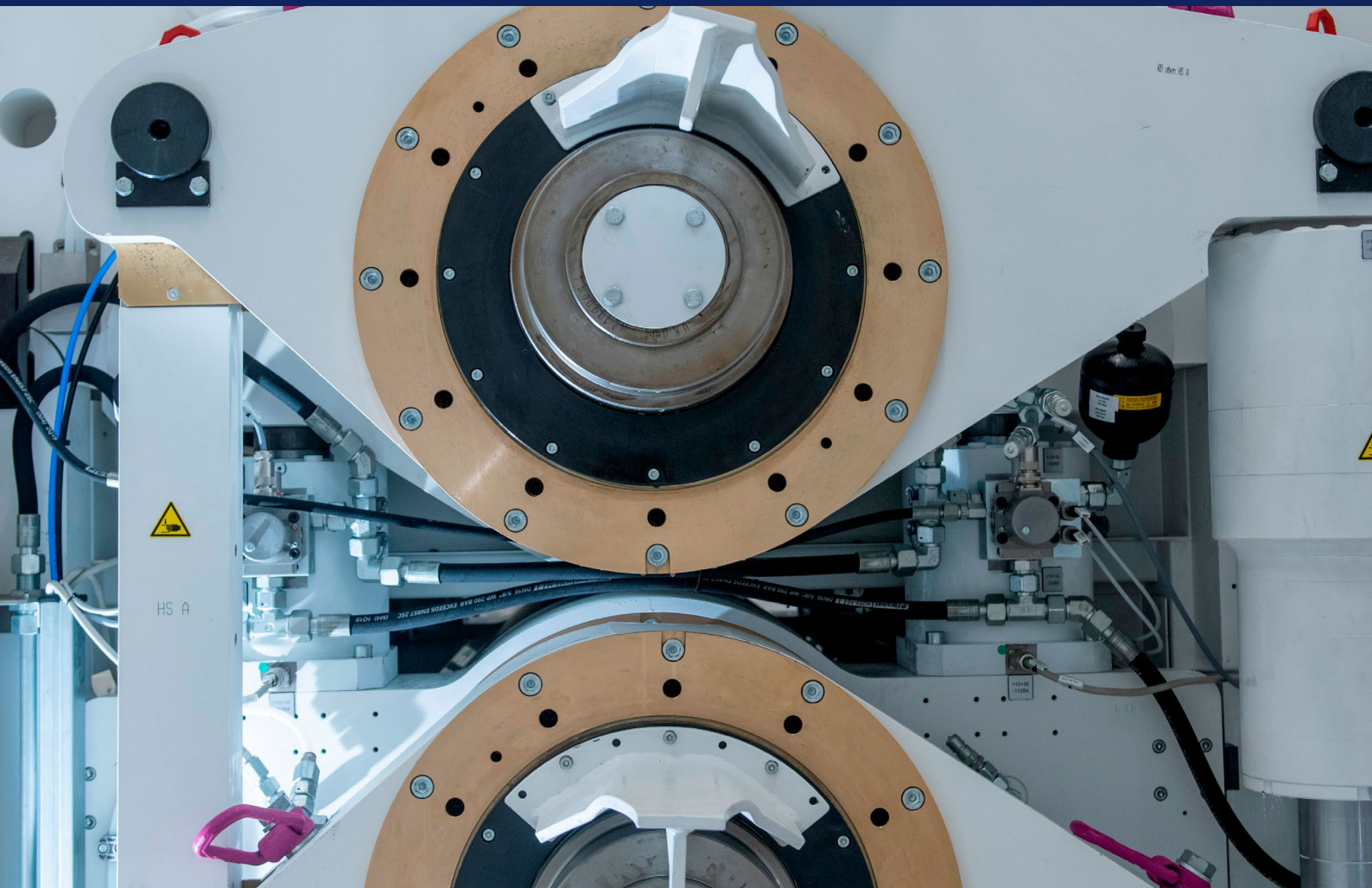


PAS 7062:2021

Electric vehicle battery cells – Health and safety, environmental and quality management considerations in cell manufacturing and finished cell – Code of Practice



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ISBN 978 0 539 12515 3

ICS 43.120

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Publication history

First published January 2021

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Foreword

This PAS was sponsored by Innovate UK. Its development was facilitated by BSI Standards Limited, and it was published under licence from The British Standards Institution. It came into effect on 31 January 2021.

Acknowledgement is given to Emma Kendrick of the University of Birmingham as the technical author, and the following organizations that were involved in the development of this PAS as members of the steering group:

- 9MAG Propulsion Ltd;
- AMTE Power;
- Health and Safety Executive (HSE);
- Horiba Mira;
- HSSMI;
- National Physical Laboratory (NPL); and
- UK Battery Industrialisation Centre (UKBIC).

Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

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Relationship with other publications

- PAS 7060, *Electric vehicles – Safe and environmentally-conscious design and use of batteries – Guide*
- PAS 7061, *Batteries for vehicle propulsion electrification – Safe and environmentally-conscious handling of battery packs and modules – Code of practice*

These PAS publications and PAS 7062 are structured to cover the different systems levels for electrically-propelled vehicles and battery systems, from vehicle level design (PAS 7060), to battery modules and pack assembly (PAS 7061), to battery cells (PAS 7062).

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Any user claiming compliance with this PAS is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this PAS are presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

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

The word “should” is used to express recommendations of this PAS. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes are provided throughout the text of this PAS. Notes give references and additional information that are important but do not form part of the recommendations.

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

Contractual and legal considerations

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

Compliance with a PAS cannot confer immunity from legal obligations.

0 Introduction

0.1 General

The increasing electrification of transport applications has led to a significant increase in the number of batteries being made and installed into electric vehicles. The manufacture, transportation, service and end-of-life disposal of batteries for electrically-propelled vehicles (EVs) is an emerging industry in the UK and Europe, which has historically been dominated by other countries. It is expected that with this e-mobility transition the UK will require large-scale manufacturing capabilities. As such, the UK is investing in innovation to improve not only the performance and cost of batteries, lithium-ion batteries and also more novel emerging cell chemistries, but also how the UK manufactures, services and disposes of batteries safely and in an environmentally-friendly way.

The examples here are mostly related to the current dominant cell chemistry, liquid electrolyte lithium-ion. The battery packs are comprised of many individual cells aggregated together to form the battery. The cell contains many raw and processed materials and components which are assembled into a cell device. All parties involved in the manufacturing of cells, modules and packs for electric vehicles might have an interest in the quality, environmental impact and health and safety of the sourcing, processing, integration, control and recycling of the materials and devices at the beginning and end of the battery life.

0.2 Battery supply chain and manufacturing process

The supply chain and manufacturing process of batteries is a complex and global system. As UK capability progresses within different sectors of the system, capturing and codifying good practice can save time and resources and build a UK knowledge base that reduces significant risks in this new manufacturing sector. The intention is to ensure the UK can continue to influence and manufacture exports, delivering EV battery products to international standards.

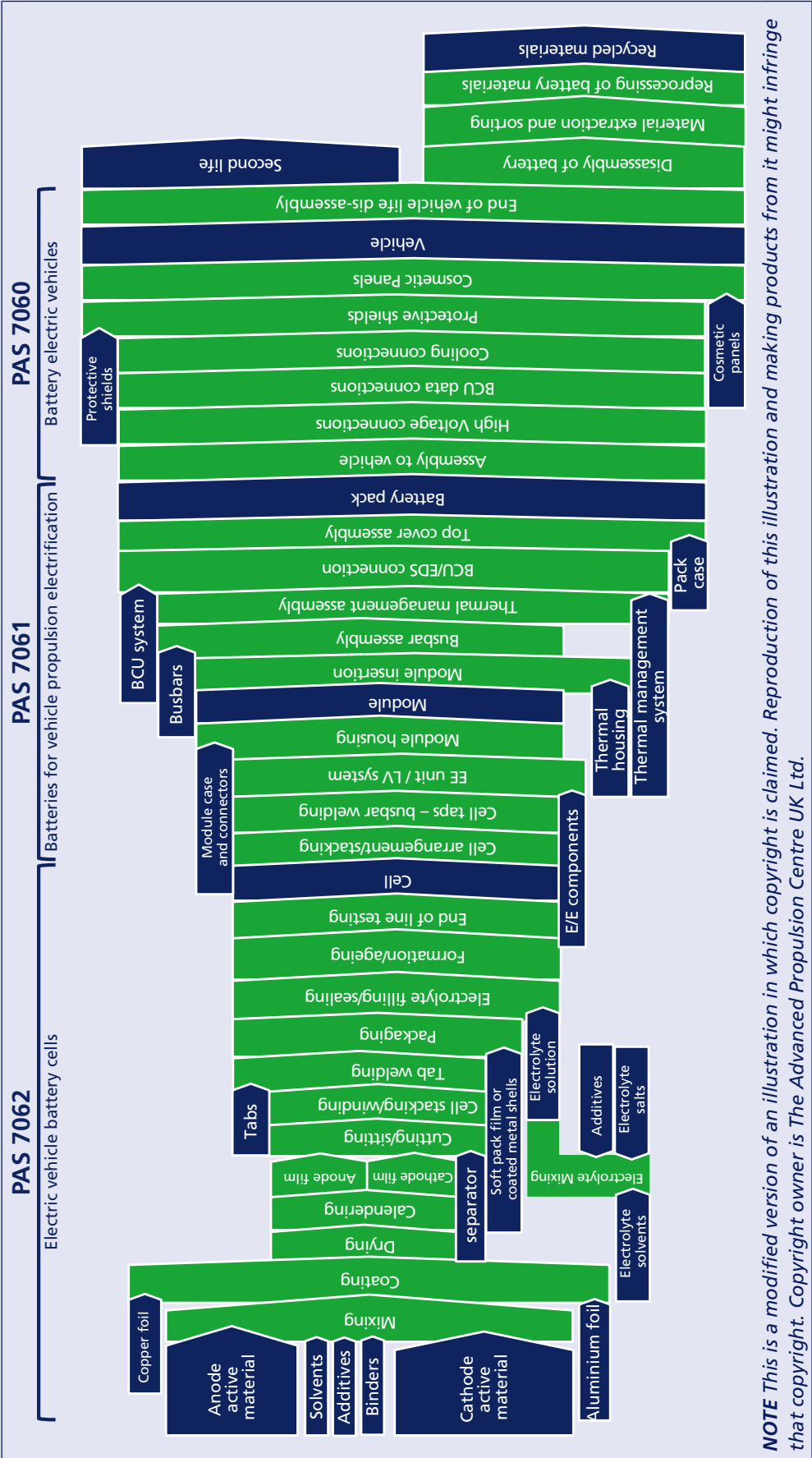
0.3 Battery supply chain and manufacturing process system boundaries

Due to the complexity of the battery supply chain and manufacturing process system, the system has been divided into three sub-systems, which are structured into three separate PAS documents.

- PAS 7060 – covering vehicle design.
- PAS 7061 – covering pack and module.
- PAS 7062 – covering electrode and cell.

A diagram to illustrate the system boundaries covered by each of these PASs is shown in Figure 1.

Figure 1 – Generic boundary diagram of supply chain and manufacturing process



0.4 The approach taken for this PAS

Initial development of this PAS commenced with input from the approaches used for PAS 7060 and PAS 7061, establishing a common framework of a combination of “top-down” and “bottom-up” approaches.

The top-down approach began with considering the existing business frameworks which drive a common approach in the management of business activities. The principal areas are quality, environment and safety systems, with the recommendations for the PAS being structured around these three themes.

The bottom-up approach followed the process flow around cell manufacturing and the sets of legislation, regulation and guidance in existence across these areas that have been produced for generic application, cross-sector application of lithium-ion batteries. There are several key points within these themes.

- The source of the raw materials, several of which are on the critical and strategic materials lists, are to be considered. Source, traceability and security of supply of materials are an important consideration for manufacturers.
- The raw materials are processed into electrodes, and manufactured in cells. Minimization of waste and waste handling is to be considered, from a safety, environmental and raw material supply aspect.
- There are health and safety risks associated with the handling and transfer of materials and chemicals and exposure mitigation, control and monitoring need to be performed for the ongoing wellbeing of the workers.
- The aggregations of like performance parameters of each individual cell are critical in maintaining a safe, long-life battery pack. The performance parameters of the cells are controlled via the materials and cell manufacturing processes. Once the cell is constructed, an array of diagnostics testing is performed to ensure a safe cell. Those which fail these tests are discarded as scrap or waste, which requires subsequent handling considerations. Any cells which reach end of life can also be treated with similar methods to the scrap cells.
- If a circular economy approach to cell manufacture is to be considered, a design for disassembly is required. Electrode and cell designs need to realize an ease for dismantling and sorting of the materials into pure waste streams for reuse, remanufacture or recycling. This might reduce the life cycle costs.

For the purposes of this PAS:

- a raw material is defined as a material which requires further processing into a battery component; and
- a component is defined as a current collector, packaging, coated electrode, electrolyte or separator.

The PAS includes the following annexes:

- Annex A: Alternative battery types; and
- Annex B: Example of safety process during formation and conditioning.

0.5 Review process

In this new, emerging and quickly-growing field, it is important that all organizations review and update their documentation as to what is current good practice. Good practice is learnt from world-wide incidents, events and newly developed protocols.

1 Scope

This PAS gives recommendations for the health and safety, environmental performance, and quality management in the manufacture of battery cells, such as the lithium-ion liquid electrolyte cell, for electrically-propelled vehicles (EVs). This PAS is intended to establish a common understanding and approach to EV battery cell manufacture and use. EV refers to any electrically assisted propelled vehicle; for example, plug-in hybrid, hybrid and full electric.

This PAS covers:

- a) sourcing;
- b) storing and handling material, traceability;
- c) assembly;
- d) chemical management (occupational health, personnel safety);
- e) hazards and environmental conditions (solvents, people);
- f) competency;
- g) test methods and conformity;
- h) formation of cell and fire hazards;
- i) storage, handling and transport of completed cells;
- j) clean rooms and dry rooms;
- k) end-of-life consideration;
- l) waste handling; and
- m) environmental impact.

This PAS does not cover performance requirements for the individual chemicals and materials. The PAS also does not cover the general risks associated with manufacturing processes such as slips, trips and falls, or any risks covered by the Machinery Directive 2006/42/EC [1].

This PAS is for use by battery cell manufacturers.

This PAS is of interest to battery cell users, automotive manufacturers and the entire supply chain.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document.¹⁾ For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

PD ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

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

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this PAS, the terms and definitions given in IEC 60050-482:2004, PD ISO/IEC Guide 51:2014 and the following apply.

3.1.1 active material

material which reacts chemically to produce electric energy when the cell discharges

NOTE In secondary cells, the active material is restored to its original state during discharge.

3.1.2 battery

one or more cells which are electrically connected, fitted with devices necessary for use; for example, case, terminals, marking and protective devices

NOTE 1 A battery can be single or multiple cells, usually associated with some or more attachments, such as: casing, connectors, circuitry, electrical bypass devices, charge control electronics, heaters, temperature sensors, thermal switches and thermal control elements.

NOTE 2 Units that are commonly referred to as “battery packs”, “battery modules” or “battery assemblies” having the primary function of providing a source of energy for vehicle propulsion are, for the purposes of this PAS, treated as batteries.

[SOURCE: BS ISO 17546:2016, 3.4, modified]

3.1.3 battery module

single unit containing one cell or a set of cells electrically connected and mechanically assembled

[SOURCE: BS EN 1987-1:1997, 3.2]

NOTE The module might include thermal management channels, safety features or control instrumentation.

3.1.4 battery pack

energy storage device that includes cells or cell assemblies normally connected with cell electronics, power supply circuits and overcurrent shut-off device, including electrical interconnections, interfaces for external systems

NOTE Examples of external systems are cooling, voltage class B, auxiliary voltage class A and communication.

[SOURCE: BS ISO 12405-4:2018, 3.2]

3.1.5 battery system

energy storage device that includes cells or cell assemblies or battery pack(s) as well as electrical circuits and electronics

NOTE 1 Battery system components can also be distributed in different devices within a vehicle.

NOTE 2 Examples of electronics are the BCU and contactors.

[SOURCE: BS ISO 12405-4:2018, 3.3]

3.1.6 capacity

electric charge which a cell or battery can deliver under specified discharge conditions

NOTE The SI unit for electric charge is the coulomb ($1\text{ C} = 1\text{ A}\cdot\text{s}$) but in practice, capacity is usually expressed in ampere hours ($\text{A}\cdot\text{h}$).

3.1.7 cell

basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals and usually separators that is a source of electric energy obtained by direct conversion of chemical energy

[SOURCE: IEC 60050-482:2004, 482-01-01]

3.1.8 cell component

coated electrode, electrolyte, separator, current collector or tab entity/system that forms a part of a larger system

[SOURCE: PAS 11281:2018, 2.1.6, modified]

3.1.9 competence

ability to apply knowledge and skills to achieve intended results

[SOURCE: BS ISO 44001:2017, 3.10]

3.1.10 component

entity or system that forms a part of a larger system

[SOURCE: PAS 11281:2018, 2.1.6]