BS EN 62485-3:2014

BSI Standards Publication

Safety requirements for secondary batteries and battery installations

Part 3: Traction batteries

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National foreword

This British Standard is the UK implementation of EN 62485-3:2014. It is identical to IEC 62485-3:2014. It supersedes BS EN 50272-3:2002 which will be withdrawn on 14 August 2017.

The UK participation in its preparation was entrusted to Technical Committee PEL/21, Secondary cells and batteries.

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

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

Published by BSI Standards Limited 2014

ISBN 978 0 580 88576 1

ICS 29.220.20; 29.220.30; 43.040.10

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2014.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 62485-3

October 2014

ICS 29.220.20; 29.220.30; 43.040.10

Supersedes EN 50272-3:2002

English Version

Safety requirements for secondary batteries and battery installations - Part 3: Traction batteries (IEC 62485-3:2014)

Exigences de sécurité pour les batteries d'accumulateurs et les installations de batteries - Partie 3: Batteries de traction (CEI 62485-3:2014)

Sicherheitsanforderungen an Batterien und Batterieanlagen - Teil 3: Antriebsbatterien für Elektrofahrzeuge (IEC 62485-3:2014)

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 62485-3:2014 E

Foreword

The text of document 21/834/FDIS, future edition 2 of IEC 62485-3, prepared by IEC/TC 21 "Secondary cells and batteries" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62485-3:2014.

The following dates are fixed:

– latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-05-14
– latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-08-14

This document supersedes EN 50272-3:2002.

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The text of the International Standard IEC 62485-3:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated :

IEC 61429	NOTE	Harmonized as EN 61429.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

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

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

Publication	Year	Title	EN/HD	Year
IEC 60204-1	-	Safety of machinery - Electrical equipment of machines - Part 1: General requirements	EN 60204-1	-
IEC 60364-4-41 (mod) -	2005 -	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock	HD 60364-4-41 + corrigendum Jul.	2007 2007
IEC 60900	-	Live working - Hand tools for use up to 1 000 V a.c. and 1 500 V d.c.	EN 60900	-
IEC 61140	-	Protection against electric shock - Common aspects for installation and equipment	EN 61140	-
ISO 3864	series	Graphical symbols - Safety colours and safety signs	-	-

CONTENTS

SAFETY REQUIREMENTS FOR SECONDARY BATTERIES AND BATTERY INSTALLATIONS –

Part 3: Traction batteries

1 Scope

This part of the IEC 62485 applies to secondary batteries and battery installations used for electric vehicles, e.g. in electric industrial trucks (including lift trucks, tow trucks, cleaning machines, automatic guided vehicles), in battery powered locomotives, in electric vehicles (e.g. goods vehicles, golf carts, bicycles, wheelchairs), and does not cover the design of such vehicles.

This International Standard covers lead dioxide-lead (lead-acid), nickel oxide-cadmium, nickel-oxide-metal hydride and other alkaline secondary batteries. Safety aspects of secondary lithium batteries in such applications will be covered in their own appropriate standards.

The nominal voltages are limited to 1 000 V a.c. and 1 500 V d.c. respectively and the principal measures for protection against hazards generally from electricity, gas emission and electrolyte are described.

It provides requirements on safety aspects associated with the installation, use, inspection, maintenance and disposal of batteries.

2 Normative references

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

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60900, *Live working – Hand tools for use up to 1 000 V a.c. and 1 500 V d.c.*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

ISO 3864 (all parts), *Graphical symbols – Safety colours and safety signs*

3 Terms and definitions

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

3.1
secondary cell
cell which is designed to be electrically recharged

Note 1 to entry: The recharge is accomplished by way of a reversible chemical reaction.

3.2
lead dioxide lead battery
accumulators (deprecated)
secondary battery with an aqueous electrolyte based on dilute sulphuric acid, a positive electrode of lead dioxide and a negative electrode of lead

3.3
nickel oxide cadmium battery
secondary battery with an alkaline electrolyte, a positive electrode containing nickel oxide and a negative electrode of cadmium

3.4
vented cell
a secondary cell having a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cell to the atmosphere

3.5
valve regulated lead-acid battery
VRLA
secondary battery in which cells are closed but have a valve which allows the escape of gas if the internal pressure exceeds a predetermined value

Note 1 to entry: The cell cannot normally receive addition to the electrolyte.

3.6
gas-tight sealed cell
gas-tight sealed secondary cell
secondary cell which remains closed and does not release either gas or liquid when operated within the limits of charge and temperature specified by the manufacturer

Note 1 to entry: The cell may be equipped with a safety device to prevent dangerously high internal pressure.

Note 2 to entry: The cell does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

3.7
secondary battery
two or more secondary cells connected together and used as a source of electrical energy

3.8
traction battery
secondary battery which is designed to provide the propulsion energy for electric vehicles

3.9
monobloc battery
battery with multiple separate but electrically connected cell compartments each of which is designed to house an assembly of electrodes, electrolyte, terminals and interconnections and possible separator

Note 1 to entry: The cells in a monobloc battery can be connected in series or parallel.

3.10
electrolyte
liquid or solid substance containing mobile ions which render it ionically conductive

Note 1 to entry: The electrolyte may be a liquid, solid or a gel.

3.11
gassing of a cell
evolution of gas resulting from the electrolysis of water in the electrolyte of the cell

3.12
charging of a battery
operation during which a secondary cell or battery is supplied with electrical energy from an external circuit which results in chemical changes within the cell and thus storage of energy as chemical energy

3.13
equalisation charge
extended charge to ensure an equal state of charge of all cells in a battery

3.14
opportunity charging
use of free time during a work period to top up the charge and thus extend the work period of a battery whilst avoiding excessive discharge

3.15
overcharge
continued charging of a fully charged secondary cell or battery

Note 1 to entry: Overcharge is also the act of charging beyond a certain limit specified by the manufacturer.

3.16
discharge
discharge of a battery
operation during which a battery delivers, to an external circuit and under specified conditions, electrical energy produced in the cells

3.17
peripheral equipment
battery peripheral equipment
equipment installed on the battery, which supports or monitors the operation of the battery

Note 1 to entry: Examples are a central water filling system, an electrolyte agitation system, a battery monitoring system, a central de-gassing system, the battery connectors (plugs and sockets), a thermal management system, etc.

3.18
charging room
room or closed area intended specifically for recharging batteries

Note 1 to entry: The room may also be used for battery maintenance.

3.19
charging area
open area designated and made suitable for recharging batteries

Note 1 to entry: The area may also be used for maintenance of batteries and battery related equipment.

4 Protection against electric shock by the battery and charger

4.1 General

Measures shall be taken on traction batteries and in traction battery charging installations for protection against either direct contact or indirect contact, or against both direct and indirect contact.

These measures are described in detail in IEC 60364-4-41 and IEC 61140. The following clauses and the resulting amendments describe the typical measures to be taken for traction battery installations.

The appropriate equipment standard IEC 61140 applies to batteries and direct current distribution circuits located inside equipment.

4.2 Protection against both direct and indirect contact

On batteries and in battery charging installations protection against direct contact with live parts shall be ensured in accordance with IEC 60364-4-41.

The following protective measures against direct contact apply:

– protection by insulation of live parts;
– protection by barriers or enclosures;
– protection by obstacles;
– protection by placing out of reach.

The following protective measures against indirect contact apply:

– protection by automatic disconnection or signalling;
– protection by protective insulation;
– protection by earth-free local equipotential bonding;
– protection by electrical separation.

4.3 Protection against direct and indirect contact when discharging the traction battery on the vehicle (battery disconnected from charger/mains)

4.3.1 For batteries having a nominal voltage up to and including 60 V d.c., protection against electric shock caused by direct contact is not formally required, as long as the whole installation corresponds to the conditions for safety extra low voltage (SELV) and protective extra low voltage (PELV).

NOTE The nominal voltage of a lead dioxide - lead cell (lead acid) is 2,0 V, that of a nickel oxide – cadmium or nickel oxide - metal hydride cell is 1,2 V. When these cells are boost charged, their voltage can reach 2,7 V in lead acid or 1,6 V in nickel oxide based systems.

However, for other reasons, e.g. short circuits, mechanical damage etc., all batteries in electrical vehicles shall be protected against direct contact of live parts, even if the battery nominal voltage is 60 V d.c. or less.

4.3.2 For batteries having a nominal voltage above 60 V d.c. and up to and including 120 V d.c., protection against electric shock caused by direct contact is required.

NOTE Batteries with nominal voltage up to and including 120 V d.c. are regarded as safe power sources for SELV-systems (safety extra low voltage) or PELV-systems (protective extra low voltage), see IEC 60364-4-41:2005,411.1.

The following protective measures apply:

– protection by insulation of live parts;
– protection by barriers or enclosures
– protection by obstacles;
– protection by placing out of reach.

If the protection against direct contact of live parts is ensured only by obstacles or placing out of reach, access to the battery accommodation shall be restricted to trained and authorized personnel only, and the battery accommodation shall be marked by appropriate warning labels (see Clause 11).

For batteries having a nominal voltage exceeding 120 V d.c., protective measures against both direct and indirect contact are required.

Battery compartments with batteries having a nominal voltage exceeding 120 V d.c. shall be locked and have access restricted to trained and authorized personnel only and shall be marked by appropriate warning labels (see Clause 11).

For batteries with a nominal voltage exceeding 120 V d.c., the following protective measures against indirect contact apply:

– protection by electrical insulation of live parts;
– protection by earth-free equipotential local bonding;
– protection by automatic disconnection or signalling.

4.4 Protection against direct and indirect contact when charging the traction battery

When battery chargers with safe galvanic separation from the feeding mains are used according to IEC 61140, the protective measures SELV or PELV shall be applied. If the nominal voltage of the battery does not exceed 60 V d.c. protection against direct contact is not formally required, as long as the total installation corresponds to conditions of SELV or PELV.

When the battery charger does not comply with these requirements, then the protective measures against direct and indirect contact shall be applied according to IEC 60364-4-41.

However, for other reasons, e.g. short circuits, mechanical damage etc., all batteries in electrical vehicles shall be protected against direct contact of live parts, even if the battery nominal voltage is 60 V d.c. or less.

5 Prevention of short circuits and protection from other effects of electric current

5.1 Cables and cell connectors

Cables and cell connectors shall be insulated to prevent short circuits.

If protection against short circuits cannot be provided by over-current protection devices for battery-specific reasons, then the connecting cables between charger, respective battery fuse, and battery, and between battery and vehicle shall be protected against short circuits and earth fault.

The cables shall meet the requirements of IEC 60204-1.

When a trailing cable is used, the protection against short circuits shall be improved by the use of single core cable according to IEC 60204-1. However, where the battery nominal voltage is less than or equal to 120 V d.c., a trailing cable of grade H01N2D, for higher flexibility, can be used.

The battery terminal cables shall be fixed in a manner that prevents tensile and torsional strain on the battery terminals.

Insulation shall be resistant to the effects of ambient influences such as temperature, electrolyte, water, dust, commonly occurring chemicals, gasses, steam and mechanical stress.

5.2 Protective measures during maintenance

In order to minimize the risk of injury during work on live equipment, only insulated tools according to IEC 60900 shall be used and the following appropriate procedures shall be implemented:

– batteries shall not be connected or disconnected before the load or charging current has been switched off;

– battery terminal and connector covers shall be provided which allow routine maintenance whilst minimizing exposure of energized conductive parts;
– all metallic personal objects shall be removed from the operator's hands, wrists and neck before starting work;
– for battery systems where the nominal voltage is above 120 V d.c., insulated protective clothing and/or local insulated coverings shall be required to prevent personnel making contact with the floor or parts bonded to earth. Insulated protective clothing and floor covering material shall be anti-static.

For reasons of safety, it is strongly advisable that batteries having a nominal voltage above 120 V d.c. are divided into sections of 120 V d.c. (nominal) or less before maintenance work is commenced.

5.3 Battery insulation

5.3.1 This subclause does not apply to batteries used in electrically propelled road vehicles where the battery insulation requirement is covered by particular standards for that application.

5.3.2 A new, filled and charged battery shall have an insulation resistance of at least 1 MΩ when measured between a battery terminal and metallic tray, vehicle frame or other conductive supporting structure. Where the battery is fitted into more than one container, this requirement applies with the sections, including metal battery containers, electrically connected.

5.3.3 A battery in use, having a nominal voltage not higher than 120 V d.c., shall have an insulation resistance of at least 50 Ω multiplied by the nominal battery voltage but not less than 1 kΩ when measured between a battery terminal and metallic tray, vehicle frame or other conductive supporting structure. If the nominal battery voltage exceeds 120 V d.c. an isolation resistance of at least 500 Ω multiplied by the nominal battery voltage is required. Where the battery is fitted into more than one container, this requirement applies with the sections, including metal battery containers, electrically connected.

5.3.4 The insulation resistance of the vehicle and traction battery shall be checked separately. The resistance test voltage shall be equal to or higher than the nominal voltage of the battery, but no more than 100 V d.c. or three times the nominal voltage (also see EN 1175-1).

NOTE Measurement can be implemented according to the procedure described in EN 1987-1:1997, 6.2.1.

6 Provisions against explosion hazards by ventilation

6.1 Gas generation

During charge processes, gases are emitted from all secondary cells and batteries using aqueous electrolyte, with the exception of gastight (secondary) cells. This is a result of the electrolysis of the water by the overcharging current. Gases produced are hydrogen and oxygen. When emitted into the surrounding atmosphere, an explosive mixture is created if the hydrogen concentration exceeds 4 % hydrogen in air.

In order to avoid abusive charging and/or excessive gassing, the charger type, its rating and characteristics shall be properly matched to the battery type in accordance with the manufacturer's instructions. In particular for valve-regulated lead-acid batteries and other types of recombination type batteries it is crucial that an appropriate charger type is used. Also see 6.2.3.

When gas emission is determined experimentally with battery test standards and the value found is lower than that used in the present standard, then no reduction of the ventilation requirements shall be admissible. If the experimental gas emission value is higher than the value assumed in the present standard, then the ventilation requirements shall be adapted i.e. increased.

When a cell reaches its fully charged state, water electrolysis occurs according to the Faraday's law. Under standard conditions i.e at 0 °C and 1 013 hPA (STP under IUPAC):

– 1 Ah decomposes 0,336 g H_2O into 0,42 l H_2 + 0,21 l O_2;
– 3 Ah decompose 1 cm^3 (1 g) of H_2O;

When the operation of the charge equipment is stopped, the emission of gas from the cells will substantially subside within one hour. However, precautions are still necessary after this time, as gas trapped within the cells can be released suddenly due to movement of the battery when it is refitted to the vehicle or when the vehicle moves in service. Some additional gas also can be produced during service e.g. owing to regenerative braking.

6.2 Ventilation requirements

6.2.1 General

The ventilation requirements of this subclause shall be met whether the battery is charged on or off the vehicle.

The purpose of ventilating a battery location or enclosure is to maintain the hydrogen concentration below the 4 % hydrogen threshold. Battery accommodation rooms are to be considered as safe from explosions, when by natural or forced ventilation, the concentration of hydrogen is kept below this limit.

The required minimum ventilation airflow for a battery charging room, charging area or battery compartment shall be calculated by use of the formula presented in 6.2.2. Where local regulations call for lower average hydrogen concentration, e.g. for environmental hygienic reasons, the rate of ventilation shall be increased accordingly. Also see 6.3.

VRLA cells and monobloc batteries used for traction purpose enter their service life with an excess of electrolyte and with incomplete oxygen recombination and thus may basically produce the same amount of hydrogen as flooded cells or batteries until they reach a mature operational stage after a number of service cycles. The possible need of increased ventilation in connection with this shall be considered by the user.

6.2.2 Calculation of the minimum ventilation air flow

The following formula for the calculation of the required minimum ventilation air flow Q shall, with the exception of special chargers (see 6.2.4), be used with any type of properly matched unregulated or regulated battery charger when charging vented or valve-regulated lead-acid batteries or vented nickel-cadmium batteries:

$$Q = v \times q \times \mathrm{s} \times n \times I_{gas} \ [\mathrm{m^3/h}]$$

where

Q is the ventilation air flow in m^3/h;

v is the necessary dilution of hydrogen: $\frac{(100\ \% - 4\ \%)}{4\ \%} = 24$;

q = $0{,}42 \times 10^{-3}$ m^3/Ah generated hydrogen at 0 °C;

For calculations at 25 °C, the value of q at 0 °C shall be multiplied by factor 1,091 5; this factor being derived from the general expression $(T+273)/273$, where T is the temperature in °C;

s = 5, general safety factor;

n is the number of cells;

I_{gas} is the gassing current value to be used for the calculation of ventilation air flow, see below.

The ventilation air flow calculation formula can be resolved into the following:

$$Q = 0,055 \times n \times I_{gas} \quad [m^3/h]$$

The formula is basically valid at 25 °C, but may, considering the safety factor used, be applied with no further adjustment up to the maximum operating temperature of the battery.

For the determination of I_{gas}, the following applies:

a) Where a regulated charger having an output characteristics independent of occurring input mains voltage variations is used, and for which the accurate value of charging current during the last portion of charging is known with certainty, then this value may be used for I_{gas} in the ventilation air flow calculation.

   If the value of charging current during the last portion of charging is not known with certainty, and a regulated multi-volt charger is used, then use the highest final charging current value it is capable of supplying for I_{gas}.

   The regulated charger manufacturer should be consulted for the value of charging current during the last portion of charging, when no values are known, to enable the use of this value for I_{gas} in the ventilation air flow calculation.

   NOTE 1 A 48 V lead-acid traction battery consisting of 24 cells is to be charged from a regulated charger delivering an end of charge current of maximum 30 A. According to the above definitions, the value of I_{gas} = 30 A. The ventilation air flow requirement at 25 °C amounts to $Q = 0,055 \times 24 \times 30 = 39,6$ [m³/h].

b) For unregulated chargers and in all other cases where the end of charge current is not known with certainty, I_{gas} shall be set equal to 40% of the rated charger output current I_n:

$$I_{gas} = 0,4 \times I_n \text{ [A]}.$$

   NOTE 2 A 48 V lead-acid traction battery consisting of 24 cells is to be charged from a unregulated charger with an output rating of 48 V/ 100 A. According to the above definitions, the value of I_{gas} = 0,4 x 100 = 40 A. The ventilation air flow requirement at 25 °C amounts to $Q = 0,055 \times 24 \times 40 = 52,8$ [m³/h].

6.2.3 Recommended charging practice

In order to reduce the risk of accidents and to ensure correct charging takes place it is essential that the charger and battery are properly matched. The manufacturer´s directions and recommendations for the selection of charger type, characteristics and size shall be followed.

It is of prime importance that the charging current during the last portion of the charging procedure is kept at a level appropriate for the battery type used. For flooded batteries, abusive charging will cause abnormal temperature rise, excessive gassing and increased water consumption resulting in risk to safety of operation, increased maintenance work and reduced battery service life. Batteries working with recombination such as valve-regulated lead-acid (VRLA) batteries also run the risk of total destruction and explosion by thermal runaway. For the VRLA and other recombination batteries, the use of a controlled charger of appropriate size is essential.

If not otherwise stated by the battery manufacturer, the values presented in Table 1 can be used as a guideline for maximum charging current to be applied during the last portion of charging. The values shown in Table 1 are not intended for use as I_{gas} in the calculation of the required ventilation air flow (see 6.2.2).

Table 1 – Guideline: Maximum final charging current in A per 100 Ah during normal conditions of use

Charger characteristics	Vented lead acid battery cells	Valve regulated lead acid cells (VRLA)	Vented nickel-cadmium cells	Sealed nickel- cadmium or nickel metal hydride cells
Taper charging	7	Not applicable	Not applicable	Not applicable
IU charging	(2,4 V/cell max.) 2	(2,4 V/cell max) 1,0	(1,55 V/cell max) 5	Consult manufacturer of cells and charger
IUI charging	5	1,5	5	

6.2.4 Special chargers

Where pulse chargers or other special chargers, e. g. those known as “fast chargers” or where other charger types with unconventional charging characteristics or performance are used, the value of I_{gas} shall be specified by the charger manufacturer. For charging regimes implying pulses during the end of charging in order to accelerate the reversal of the acid stratification, an averaged value should then be applied as I_{gas}.

6.2.5 Multiple charging

When two or more batteries are simultaneously being charged in the same room, then the ventilation requirement shall be the sum of the individual ventilation air flow needs.

6.3 Natural ventilation

The required amount of ventilation air flow should be ensured by natural ventilation. In case there is any doubt about the sufficiency of the natural ventilation, it should be checked by measurement and the positions and readings recorded to enable comparisons with future measurements. Forced (artificial) ventilation shall be implemented where needed to obtain the required ventilation air flow as stated in 6.2.2.

As a guideline, charging rooms and charging areas require an air inlet and an air outlet with a minimum free area of opening calculated by the following formula, based on the condition that the natural air velocity in the inlets and outlets is at least 0,1 [m/s]:

$$A = 28 \times Q$$

where

Q is the required ventilation flow rate of fresh air [m^3/h];

A is the free area of opening in air inlet and outlet [cm^2].

The air inlet and outlet shall be located at the best possible location to create best conditions for exchange of air, i.e. with

- openings on opposite walls;
- minimum separation distance of 2 m between openings on the same wall.

In particular, care should be given to bring about adequate ventilation in the close vicinity of the batteries being charged. Also see 6.5.

In naturally vented charging rooms or areas having a free volume of at least $2,5 \times Q$ [m^3] no forced ventilation is required unless particular technical or environmental hygienic reasons call for it.

The air extracted from the charging area/room shall be exhausted to the atmosphere outside the building.

6.4 Forced ventilation

Where an adequate air flow Q cannot be obtained by natural ventilation and forced ventilation is implemented, the charger shall be interlocked with the ventilation system or an alarm shall be actuated when the required air flow, for the selected mode of charging, is not assured.

The air movement created by forced ventilation shall be measurable for known parts of the area, and recorded as part of its commissioning, to enable retesting periodically to be undertaken to ensure its still functioning correctly. The frequency of retesting would be set by local requirements of the country.

The air extracted from the charging room shall be exhausted to the atmosphere outside the building.

6.5 Close vicinity to the battery

In the close vicinity of the battery, the dilution of explosive gases is not always secured. Therefore, a safety distance of minimum 0,5 m extending through the air without flames, electrostatic discharge, sparks, arcs or glowing objects (maximum surface temperature 300 °C) shall be observed.

6.6 Ventilation of battery compartment

6.6.1 Where removable covers are provided for the battery and when appropriate, the covers shall be removed prior to charging in order to ventilate gas produced and aid battery cooling.

6.6.2 Suitable ventilation openings shall be provided in the battery container, compartment or cover so that during discharge or rest periods, dangerous accumulation of gas does not occur when the equipment is used in accordance with the manufacturer's instructions.

The ventilation opening area shall be at least:

$$A = 0{,}005 \times n \times C_5 \qquad [\text{cm}^2]$$

where

A is the total cross-sectional area of ventilation holes required [cm^2];

n is the number of cells in battery;

C_5 is the capacity of battery at the 5 h rate [Ah].

7 Provisions against electrolyte hazard

7.1 Electrolyte and water

Electrolyte used in lead-acid batteries is an aqueous solution of sulphuric acid. Electrolyte used in NiCd and NiMH batteries is an aqueous solution of potassium hydroxide. Distilled or demineralised water is used when topping up the cells. The conductivity of freshly prepared topping-up water should be less than or equal to 10 μS/cm. For stored water, a conductivity of maximum 30 μS/cm can be accepted.

7.2 Protective clothing

In order to avoid personal injury from electrolyte splashes when handling electrolyte and/or vented cells or batteries, protective clothing shall be worn, such as

– protective glasses or face shields,
– protective gloves and aprons.

In the case of valve-regulated or gastight sealed batteries, at least protective glasses and gloves shall be worn.

7.3 Accidental contact, "first aid"

7.3.1 General

Acid and alkaline electrolytes create burns in eyes and on the skin.

A source of clean water, from tap or a dedicated sterile reservoir, shall be provided in the vicinity of the battery under charging or maintenance for removing electrolyte splashed onto body parts.

7.3.2 Eye contact

In the event of accidental contact with electrolyte, the eyes shall be immediately flooded with large quantities of water for an extended period of time. In all cases immediate medical attention shall be obtained.

7.3.3 Skin contact

In the event of accidental skin contact with electrolyte, the affected parts shall be washed with large quantities of water or with adequate neutralizing solutions. If irritation of skin persists medical attention shall be obtained.

7.4 Battery accessories and maintenance tools

Materials used for battery accessories, battery stands or enclosures, and components inside battery rooms shall be resistant to or protected from the chemical effects of the electrolyte.

In the event of electrolyte spillage, the liquids shall be removed promptly from all surfaces with absorbing and neutralizing material.

Maintenance tools such as funnels, hydrometers, thermometers which come in contact with electrolyte shall be dedicated either to the lead-acid or NiCd-batteries and shall not be used for any other purpose.

8 Battery containers and enclosures

8.1 The battery accommodation, trays, crates and compartments shall have adequate mechanical strength and be constructed either of electrolyte resistant materials or be protected against the damaging effects of electrolyte leakage and spillage.

8.2 Provision shall be made to prevent the spillage of electrolyte on to underlying equipment/components or the ground.

8.3 It shall be made possible to remove any accumulation of spilled electrolyte or water from the battery tray.

8.4 Waste electrolyte from maintenance work on batteries shall be disposed of in accordance with local regulations.

9 Accommodation for charging/maintenance

9.1 Charging areas shall be defined by clearly visible marking. The floor coating shall be acid resistant and have a resistance to ground less than 100 MΩ to avoid sparks by electrostatic discharge (not required for electric equipment for domestic use, e.g. wheel chairs, lawn movers, etc.).

9.2 The charging area shall be adequately spaced from materials which may constitute a hazard, such as inflammable or explosive goods.

9.3 Except during essential battery maintenance/repair, the charging area shall not be subjected to any sources of ignition such as sparks or sources of high temperature. The exception is where high temperature equipment is required for work on the battery and this shall be in the control of trained and authorized personnel who shall take all necessary precautions.

9.4 Prevention of electrostatic discharges when working with batteries: care shall be taken not to wear clothes and footwear which may build up electrostatic charge.

Absorbent cloth for battery cleaning shall be antistatic and used moistened only with water without cleaning agents.

9.5 When the battery is being charged or serviced, a spacing of at least 0,8 m width shall be provided on those sides required for access.

9.6 When charging batteries on or off the vehicle, the ventilation requirements of Clause 6 shall be met.

9.7 The charger as well as other installations in the charging area, e.g. battery changing equipment, shall be placed or protected in such a way that it is not vulnerable to damage by movement of the vehicle.

9.8 The charging area shall not be vulnerable to falling objects, dripping water or liquids that could leak from fractured pipes.

9.9 Battery changing equipment, if used, shall be suitable for the battery trays and weights and be regularly checked. Battery changing shall be done by personnel trained to handle heavy weights. Preferably batteries should be changed laterally by means of certified supporting devices to minimize the risk of batteries tipping over, crushing, damage to other equipment, etc.

10 Battery peripheral equipment/accessories

10.1 Battery monitoring system

When applying battery monitoring systems and devices, the recommendations of IEC/TR 61431 should be observed.

A battery monitoring system shall be designed and installed in such a way, that no hazard will occur during its use and operation, for this:

– measuring cables installed on top of the battery shall have adequate protection against faults, e.g. fuses to open a circuit before any fault current can affect the cables in contact with the battery. This would also include devices which are in contact with cell poles and electrolyte, creating an electrical path.
– cable installation shall follow the potential of the series connected cells to avoid leakage currents, e.g. by means of accumulated dirt or electrolyte contamination;
– shunt cables or other measuring equipment shall be carefully fixed to the battery.

10.2 Central water filling system

10.2.1 General

During service of vented type traction batteries, water is lost as hydrogen and oxygen due to electrolysis occurring towards the end of charge. This water shall be periodically replaced in the battery cells to restore the electrolyte level and its specific gravity. The time to carry out this task is when the battery is fully charged and its tidal upper limit is known. This would apply to any method of topping up cells in a lead acid battery.

When topping up is done with a "central" or "single point" topping up system, specific watering plugs are installed in each cell and connected in series or series/parallel through a piping system. Water is fed to the cells from a central reservoir either by gravity, vacuum or under pressure according to the plug design. Once the electrolyte level in the cell achieves the prescribed level, water is prevented from further entering into the cell. This is accomplished in different ways according to the plug design.

In the “float” design, the plug is fitted with a float which closes a water inlet valve once the electrolyte achieves the required level. The gases are vented from each cell through an opening in the plug.

In the “air-lock” design, the plug has no float or other moving parts and once the electrolyte achieves the prescribed level, an overpressure is generated in the cell space above the electrolyte or within the plug itself sufficient to prevent the water from further entering into the cell. The gases are vented from the cell through the same piping used for the water topping-up.

10.2.2 Safety aspects

In any battery where the cells are interconnected by pipes, this may be from a gas mono-venting system or a water filling system, precautions shall be taken to minimize any risk of electrical tracking or the propagation of battery explosions between cells.

The following precautions shall be followed:

– to reduce the risk of electrical tracking, the piping system shall follow the potential of the electrical circuit;
– to reduce the risks of both electrical tracking and the propagation of explosions, the number of cells connected in a piped series circuit shall be kept low;
– the maximum number of cells which are connected in a series piped branch, shall not exceed those specified by the manufacturer of the system design.

NOTE In order to prevent an explosion occurring within an individual cell from propagating into the contiguous ones, the plugs can be fitted with a built-in safety feature such as a water trap that prevents hydrogen from entering into the water piping circuit.

10.3 Central degassing systems

Central degassing systems are used to vent the battery gases outside the battery compartment. In many cases, they are associated with central water filling systems.

Batteries equipped with hydrogen gas evacuation or central degassing systems based on gas collection covers and tubing are not covered by any product-, test- or safety standard. Therefore the provisions of the present standard and particular of Clause 6 concerning ventilation of the room or vehicle where the batteries are charged, is highly recommended.

With central degassing systems, the gas venting outlets shall be located outside the battery compartment and be protected with flame arrestors against the risk of explosions caused by sources of ignition close to the gas outlets.

Where during charging individual degassing circuits are coupled to a forced ventilation system which exhausts the entire gas evolved to the outside of the charging area, the ventilation requirements of the system shall be in accordance with 6.2 and 6.4.

10.4 Thermal management systems

Where thermal management systems are installed, care shall be taken so that no hazard is caused by ignition sources, leakage currents, electrolyte flooding, etc.

10.5 Electrolyte agitation system

Lead-acid traction batteries may be equipped with an electrolyte agitation system to eliminate stratification and reduce the charging factor. Mixing of the electrolyte is achieved by means of a continuous or intermittent air stream released inside at the bottom of the cell containers.

The air is fed through flexible tubes by an air pump to an air inlet on each cell.

Provision shall be made to avoid confusion between air supply and water filling pipe systems.

The piping system shall follow the potential of the electrical circuit. The maximum number of cells with peripheral accessories connected in series in a section shall be specified by the battery manufacturer.

10.6 Catalyst vent plugs

For the reduction of water consumption and the extension of topping up intervals, catalyst vent plugs may be used. Catalyst vent pugs recombine hydrogen and oxygen generated mainly during the recharge process, forming water that drops back into the cell.

The following hazards shall be considered:

– due to the exothermal recombination, reaction heat is generated and shall be dissipated into the ambient air (hot surface areas);
– the recombination reaction takes place only with certain efficiency, depending on the relationship of catalyst size to charge current and ageing of catalyst. Surplus charging gasses, which are not recombined, will be released from the catalyst vent plugs.

The ventilation requirements according to 6.2 shall be observed, despite the use of catalyst vent plugs. To avoid a premature drying out of the battery, regular checks of the function of the catalyst and of the electrolyte level shall be made.

10.7 Connectors (plugs/sockets)

Plugs and sockets for use with traction batteries shall be in accordance with the requirements of local or international standards as for example EN 1175-1:1998, Annex A.

For plugs and connectors for voltage higher than 240 V d.c., the instructions and suggestions of the manufacturer shall be obtained.

11 Identification labels, warning notices and instructions for use, installation and maintenance

11.1 Warning labels

Warning labels shall be used to inform and warn the personnel of risks associated with batteries and battery installations.

The following symbols according to ISO 3864 series shall be present:

– follow the instructions (information sign),
– use protective cloths and goggles (command sign),
– dangerous voltage (when 60 V d.c. is exceeded) (warning sign),
– prohibition of naked flame (warning sign),
– warning sign - battery hazard (warning sign),
– electrolyte is highly corrosive (warning sign),
– explosion hazard (warning sign).

11.2 Identification label

The following information shall be indelibly marked on each battery assembly unit:

– name of battery manufacturer or supplier;
– battery type reference;
– battery serial number;
– nominal battery voltage (within one battery unit);
– battery capacity with time rating;
– service mass[1], including ballast if used.

11.3 Instructions

The following instructions shall be delivered with the battery, charger and auxiliary equipment and be formulated so to be easily understood also by maintenance and operations personnel for whom the language used to write the instructions is not their mother tongue:

– safety recommendations and installation, operation and maintenance instructions,
– information regarding disposal and recycling.

11.4 Other labels

National or international regulations may require additional markings or labelling. Such regulations are for example the EC directives 2006/66/EC, *Disposal of spent batteries and accumulators,* 2006/95/EC *Low voltage* and 1993/68/EC*, CE marking.*

12 Transportation, storage, disposal and environmental aspects

12.1 Packing and transport

The packing and transport of secondary batteries is covered in various national and international regulations and shall take in account the dangers of accidental short circuits, heavy mass and spillages of electrolyte. The following international regulations apply for example for transport, safe packing and carriage of dangerous goods depending of the geographic area and mode of transport:

a) Road: National or regional regulations to be applied, e. g.

   European Agreement for the International Carriage of Dangerous Goods by Road (ADR)

b) Rail (international):

   International Convention concerning the Carriage of Goods by Rail (CIM) Annex A: International Regulations concerning the Carriage of dangerous Goods by Rail (RID)

c) Sea:

1 Not required for individual monobloc batteries.

International Maritime Organisation, Dangerous Goods
Code IMDG Code 8 Class 8 corrosive

d) Air:

International Air Transport Association (IATA), Dangerous Goods Regulations

12.2 Disassembly, disposal, and recycling of batteries

Disassembly and disposal of batteries shall be carried out according to the prevailing local regulation by qualified personnel only.

13 Inspection and monitoring

To secure the safe operation of a traction battery, regular inspection is required. Any signs of deterioration shall be noted and be subject to repair, specifically in the case of electrolyte leakage and insulation failures.

The inspection of the battery can be incorporated into the regular maintenance routine of the battery, such as during the topping-up procedure.

Inspection and monitoring of batteries in service shall be in accordance with the battery manufacturer's instructions.

Bibliography

IEC 60050-482:2004, *International Electrotechnical Vocabulary – Part 482: Primary and secondary cells and batteries*

IEC 61429, *Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135*

IEC/TR 61431, *Guide for the use of monitor systems for lead-acid traction batteries*

ISO 7000, *Graphical symbols for use on equipment – Registered symbols*

EN 1175-1:1998, *Safety of electrical trucks – Electrical requirements – Part 1: General requirements for battery powered trucks*

EN 1987-1:1997, *Electrically propelled road vehicles – Specific requirements for safety – Part 1: On board energy storage*

EN 14458, *Personal eye-equipment*

EC directives 2006/66/EC, *Disposal of spent batteries and accumulators*

EC directive 2006/95/EC, *Low voltage*

EC directive 1993/68/EC*, CE marking*

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