, including critical processes.

Risk assessments shall be performed by suitably qualified workshop personnel.

NOTE 3 *The suitably qualified persons responsible for carrying out the risk assessment can include the site manager, the health and safety representative, a qualified person with risk assessment competence, and a qualified person with overall electric responsibility. Exact personnel are dependent on the size of the workshop.*

NOTE 4 *Combustible dusts are classified as flammable substances under DSEAR [4]. Some maintenance activities for battery electric HDVs can lead to the presence of flammable dusts or mists, such as brake servicing or hydraulic testing. Other materials are covered by general risk assessments for the activities involved and handled under the Control of Substances Hazardous to Health (COSHH) Regulations [5].*

A.2.4 Risk treatment

All identified risks in relation to the battery electric HDV workshop, and any battery electric HDVs that are handled by it, shall be reduced to an acceptable level for all foreseeable hazards including, but not limited to:

- a) fire and explosion;
- b) chemical spillage; and
- c) electrocution.

A.2.5 Risk monitoring and review

All identified risks in relation to the battery electric HDV workshop, and of any battery electric HDVs that are handled by it, shall be monitored and reviewed.

Risk monitoring and review shall be done periodically, as determined by the risk assessment.

NOTE 1 *Risk monitoring and review should be undertaken whenever there is a significant change in the circumstances of the workshop but can also be done on an ad hoc basis when:*

- *a greater number of battery electric HDVs are serviced by the workshop;*
- *battery electric HDVs from different OEMs are added to the workshop (see B.4.4.2 for decommissioning and isolation requirements);*
- *additional chargers are added within or outside the workshop;*
- *there is a change to the layout or parking plan of a workshop; and/or*
- *new equipment is added within the workshop space.*

NOTE 2 *Risk monitoring should be reviewed if any incident occurs.*

NOTE 3 *Frequency of risk monitoring might differ depending on the risks being assessed (e.g. fire risks), and should be included in the risk assessment.*

Risk monitoring and review shall be performed by a suitably qualified person.

A.2.6 Risk documentation

All identified risks in relation to the battery electric HDV workshop, and of any battery electric HDVs that are handled by it, shall be documented in a manner that clearly describes how they are managed.

NOTE *Documented information can include mitigation strategies and fire escape routes, along with any other information deemed relevant by the risk assessment.*

A.3 Battery electric HDV workshop planning

A.3.1 Tools and equipment

The battery electric HDV workshop shall have all the tools and equipment necessary to operate on battery electric HDVs in accordance with the vehicle and/or battery electrical system manufacturer's requirements.

NOTE 1 *Tools for working on high voltage systems might need to be rated to 1 000 V direct current (DC) or above.*

Tools and equipment shall be managed by a suitably qualified person. Management of tools and equipment shall include but is not limited to procurement, periodic inspection, calibration, upgrading and replacement.

***NOTE 2** The non-exhaustive list of recommended tools and equipment provided in Annex J should be observed.*

Noise levels from equipment shall be evaluated and measures shall be put in place to minimize the impact of noise on people in the workshop and on the external environment.

***NOTE 3** Equipment should be provided with accompanying information which states expected noise levels. Measures to minimize the impact of noise can include PPE, such as ear protection. Attention is drawn to The Control of Noise at Work Regulations 2005 [6], and the Health and Safety Executive's Noise at work [7] guidance.*

A.3.2 Personal protective equipment

Battery electric HDV workshop occupants shall wear PPE, as determined by a risk assessment and the vehicle manufacturer's maintenance manual and dependent on the maintenance tasks being undertaken.

***NOTE 1** Types of PPE include a face mask, insulation gloves (and pumps to test insulation gloves for holes), protective eyewear, isolation mats, and insulation shoes. Other tools required for inspection, diagnostics and maintenance of the vehicle electrical system can include personal padlocks, a voltage tester, and an HV electrical safety pole/hook. These hooks can be used to safely pull someone away from an electrical shock. It is also recommended to keep a defibrillator on site.*

***NOTE 2** Insulation gloves are defined in BS EN 60903.*

***NOTE 3** Some clothing might need to be changed for working on battery electric HDVs, such as non-conductive fasteners for overalls, and changing footwear. Some footwear, such as steel toe boots and footwear with puncture protection plates, might have conductive materials unsuitable for working on battery electric HDVs.*

Measures shall be put in place to confirm that PPE is always worn in accordance with a risk assessment and dependent on the maintenance tasks being undertaken.

Measures shall be put in place to check that all PPE is properly maintained.

***NOTE 4** Different types of PPE have different processes for monitoring how it is used and maintained; supplier instructions or manuals for PPE should be consulted which may also include information on replacement. Measures to check that PPE is worn correctly and to check that PPE is properly maintained can be incorporated into a workshop's operating procedures, which can be subject to review and periodic verification.*

A.3.3 Security measures

The battery electric HDV workshop shall implement security measures in order to prevent unauthorized persons from accessing areas of the site, particularly restricted areas, and especially when it is unoccupied.

A.3.4 Emergency planning

A.3.4.1 Emergency procedures

The battery electric HDV workshop shall have emergency procedures to respond to at least the following events:

- a) a fire (conforming to the provisions of the local fire prevention authority); and
- b) an accident or injury to personnel, including crush injuries.

NOTE An emergency response plan can be developed to assist with emergency procedures and emergency preparedness. In the context of a battery electric HDV workshop, and the battery electric HDVs handled by the workshop, emergency planning can include, but is not limited to:

- defining how to call three services and who is responsible;
- defining key escape routes and assembly points;
- defining procedures for liaison with fire brigade on arrival;
- presence of firefighting equipment;
- defining duties and responsibilities of employees with specific tasks (e.g. trained fire wardens, staff trained for evacuation);
- defining how to deal with electrical shocks;
- arrangements for safe evacuation of persons identified as being at high risk (e.g. PEEP for disabled persons);
- arrangements for high-risk areas (e.g. battery storage, diesel tanks); and
- identifying training needs and arrangements.

A.3.4.2 Emergency access and escape

Provision shall be made for the access and escape requirements of emergency response providers (e.g. ambulance, fire brigade).

If a workshop stores batteries, additional requirements for emergency access measures shall be in place in accordance with C.4 and C.5.

A.3.4.3 Emergency equipment

The battery electric HDV workshop shall be furnished with equipment to deal with emergency situations, such as fire protection systems (A.6.2) and first aid kits.

NOTE Emergency equipment can also include defibrillators and PPE (see A.3.2).

First aid arrangements shall confirm their capacity to deal with electric shock injuries in terms of both training and equipment.

A.4 Battery electric HDV workshop occupants

A.4.1 General safety

The battery electric HDV workshop owner shall provide safety instructions to all persons accessing the battery electric HDV workshop premises, including but not limited to technicians, contractors/subcontractors, administration staff and visitors.

Battery electric HDV workshop occupants shall wear PPE suitable for the maintenance task being undertaken as determined by a risk assessment.

NOTE A.3.2 provides further information on PPE for installation, repair and maintenance of battery electric HDVs.

A.4.2 Battery electric HDV workshop technicians

The battery electric HDV workshop owner shall check and verify that battery electric HDV workshop technicians, including contractors/subcontractors, are:

- a) trained according to the requirements of A.4.3;
- b) qualified to perform the specific tasks assigned to them according to the written procedures as defined in A.7.1.1 and C.1.3, and allocated work as defined in B.4.3; and
- c) provided with the tools and equipment to safely work with battery electric HDVs.

NOTE Necessary tools and equipment can include PPE (see A.3.2), isolation mats, safety hooks, and a set of padlocks if necessary for isolation and decommissioning (see B.4.4.2).

A.4.3 Training

The training of battery electric HDV workshop technicians shall include, at a minimum, the following aspects:

- a) familiarization with battery electric HDV technology and an understanding of the management of maintenance and repair of battery electric HDVs;
- b) hazards and associated risks in relation to the battery electric HDV workshop and in the handling of battery electric HDVs, including but not limited to:
 - 1) electric vehicle hazards and electrical safety;
 - 2) safe operation of electrical installations in electric products;
 - 3) the presence of battery electric HDVs;
 - 4) hazards and risks related to the presence of traction batteries; and
- c) the theory and practice of dealing with emergency situations, including:
 - 1) use of hand-held fire extinguishers; and
 - 2) evacuation of the battery electric HDV workshop.

***NOTE** NOS specify training and qualification requirements for working with electric vehicles. Training is administered by AO-approved training and assessment centres and AO certification, or through OEM certification (see Annex K).*

Battery electric HDV workshop technicians shall have access to all accompanying documentation from the battery electric HDV system manufacturer/supplier on risks and hazards in the context of safe operation of electrical installations in electric products.

A.4.4 Qualification

Battery electric HDV workshop personnel shall demonstrate that they are qualified for the tasks and levels of activity assigned to them.

***NOTE** Qualification can be demonstrated by an awarding organization with reference to NOS or through OEM certification (see Annex K).*

A.5 Battery electric HDV workshop layout

A.5.1 Designated areas

The battery electric HDV workshop shall have clearly designated areas for its various activities. Typical areas shall include but are not limited to:

- a) parking areas for battery electric HDVs;
- b) working areas for battery electric HDVs;
- c) service pits for battery electric HDVs; and
- d) storage areas for batteries, where present.

***NOTE 1** Quarantine zones can be designated areas outside workshops for battery electric HDVs. It is considered good practice to provide space for a quarantine zone. Where space constraints prevent establishing a permanent quarantine zone, vehicles should be safely cordoned off if an incident occurs.*

***NOTE 2** Where vehicles of different fuels/powertrains are present in the same workshop, it should be possible to determine the fuel type of each vehicle (e.g. by a marking or sticker in the window, a fleet identification system, or other means identified by the workshop systems), and what types of vehicles each maintenance bay is set up to service (e.g. through provision of appropriate signage).*

***NOTE 3** Battery disassembly and repair only takes place in a dedicated authorized battery repair facility or cleanroom which has additional safety precautions in place (see B.4.5.4.1, C.3.2 and C.6.1).*

A.5.2 Marking of areas

If the working area does not encompass the entire battery electric HDV workshop, the designated working area(s) for battery electric HDVs on the workshop floor shall be clearly marked.

A.5.3 Hazardous areas

Where hazardous installations, such as ignitable liquids storage, are present, charging of battery electric HDVs shall be separated from the edge of hazardous areas by a minimum separation distance determined by a quantitative risk assessment.

A.5.4 Warning signs and notices

The battery electric HDV workshop shall display signage in different areas of the workshop addressing the risks to which persons entering these areas are subjected to.

NOTE Signage can identify locations for isolation and decommissioning (B.4.4.2), along with indicating whether a workshop bay is equipped to service battery electric HDVs.

A.6 Battery electric HDV workshop systems

A.6.1 General

The necessity for battery electric HDV workshop systems, such as mechanical ventilation, air compressor, or gas detection, shall be determined by the fire risk assessment.

NOTE Workshops where many batteries are stored might need to be fitted with additional workshop safety systems (see C.4 and C.5).

A.6.2 Fire protection system

A.6.2.1 General

Fire protection systems shall be installed based on the outcomes of a fire risk assessment.

NOTE 1 Fire protection systems can include suitable fire extinguishers, hose reels in suitable locations of the battery electric HDV workshop, fire alarms, and water sprinkler systems, dependent on the fire risk assessment.

NOTE 2 Sprinkler systems provide the best form of active fire protection for enclosed vehicle parking. The use of sprinkler systems should be determined by a risk assessment.

NOTE 3 The Fire Protection Association has provided recommendations for fire safety when charging electric vehicles.

NOTE 4 Firefighting of batteries should only be performed by the fire and rescue service. If possible and safe to do so, any other batteries or battery electric HDVs that are not near the fire should be moved to a safe location in the event of a fire.

Fire protection systems shall be inspected on a regular basis, in accordance with the outcome of a risk assessment.

Fire-water retention facilities shall be provided. The need for fire-water handling shall be determined on a case-by-case basis.

NOTE 5 Firefighting water might contain toxic materials.

NOTE 6 Fire-water management plans should be taken into account.

Precautionary measures against electrostatic discharge shall be taken, as determined by a risk assessment.

NOTE 7 Attention is drawn to the Health and Safety Executive's guidance on working with electric and hybrid vehicles [8].

A.6.2.2 Fire walls

Fire walls, where installed, shall have a fire resistance of at least 1 h.

NOTE Fire curtains and fire blankets can also be useful to prevent the spread of fires.

A.6.3 Measurement system

All measuring instruments used for the vehicle conformity assessment shall conform to BS EN ISO 10012.

A.7 Battery electric HDV workshop operations

A.7.1 Documentation

A.7.1.1 Written procedures

Written procedures shall be provided regarding battery electric HDV operations, safety, and emergencies.

NOTE Procedures can be supplied by the vehicle manufacturer or the system manufacturer, in addition to the workshop owner.

A.7.1.2 Record keeping

In order to maintain traceability of activities made on battery electric HDVs, documentation shall include:

- a) who has performed the work;
- b) when the work was performed;
- c) what has been done; and
- d) who has approved it.

NOTE Attention is also drawn to Goods vehicle operator licensing guide [9], Guide to maintaining roadworthiness [10] and the associated Maintenance Provision Rating Scheme.

A.7.2 Battery damage management

A.7.2.1 Reporting of defective or severely damaged batteries

A battery electric HDV which is suspected or detected to have a defective or damaged battery shall be reported immediately to the designated responsible person of the battery electric HDV workshop and/or to the vehicle OEM or battery electrical system supplier.

NOTE 1 Reporting of battery damage, in terms of what organization to contact in the event of battery damage, depends on the maintenance and warranty agreements in place between the vehicle owner and the vehicle OEM and/or battery electrical system supplier.

NOTE 2 For defective and severely damaged batteries, see C.2.2.

A.7.2.2 Handling battery electric HDVs with battery damage

A suitably qualified person shall advise on whether a battery electric HDV with suspected or detected battery damage is moved or remains in situ.

NOTE 1 The suitably qualified person may be within a technical team of the vehicle OEM and/or the battery electrical system supplier.

An exclusion zone shall be formed around a battery electric HDV with suspected or detected battery damage, if advised by a suitably qualified person that the vehicle cannot be moved.

If a battery electric HDV with suspected or detected battery damage can be moved, as advised by a suitably qualified person, the vehicle shall be moved to a safe area separate from other vehicles and the workshop.

NOTE 2 The vehicle can be moved to a quarantine zone if one is present (see A.5.1).

A risk assessment shall determine the process and roles and responsibilities for dealing with a battery electric HDV with suspected or detected battery damage.

Annex B (normative)

Management of battery electric HDVs

B.1 General vehicle management

The battery electric HDV owner shall confirm that the battery electric HDV is inspected, maintained and operated in accordance with the vehicle manufacturer/battery supplier manual(s) and instruction manual(s).

***NOTE** Attention is drawn to Goods vehicle operator licensing guide [9], Guide to maintaining roadworthiness [10] and the associated Maintenance Provision Rating Scheme.*

The battery electric HDV owner shall confirm that any work on the battery electrical system is carried out by a suitably qualified person, in accordance with **B.4.3**.

Work on battery electric HDVs shall conform to BS EN 50110-1.

B.2 Parking areas

COMMENTARY ON B.2

A parking area can be underground, closed cover, open, fixed or mobile (e.g. ferries, railcar, etc.).

Signage and information shall be provided to manage the access of battery electric HDVs to the parking area. A qualified person shall be responsible for drafting and applying emergency procedures.

***NOTE** A quarantine area, where present, may be located in the parking area (see A.5.1).*

B.3 Inspection and diagnostics

B.3.1 Routine assessment

Battery electrical systems installed on battery electric HDVs shall be subjected to periodical inspection, diagnostics and maintenance according to the manufacturer's manual.

Routine inspection and fault diagnostics shall be performed by a suitably qualified person.

The inspection regime for battery electrical systems shall be incorporated into the vehicle's inspections specified by the manufacturer.

***NOTE 1** Attention is drawn to Goods vehicle operator licensing guide [9], Guide to maintaining roadworthiness [10] and the associated Maintenance Provision Rating Scheme.*

On-board vehicle diagnostic equipment shall be checked that it is functioning to the manufacturer's specification during routine assessment.

***NOTE 2** The manufacturer's manual should be consulted to determine whether the vehicle diagnostic equipment is functioning to specification.*

B.3.2 Unplanned assessment

If a battery electric HDV has been involved in a major incident, the integrity of the battery electrical system shall be assessed for damage by a suitably qualified person by means of a full safety inspection. If a battery electric HDV has been involved in a minor incident, a suitably qualified person shall determine whether a full safety inspection needs to take place.

The battery electric HDV shall have the battery system inspected and processed according to Annex C.

B.4 Installation, repair and maintenance

B.4.1 General

B.4.1.1 Battery electrical system and components

COMMENTARY ON B.4.1.1

BS ISO 19453-6 provides information on environmental conditions and testing for electrical and electronic equipment for traction battery packs and systems within electrically propelled vehicles.

Following any installation, repair and/or maintenance activities, it shall be confirmed that the vehicle battery electrical system components conform to their intended service conditions.

B.4.1.2 Battery electrical system location

Following any installation, repair and/or maintenance activities, the battery electrical system shall be re-installed in its intended location.

NOTE Attention is drawn to the Road Vehicles (Construction and Use) Regulations 1986 [11] and associated certification.

All battery electrical system connections shall be made their intended locations where access is possible for inspection.

B.4.1.3 Dealing with nonconformity

If during inspection or diagnostics, any component of a battery electrical system is found not to conform to the original condition, it shall immediately be subjected to repair until the original conditions are restored.

NOTE Repair may be undertaken by the vehicle OEM or the battery electrical system supplier, dependent on the warranty agreements in place.

The non-conformity assessment shall be undertaken by a suitably qualified person.

B.4.2 Preventative measures for overheating

B.4.2.1 Welding and brazing

Where battery electrical system components are affected by the application of heat from work on a battery electric HDV, such as welding or brazing, they shall be removed or shielded from the heat source, welding arcs, and/or weld splatter through a non-conducting shield.

NOTE Battery electrical system isolation and decommissioning is covered in B.4.4.2. Hot work and permit-to-work is covered in C.2.5.

B.4.2.2 Heated paint booth

Vehicle manufacturer/battery supplier guidance shall be followed in respect of allowable temperatures for batteries when entering a heated paint booth.

Before a battery electric HDV enters a heated paint booth, a risk assessment shall determine whether the battery electrical system needs to be isolated, decommissioned and removed by a suitably qualified person and in accordance with the specifications of the vehicle manufacturer or battery system manufacturer.

NOTE Battery electrical system isolation and decommissioning is covered in B.4.4.2. Hot work and permit-to-work is covered in C.2.5.

B.4.3 Allocation of work

COMMENTARY ON B.4.3

Work is allocated within a battery electric HDV workshop based on the level of qualification of the technicians, as defined by NOS or through OEM certification. Technicians should be trained to specifically work on electric vehicles. Various roles within a workshop might include a site manager, workshop manager and supervisor, and technicians with different training levels (see Annex K). Workshop managers and supervisors might be directly responsible for the allocation of work to suitably qualified persons.

Work on battery electrical systems should be undertaken by suitably qualified persons, with qualification obtained through an AO or through OEM certification (see Annex K). The roles of these qualified persons might include:

- *assessing the integrity of battery electrical systems for a vehicle with physical damage or a specific electrical fault;*
- *decommissioning and isolating the traction battery system before maintenance and repair are carried out;*
- *monitoring any general maintenance and repair, ensuring the integrity of the electrical system is not compromised;*
- *carrying out maintenance and repair activity on the battery electrical system;*
- *fault diagnosis;*
- *testing and confirming the integrity of the electrical system following any repair and maintenance; and*
- *removing any isolation and recommissioning of the traction battery system following repair and maintenance.*

Work involving removal of potentially damaged electrical system components, or risk of exposure to live parts, should be undertaken by those with a suitable, additional level of qualification from an AO. Works including vehicle inspection, diagnostics and testing, and running repairs might not require specific qualification for work on electric vehicles but might need to be supervised by a suitably qualified person.

A battery electric HDV workshop shall have processes in place for:

- a) the allocation of work to suitably qualified persons; and
- b) checking that working arrangements are clarified and that persons are trained and certified to the level required for the specific task being carried out.

NOTE 1 *This can be facilitated by maintaining a list of standard maintenance repair works, along with maintenance works that are to be carried out by those trained to work on battery electrical systems.*

No work shall be carried out on battery electrical systems by those not trained for that work.

A battery electric HDV workshop shall have defined roles and responsibilities in terms of the management, supervision, and allocation of work.

The maintenance roles and responsibilities shall be defined based on the battery electrical system components.

NOTE 2 *Some service tasks might need to be carried out by third parties, for example, the vehicle OEM, the electrical system supplier, or the battery supplier, dependent on warranties and agreements in place. Some of this work might be undertaken onsite, whilst other work might need to be undertaken in a separate workshop.*

Anyone carrying out servicing or maintenance work on battery electric HDVs shall be able to provide evidence of sufficient training and be suitably qualified and competent to carry out the work.

A suitably qualified person shall be allocated responsibility for electrical safety where general maintenance and repair work is being undertaken.

***NOTE 3** Allocation of work can be based on the type of work being undertaken, e.g. dividing between maintenance and repair of the electrical systems, general maintenance and repair, and running repairs, inspection and testing.*

B.4.4 Prior to work

B.4.4.1 Visual inspection of electrical system

If a battery electric HDV has been involved in an accident or major incident, or if there is suspected or confirmed damage to the electrical system, a suitably qualified person shall carry out a visual inspection of the vehicle electrical systems and components to confirm the vehicle is safe to work on.

***NOTE 1** A visual inspection of vehicle electrical systems should be carried out in all cases prior to the vehicle entering the workshop. If battery electrical system components are located on the roof of the vehicle, this may not be possible.*

***NOTE 2** On-board vehicle diagnostic systems can assist with identifying any damage to battery electrical systems. See A.7.2.2 for handling of vehicles with suspected or confirmed damage.*

A battery electric HDV undergoing work shall be parked in an appropriate location within the workshop where work on the vehicle can be undertaken.

B.4.4.2 Decommissioning and isolation of electrical system

COMMENTARY ON B.4.4.2

Different vehicle OEMs and different types of battery electric HDV can have different decommissioning and isolation procedures. The manufacturer's manual should always be consulted prior to undertaking decommissioning and isolation, especially for a new vehicle type to a workshop. Familiarization training for decommissioning and isolation should be provided based on individual vehicle types.

Decommissioning and isolation of a battery electrical system shall be undertaken in accordance with the vehicle OEM/battery electrical system supplier's manuals and specifications.

Decommissioning and isolation of the electrical system shall be completed in a single pass without interruption.

A suitably qualified person shall isolate the vehicle traction electrical circuit, lock out the traction battery system, and confirm that the vehicle traction electrical circuit is not live.

The safety steps shall include but are not limited to:

- a) isolating the traction system;
- b) checking that the battery disconnection units have functioned correctly;
- c) disconnecting and lock out the traction system batteries; and
- d) testing that the traction system is voltage free.

***NOTE 1** There might be residual charge left in the vehicle before it reads as voltage free. Discharge rates differ between OEMs, and it is advised to wait a certain period before testing and work, as advised by the OEM.*

***NOTE 2** A voltage detector can be used to test that the traction system is voltage free (i.e. "check for dead"). A proving unit can be used to check the correct function of the voltage detector. A multimeter can be used after the voltage detector to confirm for dead and obtain a voltage reading. The reading on a multimeter should be checked before and after the measurement is taken.*

NOTE 3 Another qualified person who is trained in first aid should observe and check that safety measures are followed during decommissioning and isolation in case an incident occurs; sometimes referred to as a “buddy system”.

A battery electric HDV shall not be connected to a charging system during decommissioning and isolation.

PPE shall be worn during the decommissioning and isolation process, in accordance with the manufacturer’s maintenance manual and the risk assessment as outlined in **A.3.2**.

NOTE 4 All safety steps should be recorded in accompanying documentation, such as a job pack.

B.4.4.3 Confirmation of safe condition

If the system cannot be verified as safe, work shall stop immediately, and technical support shall be sought from a suitably qualified person.

NOTE 1 Verification of safety can be undertaken by testing the traction system with a voltage detector.

NOTE 2 Technical support may include support from the vehicle OEM or battery electrical system supplier, dependent on warranties and agreements in place.

B.4.5 During work

B.4.5.1 Qualified person and conformity assessment

A qualified person shall perform a conformity assessment according to the instructions and requirements given by the vehicle manufacturer and battery supplier, which includes a visual inspection of the traction voltage system.

B.4.5.2 Part replacement

Any work involving removal of potentially damaged electrical system components shall be carried out by a suitably qualified person.

NOTE 1 This includes any work where there is a risk of exposure to live parts other than circuit testing as part of the decommissioning/recommissioning processes.

NOTE 2 Part replacement may be undertaken by the vehicle OEM or battery electrical system supplier, dependent on warranties and agreements in place.

In the case of repairs and replacement of parts of the electrical system installation, materials and parts shall meet the specifications of the manufacturer or the supplier.

NOTE 3 Traction batteries are non-serviceable components in standard maintenance and repair workshops (see **B.4.5.4.1**).

B.4.5.3 Operation and maintenance instructions

The operation and maintenance instructions of the manufacturer or the supplier(s) of the battery electrical system installation shall be followed. These operation and maintenance instructions shall be available to the battery electric HDV workshop personnel.

B.4.5.4 Restrictions during fault diagnosis, repair and maintenance

B.4.5.4.1 Repair and maintenance of traction batteries

Traction batteries shall not be disassembled within a standard maintenance and repair workshop.

Traction batteries shall only be worked on in dedicated battery repair facilities or cleanrooms, in accordance with the battery supplier’s specifications.

NOTE Dedicated battery repair facilities and cleanrooms have additional safety precautions to work on batteries.

B.4.5.4.2 Temporary recommissioning during repair and maintenance

Traction batteries shall not be temporarily reconnected during maintenance and repair, unless as part of controlled connections within diagnostic requirements.

The recommissioning processes shall be undertaken in full if reconnection of the traction battery is required during a maintenance or repair process.

Vehicle lock out and isolation shall be formally handed over between suitably qualified persons if necessary.

At no time shall a battery electric HDV be left without lock out during work.

B.4.5.4.3 Charging during repair and maintenance

Battery electric HDV charging, or connection of an external power source, shall not be carried out during maintenance and repair.

B.4.6 After work

B.4.6.1 Battery electrical system inspection

A suitably qualified person shall inspect work on completion to confirm the safety and integrity of the whole battery electrical system and all components prior to recommissioning.

NOTE 1 The suitably qualified person inspecting work on completion may be the same person that has undertaken the work, dependent on their level of qualification and the workshop size.

The electrical system inspection shall include but is not limited to inspection of the vehicle traction electrical circuit to confirm that all components are correctly located, properly attached to the vehicle, and connected to each other by the correct cables.

NOTE 2 A circuit diagram may be used as a reference.

A safety check shall be performed before reconnection to confirm the function of the battery disconnection unit. The safety check shall involve the connection of a test device to the battery.

If the traction battery fails the test, a suitably qualified person shall be informed.

NOTE 3 Support from the vehicle OEM or battery electrical system supplier might be necessary, dependent on warranties and agreements in place.

NOTE 4 If the traction battery fails the test, it might be necessary to change the traction battery. Battery replacement may be undertaken by the vehicle OEM/battery electrical system supplier or by the workshop, dependent on warranties and agreements in place and on the ability of the workshop to change traction batteries in terms of available equipment.

B.4.6.2 Removing isolation and recommissioning

COMMENTARY ON B.4.6.2

Recommissioning procedures might differ across vehicle and battery types. The manufacturer's manual should be consulted prior to undertaking recommissioning, especially for a new vehicle type to a workshop. Familiarization training for recommissioning should be provided based on individual vehicle types.

Removal of isolation and recommissioning of a battery electrical system shall be undertaken in accordance with the vehicle OEM/battery electrical system supplier's manuals and processes.

Removal of isolation and recommissioning of the electrical system shall be completed in a single pass without interruption by a suitably qualified person.

Once the electrical system has been confirmed as safe by a qualified person (see B.4.6.1), a suitably qualified person shall undertake removal of isolation and recommissioning.

B.5 Vehicle disposal

B.5.1 Vehicle scrapping

The traction battery shall be removed by a suitably qualified person prior to vehicle scrapping.

NOTE 1 Disposal and recycling of batteries are covered in C.9.

Scrapping operations shall only be carried out by authorized scrapping centres.

NOTE 2 Some workshops might have a designated area where vehicles for disposal are temporarily parked.

B.5.2 Vehicle resale

When the vehicle is sold as a battery electric HDV, the relevant battery electric HDV documents, including documentation related to the traction battery (see C.8), shall be transferred with the vehicle.

NOTE Vehicle technical manuals can be made available electronically.

B.6 Transportation of battery electric HDVs

COMMENTARY ON B.6

This subclause is focused on the transportation of battery electric HDVs, rather than the transportation of lithium-ion batteries, which is covered in UN regulation UN3480 [3]. Attention is also drawn to MGN 653 [12] for guidance on electric vehicle onboard passenger roll-on/roll-off ferries.

When the battery electric HDV is to be transported by road, rail or ferry, or a tunnel is to be used, the battery electric HDV owner shall inform the driver of any restrictions. The battery electric HDV owner shall advise those responsible for transporting the battery electric HDV of all the fuel sources on board of the vehicle.

B.7 Documentation for battery electric HDVs

The battery electric HDV owner shall review the documentation provided by the supplier of the vehicle and of the battery on the safe operation of the battery electric HDV. The documentation shall include the safety related properties of the battery electrical system.

NOTE 1 Workshops can incorporate an auditable trail (for example, a logbook) to monitor that the documentation has been reviewed by the correct workshop personnel.

The battery electric HDV owner shall keep the operational information up to date with available documentation as supplied.

A battery electric HDV shall be equipped with a vehicle manual that contains at least information about:

- a) safe operations of the vehicle;
- b) safety precautions;
- c) battery properties;
- d) electrical safety;
- e) charging operations;
- f) required periods for inspections, diagnostics and maintenance;
- g) accidents; and
- h) vehicle disposal and scrapping.

NOTE 2 Some battery electric HDVs might have multiple manuals if different components of the vehicle are manufactured by different OEMs.

Annex C (normative)

Management of batteries and battery systems

C.1 Use

C.1.1 Service conditions of battery system

The battery electric HDV user shall be informed by the OEM or battery system manufacturer about the intended service conditions of the battery, including but not limited to its life in years, the battery chemistry, and the number of expected charging cycles.

NOTE 1 Attention is drawn to PAS 7060 for guidance on the safe and environmentally conscious design and use of batteries for electric vehicles.

NOTE 2 Warranty conditions may be provided by the OEM, and performance of the battery may be monitored.

C.1.2 Installation instructions for battery system

Installation instructions shall be provided by the OEM or battery system manufacturer and followed so that the battery system does not suffer damage during installation and during normal operation over the intended service life.

NOTE Provision of in-depth installation instructions for battery systems might depend on agreements in place between vehicle owners/operators and the vehicle OEM and/or battery supplier. Workshops with suitably qualified persons and suitable equipment can replace batteries within these workshops (see C.6).

C.1.3 Tasks of the qualified person

The qualified person shall check that:

- a) there are written procedures to confirm safe working practices; and
- b) all the personnel involved in any process regarding management of battery systems are well informed and trained on working practices, associated risks, and emergency procedures.

C.2 Handling of batteries

COMMENTARY ON C.2

Attention is drawn to PAS 7061 for recommendations on the safe and environmentally conscious handling of battery packs and modules for batteries for vehicle propulsion electrification.

C.2.1 General

A risk assessment shall be made prior to a decision regarding the handling of batteries within a workshop (A.2.3.2), which shall include batteries requiring lifting devices.

Clear instructions and procedures for handling defective and severely damaged batteries shall be in place (C.4 and C.5).

Batteries shall be removed from their original packaging at the latest possible stage in order to maintain protection against mechanical impact.

Batteries shall always be kept in an upright position.

The lifting points shall be used when removing batteries from their packaging, including when a lifting device is used.

C.2.2 Classification of batteries

COMMENTARY ON C.2.2

Workshops servicing battery electric HDVs, and workshops that store batteries, should have a system in place to classify batteries based on their condition. Within this document, three categories of batteries are covered: general (safe condition), defective (subject to repair), and severely damaged (damaged beyond repair). Different workshops might have different classification systems; however, a classification system should be in place, as different battery classifications are handled in different ways. The exact battery classification system can be determined by a risk assessment. The number and type of battery categories should be determined by the workshop owner based on the batteries handled by the workshop.

NOTE 1 *Workshops can have additional battery categories than the three listed above, dependent on the batteries being handled by the workshop.*

A suitably qualified person shall have overall responsibility regarding the classification of batteries into the categories of, at a minimum safe, defective, or severely damaged.

NOTE 2 *Workshops can have additional battery categories than the three listed above, dependent on the batteries being handled by the workshop.*

A labelling system shall be used to distinguish between different batteries that fall under different categories of the classification system.

NOTE 3 *A risk assessment should determine the labelling to be used, for example, coloured labels.*

C.2.3 Handling of defective or severely damaged batteries

A suitably qualified person shall compile and collate information to confirm correct battery classification.

Information regarding the battery and its previous use/misuse shall be documented and made available to all concerned parties (C.8).

Handling of defective or severely damaged batteries shall be supplemented on all sites with local guidelines.

NOTE 1 *Attention is drawn to PAS 7061 for recommendations on the safe and environmentally conscious handling of battery packs and modules.*

NOTE 2 *Defective and damaged batteries are subject to specific storage requirements (C.4 and C.5).*

C.2.4 Unacceptable damage

Handling procedures shall be specified and provided to prevent damage.

NOTE *Unacceptable damage refers to damage caused to the battery that can be avoided, e.g. due to improper handling and storage.*

When battery systems are removed from battery electric HDVs, measures shall be taken to avoid any mechanical damage to these battery systems due to an improper handling.

C.2.5 Hot work

Hot works shall be subject to an individual risk assessment and permit-to-work controls. A duty manager shall sign the risk assessment off once the relevant cautions have been put in place.

For special operations where hot work (such as baking the battery electric HDV in a paint-curing oven) is involved, the battery electric HDV workshop shall observe all the relevant procedures and precautions, including those of the battery electric HDV manufacturer/battery system supplier and allowable temperature limits.

NOTE *Subject to a dynamic risk assessment, the battery might need to be removed or the traction battery isolated to avoid the potential for any damage to the batteries from heat and/or electricity.*