IEC TS 61044

Edition 1.0 2021-08

TECHNICAL SPECIFICATION

Opportunity charging of lead-acid traction batteries

IEC TS 61044:2021-08(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

IEC TS 61044

Edition 1.0 2021-08

TECHNICAL SPECIFICATION

Opportunity charging of lead-acid traction batteries

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.220.20; 29.220.99 ISBN 978-2-8322-1006-7

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

OPPORTUNITY CHARGING OF LEAD-ACID TRACTION BATTERIES

FOREWORD

IEC TS 61044 has been prepared by IEC technical committee 21: Secondary cells and batteries. It is a Technical Specification.

This first edition cancels and replaces the second edition of IEC TR 61044 published in 2002. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the recommended depth of discharge for opportunity charging has been adjusted;

b) a distinction is made between valve regulated lead-acid batteries (VRLA) and vented lead-acid batteries.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
21/1081/DTS	21/1088/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Lead-acid traction batteries find a widespread application in industrial transportation vehicles because of their particular properties of providing a reliable power supply source with a very low environmental impact.

In such applications, both monitoring and power management by electronic means have made great strides not only on the discharge side of the energy balance but during charging as well.

This progress permits refuelling, i.e., charging of a lead-acid traction battery in a well-controlled manner during idle periods in the course of a working schedule.

As a result, the total capacity or ampere-hour output of the lead-acid battery increases per working day substantially beyond the manufacturer's maximum recommended value.

However, such opportunity charging will provide improved capital efficiency only if adequate precautions are taken to prevent premature deterioration of the state of the lead-acid traction battery caused by such a practice.

This document is intended to present requirements, derived from the field experience of battery manufacturers in general and from opportunity charging of lead-acid traction batteries in particular, with the aim of preventing detrimental effects on batteries and industrial equipment.

OPPORTUNITY CHARGING OF LEAD-ACID TRACTION BATTERIES

1 Scope

This document covers opportunity charging of lead-acid traction batteries, i.e., the use of idle time during a working period to increase the state of charge (SoC) so as to extend the daily working period of a lead-acid traction battery while at the same time avoiding an excessive depth of discharge.

This document specifies requirements for the use of opportunity charging of lead-acid traction batteries of vented and valve regulated types when the battery manufacturer has not provided alternative specific operating procedures.

This document is only applicable for lead-acid traction batteries of vented and valve regulated design for which the battery manufacturer has not provided specific operating procedures.

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 document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62485-3:2014, *Safety requirements for secondary batteries and battery installations – Part 3: Traction batteries*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
opportunity charging
use of periods of inactivity of a partially discharged battery to increase its state of charge

Note 1 to entry: Opportunity charging at a state of charge (SoC) of > 70 % is less effective and can result in a significant increase of battery temperature and water loss.

3.2
regular charge
charge of a battery as specified by the manufacturer necessary to attain the state of maximum storage of electric energy

3.3
self-compensating charger
device which supplies charge, monitors the state of charge, and terminates the charge of the battery when the correct amount of electric charge has been supplied

Note 1 to entry: The control logic of the self-compensating charger will prevent overcharging if a fully charged battery is connected to the charger.

3.4
vented lead-acid battery
secondary battery in which cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cell to the atmosphere

[SOURCE: IEC 60050-482:2004, 482-05-14, modified – the term "vented cell" has been replaced by "vented lead-acid battery" and the words "secondary cell having" have been replaced by "secondary battery in which cells have".]

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 or battery cannot normally receive additions to the electrolyte.

[SOURCE: IEC 60050-482:2004, 482-05-15, modified – a hyphen has been added to the term.]

3.6
excessive discharge
discharge of a battery exceeding the maximum depth of discharge as declared by the manufacturer

Note 1 to entry: For purposes of this document, the maximum depth of discharge is 80 % for vented lead-acid batteries and 60 % for valve regulated lead-acid batteries except when otherwise declared by the manufacturer.

3.7
state of charge
SoC
available capacity in a battery expressed as a percentage of a rated capacity

4 Planning the implementation of opportunity charging

The following list items a) to c) shall be considered when planning to introduce opportunity charging.

- Indications that opportunity charging may be beneficial are:
  a) when the maximum permissible physical size of the battery for the vehicle does not have enough capacity to complete the daily workload before a next complete recharge becomes necessary. This allows an undesirable physical change-out of the battery to be avoided.
  b) when the operational requirements of the vehicle are such that it is impossible to predict when the battery will next be released for a complete recharge. This can occur for example in locations such as airports where 24 h per day working is a rule.
  c) when a battery is close to the end of its operational life and the use of opportunity charging can be shown to maintain an acceptable performance of the vehicle.

An implementation of opportunity charging will result in an additional energy turnover in the battery beyond the 60 % or 80 % limit per cycle specified by the manufacturer. This change in operational mode is therefore to be cleared beforehand with the battery manufacturer as it is possible that this will have an impact on warranty terms and conditions.

NOTE 1 If the periods available for charging are of short duration and infrequent, then opportunity charging will be of little benefit.

NOTE 2 When opportunity charging enables the user to discharge substantially more than the recommended percentage of the rated capacity each day, the battery-life measured in years will be reduced as the battery-life measured in terms of cumulative ampere-hours discharged is approximately constant.

NOTE 3 Opportunity charging at a SoC > 70 % is less effective and can result in a significant increase of battery temperature, gassing, water loss or sudden failure of VRLA designs.

NOTE 4 Opportunity charging results in higher electrolyte working temperatures that accelerate battery ageing.

5 Operational procedures

5.1 General

The following information in 5.2 to 5.5 shall be considered when operational procedures are being established.

5.2 Charging conditions

Self-compensating chargers are preferred when opportunity charging is carried out. A correctly sized battery and charger combination is essential for all batteries.

For opportunity charging of valve regulated lead-acid batteries, it is essential that only chargers with a current-voltage-time characteristic in accordance with the battery manufacturer's recommendation are used.

In order to maximize the beneficial effects of opportunity charging, such an operation is preferably carried out only when the fully charged battery has been discharged by at least 30 % of its rated capacity.

This limit is especially important when vented lead-acid batteries are charged with non-self-compensating chargers. Non-self-compensating chargers shall not be used for valve regulated lead-acid batteries.

For intensive energy throughput applications with expected high battery temperatures, opportunity charging shall be initiated only when at least 40 % of the rated capacity has been discharged from the fully charged battery.

An air agitation system of the electrolyte is highly recommended for vented lead-acid batteries in order to prevent acid stratification and to improve the efficiency of the opportunity charging.

Where a known duty cycle exists, a calculation of the energy balance or ampere-hour balance is recommended. The availability of adequate charging time and intervals for opportunity charging shall be verified beforehand.

5.3 Regular charges

The frequency of a regular charge, whereby the battery is allowed to complete its charging cycle and thus prevent premature deterioration of the battery, is as follows:

– for standard vented lead-acid batteries and valve regulated lead-acid batteries, one regular charge every working day. It is possible that this will not be applicable for the scenarios described under Clause 4, list item b) and if that is the case a compromise solution is to be found in discussions with the battery manufacturer.

– for vented lead-acid batteries with air agitation system and especially with valve regulated traction batteries, an interval of up to 1 week between complete recharges may be feasible.

5.4 Ventilation

During opportunity charging, adequate battery ventilation consistent with IEC 62485-3:2014 shall be provided. Forced ventilation is recommended unless the opportunity charging is performed in open air.

5.5 Temperature

Elevated battery temperatures cause premature battery ageing and temperature compensated charging is recommended. If during opportunity or regular charging the battery or the electrolyte temperature exceeds the manufacturer's recommended upper limit, charging is to be stopped until the battery has cooled down to the recommended value. Providing forced ventilation can speed this process up. The resulting airflow shall be vented to the open air outside the building and not carry hydrogen gas or acid mist toward people and sensitive equipment.

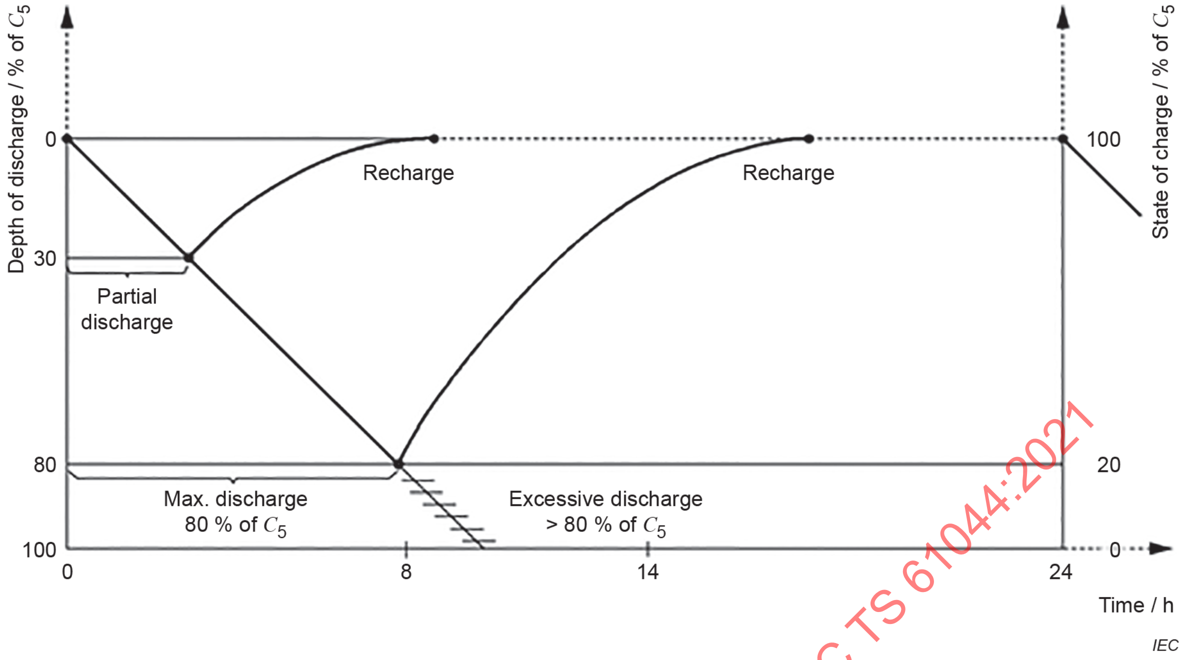
Means for measuring the temperature of a battery shall be available to the operating personnel, as well as information on the upper temperature limit set by the manufacturer. The corrosion-proof temperature probe is to be located either in the electrolyte or between cells at the potentially hottest location in the battery.

With valve regulated batteries the electrolyte temperature cannot be measured directly, and the user shall ask the manufacturer to provide the substitute temperature measuring location.

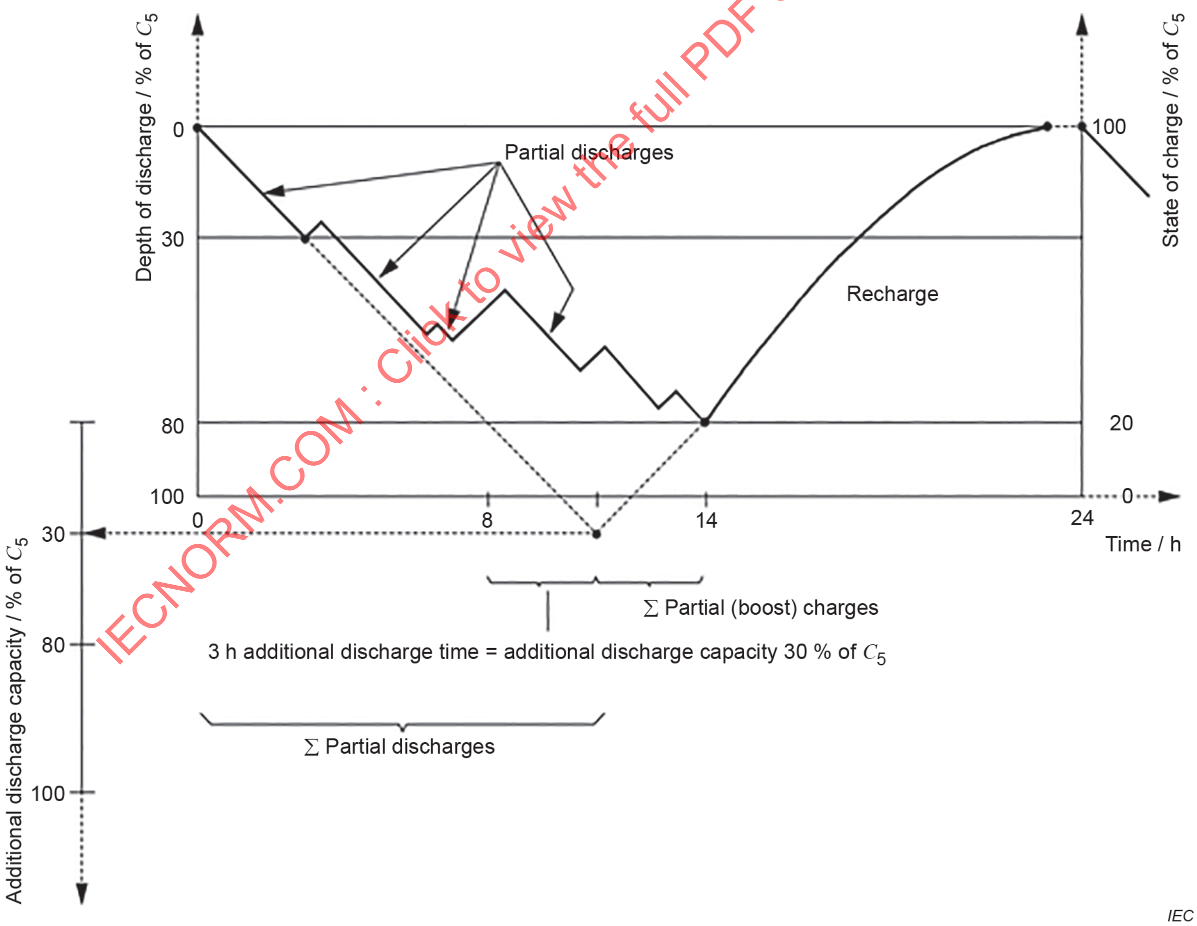
If no other recommendation is available, a maximum temperature of 55 °C for vented lead-acid batteries and of 45 °C for valve regulated lead-acid batteries is appropriate.

5.6 Examples of discharge and charge profiles

Figure 1 and Figure 2 show typical discharge and charge curves for vented lead-acid batteries with regular (Figure 1 a)) and opportunity charging (Figure 1 b)) and, for valve regulated lead-acid batteries, with regular (Figure 2 a)) and opportunity charging (Figure 2 b)).



a) Schematic pattern of a 24 h (daily) normal discharge and charge duty of a vented lead-acid battery



b) Schematic pattern of a 24 h (daily) duty of a vented lead-acid battery with opportunity charging resulting in an extension of available discharge capacity

Figure 1 – Examples of discharge and charge profiles of vented lead-acid batteries