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Secondary cells and batteries — Test methods for checking the performance of devices designed for reducing explosion hazards — Lead-acid starter batteries

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National foreword

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— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

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Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

Summary of pages

This document comprises a front cover, an inside front cover, the IEC/TR title page, pages 2 to 11 and a back cover.

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TECHNICAL REPORT

IEC 61430

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Secondary cells and batteries – Test methods for checking the performance of devices designed for reducing explosion hazards – Lead-acid starter batteries

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INTRODUCTION

Lead-acid starter batteries contain an aqueous electrolyte of dilute sulphuric acid. They can emit hydrogen and/or oxygen gas during use, particularly during charging. Hydrogen-air or hydrogen-oxygen mixtures will explode, if ignited, over a wide concentration range of hydrogen (4 % V/V to 96 % V/V H_2). When such explosion occurs inside a battery, a rupture of the container associated with ejection of electrolyte and solid objects takes place.

The use of an effective flame arrester in the battery venting system will prevent an external explosion propagating into the battery.

No alterations should be made to the venting system of the battery for they may significantly affect the level of protection. Users wishing to make any change or addition to the battery assembly should seek advice from the battery manufacturer.

SECONDARY CELLS AND BATTERIES – TEST METHODS FOR CHECKING THE PERFORMANCE OF DEVICES DESIGNED FOR REDUCING EXPLOSION HAZARDS – LEAD-ACID STARTER BATTERIES

1 General

1.1 Scope

This technical report gives guidance on procedures for testing the effectiveness of devices which are used to reduce the hazards of an explosion, together with the protective measures to be taken.

1.2 Normative references

The following normative document contains provisions which, through reference in this text, constitute provisions of this technical report. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this technical report are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60095-1:1988, *Lead acid starter batteries – Part 1: General requirements and methods of test*

2 Protective measures

2.1 General

When working with or in close proximity to a battery, the precautions in 2.2 to 2.5 should be observed.

2.2 Short circuits

Insulated tools are necessary when working on batteries to avoid any accidental short circuits. All metallic personal adornments should be removed from hands, wrists and neck before commencing work.

2.3 Static charge

Care should be taken to avoid static charges which could result in an ignition of the gases.

2.4 Electrical connection and disconnection

2.4.1 Connections to batteries should not be made or broken when a current flow is possible/occurring.

2.4.2 When disconnecting a battery from the electric circuit of a vehicle, the terminal connected to the frame (earth) should be disconnected first and reconnected last.

2.4.3 No smoking, naked flames or sparking should be permitted near the battery.

2.5 Charging area

Charging should be performed in a well ventilated area.

NOTE – Some battery installations are poorly ventilated. Special care is necessary to disperse the explosive gases before commencing work.

3 Safety precautions when testing devices for reducing explosion hazards

WARNING – Testing of a venting system can result in an explosion. It is necessary that extreme caution be exercised to avoid personal injury. The safety precautions must be strictly followed.

3.1 The gas source, spark electrodes and test fixture shall be fully contained in an externally vented explosion test chamber, which can be viewed indirectly by adequate means.

3.2 The battery charging source shall be located outside the explosion test chamber and convenient to the testing personnel. The charging circuit shall be electrically isolated from the spark generating circuit and shall have two emergency disconnect switches located

a) where they are readily accessible to the testing personnel, and

b) at a remote position at least 3 m from the explosion test chamber.

These emergency switches shall not be used under normal circumstances, but in cases of emergency only, since their use may damage some types of chargers.

3.3 A suitable test area should be designated, 3 m^2 or more. Signs shall be posted prohibiting unauthorised persons from entering the area whilst any electrical circuit in the explosion test chamber is or could be energized.

3.4 During testing, the test area in which the explosion test chamber is located shall be clearly marked to prohibit the entry to all persons not fully familiar with all the safety precautions and not wearing full protection from the hazard to be encountered (see 3.6).

3.5 It is essential that smoking, naked flames or other spark sources not associated with the tests are not permitted in the area during testing. Any light fitting shall be of the explosion-proof type.

3.6 Full face protection devices shall be worn within the restricted area. Additionally, suitable ear protectors should be worn against the considerable noise that can be generated by an exploding battery.

3.7 The spark generating circuit, as well as being electrically isolated from the battery charging circuit, shall have an emergency disconnect switch readily accessible to the testing personnel.

3.8 The exhaust fan of the explosion test chamber shall be operating during the entire test, unless the procedure requires it to be switched off (see annex B).

On completion of any test sequence, charging and sparking circuits into the explosion test chamber shall be interrupted for at least 5 min with the exhaust fan operating before anyone is permitted access to the chamber. This time interval allows any hydrogen to be purged from the chamber and precludes the possibility of a delayed explosion occurring due to a sustained “hidden” flame.

WARNING – Hydrogen gas can burn without visible flame.

3.9 Failure of the venting system can result in the rupture of the battery with subsequent loss of electrolyte: reference should be made to advice on dealing with a spillage of dilute sulphuric acid, which is obtainable through acid suppliers, fire and rescue authorities etc.

4 Preparation for testing

4.1 Spark test conducted on a venting system fitted to the battery

4.1.1 The test battery system shall be checked for gas leakage at any place other than the venting holes, e.g. with soap solution whilst it is on charge.

4.1.2 Check that the spark source functions properly before charging the battery.

4.1.3 The battery to which the vent under test is fitted shall be fully charged and gassing vigorously.

NOTE – A battery is considered to be fully charged if it has undergone a charging procedure conforming to either 4.2.1 or 4.2.2 of IEC 60095-1, which are procedures carried out at 25 °C ± 10 °C.

4.1.4 Within 1 h of charging the battery, commence the gassing test (see annex A).

4.2 Spark test conducted with a venting system only, using a test fixture

4.2.1 The gas inlet to the test fixture shall be well below the water level, as shown in figure 1, to prevent ignited gasses from reaching the gas source.

4.2.2 Fill the test fixture with water to a level 3 mm below the underside of the top. Place the hold-down frame over a 0,025 mm thickness of polyethylene film cut as shown in figure 1. Place the frame, with the film in place, over the four studs so that the film covers the open area between the fixture and the frame. Tighten the frame down finger tight with wing nuts to ensure a gas-tight seal around the gasket. Fit the vent system to be tested into the fixture.

4.2.3 The whole system shall be checked for gas leakage at any place other than the vent opening, for example with a soap solution whilst charging the gas source battery.

4.2.4 Make sure the ignition source works and that the gas source battery is fully charged (see note under 4.1.3).

4.2.5 Within 1 h of charging the gas source battery commence the gassing test, if appropriate (see annex A), otherwise commence the spark test described in B.2.

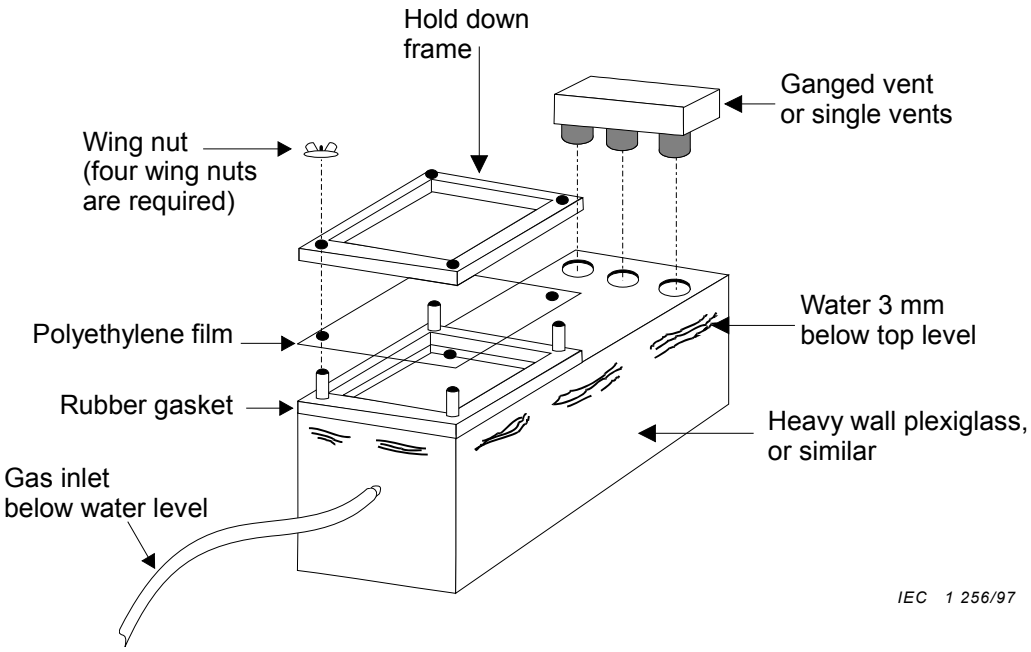
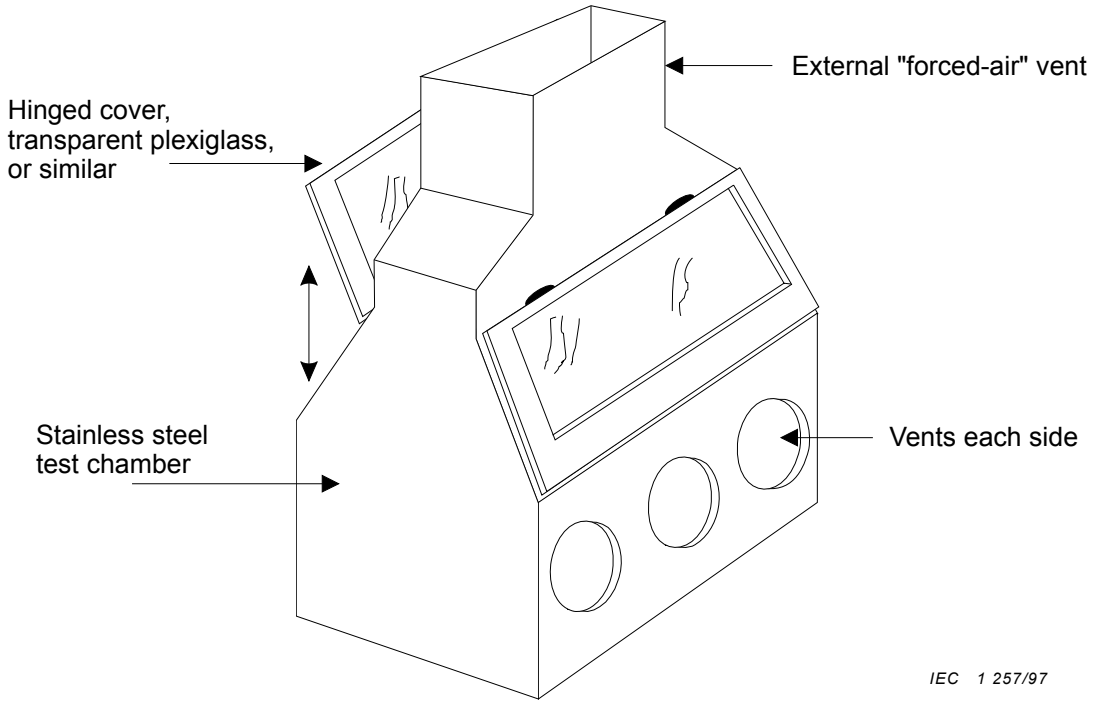


Figure 1 – Test fixture



NOTE – This illustrates the essential facilities only. The plan area of the chamber should be approximately twice that of the test battery.

Figure 2 – Explosion test chamber

Annex A
(normative)

Gassing test

NOTE – This test is sometimes of dubious accuracy when the venting system is attached to a test fixture since the configuration of the intended battery may be different from that of the test fixture (see figure 1).

A.1 Apparatus

A.1.1 A water bath, capable of being controlled at 40 °C ± 2 °C.

A.1.2 A charging source, capable of voltage control and a current output of at least 10 A.

A.1.3 Blotting paper.

A.2 Procedure

A.2.1 Place the battery in the water bath, at a temperature of 40 °C ± 2 °C, such that the top surface stays completely dry and that the top of the battery case does not emerge more than 25 mm above the level of the water. A minimum space of 25 mm shall be maintained around the battery.

Place the blotting paper close to the vent orifice(s).

A.2.2 Charge the battery, complete with the venting system under test, at a constant voltage of 14,8 V ± 0,05 V or 16 V ± 0,05 V depending upon the battery design, for a period of 16 h.

A.2.3 At the end of the charge period, observe whether any droplets of acid can be detected on the blotting paper.

A.2.4 Within 1 h proceed to the spark test described in annex B, if no droplets of acid have been observed on the blotting paper.

Annex B
(normative)

Spark tests

NOTE – Where more than one device, intended to prevent an external explosion propagating into a battery, is to be used in an installation, it is necessary to spark test them in combination as well as individually. This applies, for example, to a battery fitted with remote venting via a gas-tight tube together with a flame arrester system.

B.1 Spark test for a battery with a vent system fitted

B.1.1 Apparatus

B.1.1.1 An explosion test chamber, having the facilities illustrated in figure 2, with an explosion-proof fan of adequate size to produce approximately one chamber air volume change per minute, vented directly to the exterior of the building.

B.1.1.2 A charging source, capable of current control, with an output of at least 10 A when overcharging the battery under test.

B.1.1.3 A suitable spark source, for example a mains supplied transformer-rectifier-capacitor unit with a switch to a spark gap probe. The components have to be capable of producing a spark of at least 0,02 mJ across a gap of 0,5 mm to 2,0 mm consistently.

B.1.1.4 A battery, to which the venting system is fitted, prepared in accordance with clause 4.

B.1.2 Procedure

B.1.2.1 Place the test battery and equipment in the explosion test chamber at an ambient temperature of 20 °C ± 5 °C.

B.1.2.2 Charge the battery at a current of 10 A.

B.1.2.3 Allow the gas flow to stabilize.

NOTE – With a fully charged battery, this should occur after between 1 min and 5 min.

B.1.2.4 Create a spark of at least 0,02 mJ of energy 10 mm from the vent system opening(s) in the path(s) of the gas flow.

B.1.2.5 Repeat the spark at 10 s intervals for a minimum of six times at each vent to ensure that evolved gases are given ample opportunity to ignite.

NOTE – If the burning gases ignite the battery, time has to be allowed for the battery to self extinguish or ignite the gas mixture within it. There may be also a persisting flame outside the battery venting which may go undetected.

B.1.2.6 After the sixth spark at each vent, switch off the fan ventilation of the explosion test chamber for 5 min. Then switch it on again immediately.

B.1.2.7 Observe whether gas ignition takes place within the battery.

B.1.2.8 Repeat the procedure given in B.1.2.2 and B.1.2.3.

B.1.2.9 Terminate the charge current and wait for 1 min before repeating the procedure given in B.1.2.4 to B.1.2.7.

B.2 Spark test for a venting system only

B.2.1 Apparatus

B.2.1.1 An explosion test chamber, having the facilities illustrated in figure 2, with an explosion-proof fan of adequate size to produce approximately one chamber air volume change per minute, vented directly to the exterior of the building.

B.2.1.2 A charging source, capable of current control, with an output of at least 10 A when overcharging the gas generation battery.

B.2.1.3 A suitable spark source, for example a mains supplied transformer-rectifier-capacitor unit with a switch to the spark gap probe. The components have to be capable of producing a spark of at least 0,02 mJ across a gap of 0,5 mm to 2,0 mm consistently.

B.2.1.4 A fully charged gas source battery, vented by a gas-tight tube to the test fixture (see note under 4.1.3).

B.2.1.5 A test fixture similar to that illustrated in figure 1, suitable for accepting the vent system under test.

B.2.2 Procedure

B.2.2.1 Within 1 h of charging the gas source battery, place the test fixture and the gas source battery into the explosion test chamber with the test equipment at an ambient temperature of 20 °C ± 5 °C.

B.2.2.2 Charge the gas source battery at a current of 10 A.

NOTE – When all the gas generated from a 12 V battery is passed into the simulated three cell test fixture (see figure 1), the effective gassing rate is twice that indicated by the charge current reading for either single or ganged vent systems. This needs to be allowed for the gassing tests of the annex A and for the spark tests described in this annex if it is not possible to divert evolved gases from three cells of the source battery.

B.2.2.3 Allow the gas flow to stabilise.

NOTE – With a fully charged gas source battery this should occur after between 1 min and 5 min.

B.2.2.4 Create a spark of at least 0,02 mJ of energy 10 mm from the test vent opening(s) in the path(s) of the gas flow.

B.2.2.5 Repeat the spark at 10 s intervals for a minimum of six times at each vent to ensure that the evolved gases are given ample opportunity to ignite.

NOTE – If the burning gases ignite the vent(s), time has to be allowed for the vent(s) to self extinguish or ignite the gas mixture within the test fixture. There may be also a persisting flame outside the venting which may go undetected.

B.2.2.6 After the final spark, switch off the fan ventilation of the explosion test chamber for 5 min. Then switch it on again immediately.

B.2.2.7 Observe whether gas ignition takes place within the test fixture.

B.2.2.8 Repeat the procedure given in B.2.2.2 and B.2.2.3.

B.2.2.9 Terminate the charge current and wait 1 min before repeating the procedure given in B.2.2.4 to B.2.2.7 with no charge flowing.

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