



SURFACE VEHICLE INFORMATION REPORT

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(R) Technical Information Report on Automotive Battery Recycling

RATIONALE

Due to the pace of the evolution of vehicle battery technology, this technical information report aims to assist recycling and final disposition of automotive batteries by providing a common understanding of terms and of generalized disassembly and recycling methodologies. The following terms and methodology are intended to aid in the understanding and clarity of future documents describing the multiple conditions occurring at the end of battery life. With increasing hybridization and general electrification of cars and trucks, the number of batteries in uncertain conditions will be increasing.

1. SCOPE

This document will focus on the language used to describe batteries at the end of battery or vehicle life as batteries are transitioned to the recycler, dismantler, or other third party. This document also provides a compilation of current recycling technologies and flow sheets, and their application to different battery chemistries at the end of battery life. At the time of document authorship, the technical information cited is most applicable to Li-ion battery type rechargeable energy storage systems (RESS), but the language used is not to be limited by chemistry of the battery systems and is generally applicable to other RESS.

2. REFERENCES

2.1 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1715 Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology

SAE J1715/2 Battery Terminology

SAE J2344 Guidelines for Electric Vehicle Safety

SAE J2936 SAE Electrical Energy Storage Device Labeling Recommended Practice

SAE J2950 Recommended Practices (RP) for Shipping Transport and Handling of Automotive-Type Battery System - Lithium Ion

SAE J2984 Identification of Transportation Battery Systems for Recycling Recommended Practice

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Documents

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2.1.2 Other Publications

European Union Battery Directive 2006/66/EC of the European Parliament and of the Council of the 6 September 2006 on batteries and accumulators and repealing Directive 91/157/EEC.

ECAR - Hybrid Vehicle Dismantling Guide v3, 2012: <http://www.ecarcenter.org/>.

USABC - Recommended Practice for Recycling of xEV Electrochemical Energy Storage Systems, 2014. Town Center Drive, Suite 300, Southfield, MI 48075. Sept. 11, 2017: http://www.uscar.org/commands/files_download.php?files_id=463.

16 CFR Part 20 - Guides for the Rebuilt, Reconditioned, and Other Used Automobile Parts Industry. July 22, 2016: <http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=16:1.0.1.2.12>.

Lithium Ion Batteries, Hazard and Use Assessment, 2016. 1 Batterymarch Park, Quincy, MA 02169. Oct. 23, 2017: <http://www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Research-reports/Hazardous-materials/Lithium-ion-batteries-hazard-and-use-assessment>.

Rescue and Training Manual, Lithium Batteries in Storage, 2014. 168 av. De Tervueren, box 3; B-1150 Brussels, Belgium. Oct 23, 2017: <http://www.rechargebatteries.org/wp-content/uploads/2015/01/RESCUE-AND-TRAINING-MANUAL-LITHIUM-BATTERY-IN-STORAGE-2014-12-05.pdf>.

3. DEFINITIONS

3.1 BATTERY CELL

An electrochemical cell is a device that converts chemical energy into electrical energy or vice versa when a chemical reaction is occurring in the cell. Typically, it consists of two electrodes immersed into a solution (electrolyte) with electrode reactions occurring at the electrode-solution surfaces (see Figure 1a). Refer to SAE J1715/2.

3.2 BATTERY COLLECTION

Gathering of batteries for the purpose of shipment to a treatment facility.

NOTE: Treatment facility may include any end of life treatment facility such as a recycler or licensed disposal site. It can also include other processes such as evaluation, remanufacture, and/or repurpose.

3.3 BATTERY MODULE

Refers to the multiple connections of electrochemical or electrostatic cells. Battery modules may or may not include sensors such as voltage and temperature sensors, safety components, and a cooling structure, so that each module can be controlled and managed independently (see Figure 1b). Refer to SAE J1715/2.

NOTE: May also be known as a battery monoblock.

3.4 BATTERY PACK

A battery pack may consist of only one module or multiple modules. The pack includes sensors, interlocks, contactors, battery management controller, safety devices, thermal management, and structural components (see Figure 1c). Refer to SAE J1715/2.

3.5 BATTERY SYSTEM

One or more packs connected in parallel and/or series configuration and associated electronics (see Figure 1d). Refer to SAE J1715/2.

3.6 ENERGY RECOVERY

Recovery of energy from materials contained within a product; i.e., waste-to-energy.

3.7 HAZARDOUS MATERIALS

Goods that can harm persons, property, or environment, and specified by law for identification, packaging for transport, use, storage, and/or disposal. (Also known as hazmat or dangerous goods). Refer to SAE J2990.

3.8 HIGH VOLTAGE

Above 60 DC V (refer to SAE J2344); when high-voltage personnel protective equipment (PPE) becomes required (refer to ISO 6469).

3.9 REBUILT

Includes factory rebuilt and remanufactured, and refers to a component (such as a battery) that has been dismantled and reconstructed, as necessary. Its internal and external parts have been cleaned and made rust- and corrosion-free; all impaired, defective, or substantially worn parts have been restored to a sound condition or replaced with new; it has rebuilt (in accordance with the provisions of this paragraph) or unimpaired used parts; all missing parts have been replaced with new, rebuilt, or unimpaired used parts; and such rewinding or machining and other operations have been performed as necessary to put the industry product in sound working condition according to OEM specifications and parameters.

NOTE: Non-defective cells with reduced capacity may be used as long as they are still within the OEM specifications.

3.10 RECHARGEABLE ENERGY STORAGE SYSTEM (RESS)

Any energy storage system that has the capability to be charged and discharged. (Examples: batteries, capacitors, and electro-mechanical flywheels.) Refer to SAE J1715/2.

3.11 RECYCLING

Transformation of end of life products (RESS, batteries, or scrap) into usable products.

3.11.1 CATHODE-TO-CATHODE RECYCLING

A type of direct recycling where the target is to recover post-consumer active material from the cathode and make it suitable for use as active material in a new cathode.

3.11.2 DIRECT RECYCLING

“Nominal” recycling process, where materials contained in a postconsumer product (RESS, battery) are recovered and made functional for their original purpose with minimal processing.

NOTE: Direct recycling is differentiated from pyrometallurgical or hydrometallurgical processing as there is no attempt made to return the material to a base component (i.e., smelting or electrowinning to metal).

3.12 RESS INCIDENT

When the RESS experiences a deviation from the intended design state or application (e.g., crash, fire, flood, internal fault).

3.13 RESS-INTENDED DESIGN STATE

RESS, in vehicle, communicating and functioning within OEM parameters.

3.14 SALVAGE

Removal and recovery of usable components from an end of life vehicle.

3.15 UNIVERSAL WASTE

Streamlined hazardous waste management regulation put out by the United States at the federal (EPA) and local (state) level, with the goal of promoting the collection and recycling of these materials by easing the regulator burden on the collection and transport, and encouraging the development of programs to reduce the quantity going to municipal solid waste facilities of certain common hazardous wastes.

4. GENERAL RECYCLING INFORMATION FOR AUTOMOTIVE BATTERY SYSTEMS

4.1 Generic High-Voltage Battery Configuration

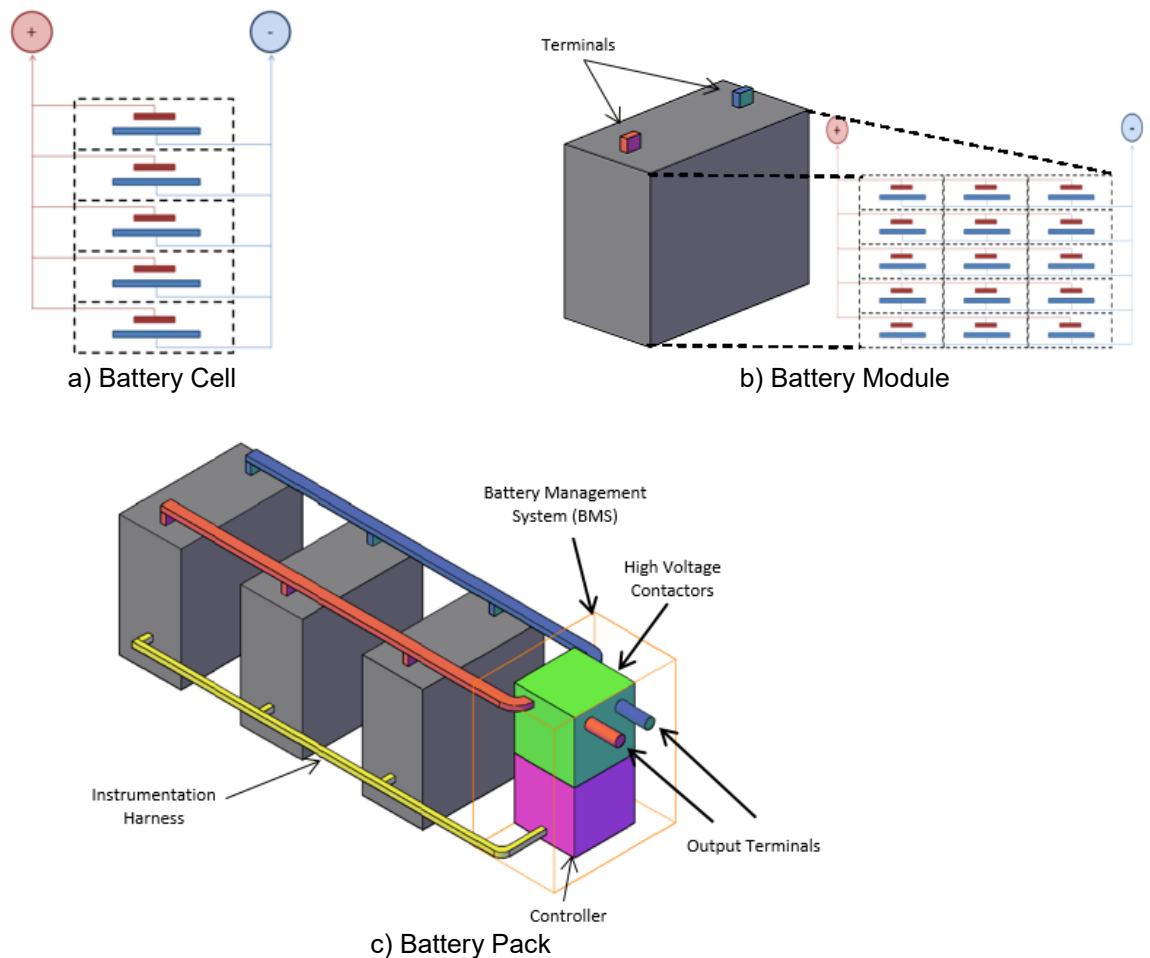


Figure 1 - Typical energy storage system

A general view of a battery. The battery system may be contained all within a single case (not shown here, for clarity) or distributed about the application as space permits. Battery management system (BMS) functionality may be distributed to the module level or centralized as shown at the system level.

4.2 Transportation

Nearly all automotive battery-type RESS, at all stages in life, are subject to dangerous goods transportation regulations for commercial transport. These require specialized training for shipping and transporting personnel, additional documentation, specific packaging, and/or other requirement specific to the RESS-type and transportation mode selected. Table 1 identifies additional sources of information on transportation requirements.

For recommendation when transporting RESS following an incident, SAE J2990 includes post-incident inspection of the vehicle for additional hazards and SAE J2950 includes recommendations for transporting a potentially damaged Li-ion