SURFACE VEHICLE RECOMMENDED PRACTICE

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(R) Chemical Identification of Transportation Batteries for Recycling

RATIONALE

Electrification of the transportation industry is increasing rapidly, with a corresponding increase in the use of battery systems. Furthermore, battery systems can consist of various chemistries that are dependent on design objectives. A chemistry identification system can assist in proper recycling as these battery systems reach their end of life. Because battery systems can be installed in products that may be available in various countries, the harmonization of chemistry identification systems worldwide is beneficial. This document provides a general chemistry identification system that is consistent with other international systems.

1. SCOPE

The chemistry identification system is intended to support the proper and efficient recycling of rechargeable battery systems used in transportation applications with a maximum voltage greater than or equal to 12 V. These applications include propulsion, starting/lighting/ignition, and providing power to other vehicle equipment. Other battery systems such as non-rechargeable batteries, batteries in electronics, and telecom/utility batteries are not considered in the development of this specification. This does not preclude these systems from adapting the format proposed if they so choose.

1.1 Purpose

A simple common identifier can enable consumers, service, and waste management personnel to direct unidentifed battery types to appropriate recyclers. Recyclers also benefit from this identifier as it allows them to segregate, screen for potential contamination to existing process streams, and identify the responsible organization so they may contact them to find detailed information about the battery to ensure proper and safer recycling.

This SAE Recommended Practice is not intended to replace regulatory reporting requirements nor provide intricate details of the battery system's chemistry. The method and specific location for applying the identifier is not defined in this SAE Recommended Practice. For applicable battery labeling practices, refer to SAE J2936.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
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SAE WEB ADDRESS: http://www.sae.org

For more information on this standard, visit
https://www.sae.org/standards/content/J2984_202109/

2. REFERENCES

2.1 Applicable Documents

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 J2464 Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing

SAE J2936 SAE Electrical Energy Storage Device Labeling Recommended Practice

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

2.1.2 Related Publications

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

European Union 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. s.l.: Europa, 2006. Directive 2006/66/EC, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32006L0066.

National Standard of the People's Republic of China, "Coding regulation for automotive traction battery," GBT 34014-2017, issued July 12, 2017.

Battery Association of Japan (BAJ), "Program to make the portable secondary battery recycle mark an international standard," BAJ Website [Online] BAJ, 2010 [Cited: October 10, 2011], http://www.baj.or.jp/e/recycle/recycle10.html.

Battery Association of Japan (BAJ), "Revised guideline for recycle marking on li-ion batteries for the Japanese market," BAJ Website [Online] BAJ, 2010 [Cited: October 10, 2011], http://www.baj.or.jp/e/recycle/recycle11.html.

3. DEFINITIONS

3.1 BATTERY

A battery is a general term that inclusively refers to electrochemical cells, modules, packs, and energy storage systems. More specific terminology should be used to describe the level of functionality where appropriate. Refer to SAE J1715/2.

3.2 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. Refer to SAE J1715/2.

NOTE: Also known as battery monoblocks. It is shown schematically in Figure 1(c).

3.3 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. Refer to SAE J1715/2.

3.4 BATTERY SYSTEM

See energy storage system.

3.5 CELL

See electrochemical cell.

3.6 COMBUSTIBLE LIQUIDS

A liquid that has a closed-cup flash point at or above 100 °F (37.8 °C). Refer to SAE J2464.

NOTE: Upper limit of flashpoint for combustible liquid is <200 °F (49 CFR 173.150 and 29 CFR 1926.155(c)).

3.7 [BATTERY] DISMANTLER

An entity that disassembles the battery system to facilitate recycling.

NOTE: For this document, dismantler is focused on batteries only.

3.8 ELECTROCHEMICAL 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. Refer to SAE J1715/2.

3.9 ENERGY STORAGE SYSTEM (BATTERY SYSTEM)

One or more packs connected in parallel and/or series configuration and associated electronics.

NOTE: A energy storage system is shown schematically in Figure 1(a).

3.10 FLAMMABLE LIQUIDS

A liquid that has a flash point below 100 °F (37.8 °C) and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100 °F (37.8 °C). Refer to SAE J2464.

3.11 FLASH POINT

Flash point is defined in OSHA's 29 CFR 1910.106 as the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. Refer to SAE J2464.

3.12 LI-ION

Lithium-ion.

3.13 NiCd

Nickel-cadmium.

3.14 NiMH

Nickel metal hydride.

3.15 MODULE

See battery module.

3.16 PB-ACID

Lead-acid battery.

3.17 PHOSPHATE

For this application, phosphates refer to a battery with phosphorous content greater than one weight percent in their respective cathode or anode active material (e.g., $LiFePO_4$, $LiMnPO_4$).

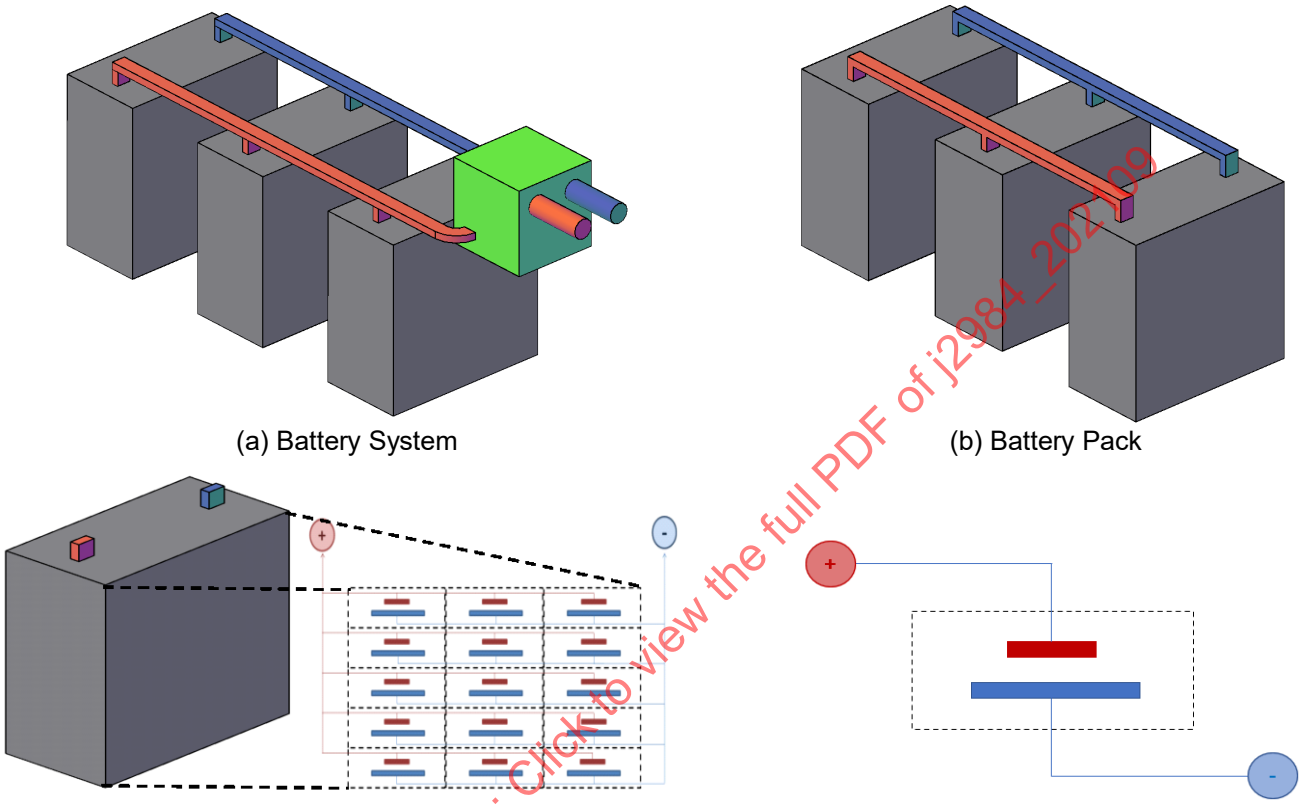

Figure 1 - Schematics of battery terminology for (a) battery system, (b) battery pack, (c) battery module, (d) cell

3.18 RARE EARTHS

For this application, rare earths refer to battery chemistries in which any of the lanthanide elements and scandium and yttrium are added in total greater than one weight percent in their respective cathode or anode active material.

3.19 RECYCLING

Transformation of end of life products or scrap into usable products or materials.

NOTE: In this context, products could be batteries or battery components, including cells, modules, packs, or parts therein. Scrap could be spent batteries but would also include manufacturer scrap.

3.20 RESPONSIBLE ORGANIZATION (RO)

The organization which is responsible for overseeing the required tests and assuring the propriety of the tests and results; examples are vehicle and battery system manufacturers or independent test authorities. Refer to SAE J2950.

NOTE: For this document, the RO needs to be able to supply additional information about the battery system, including specifics on chemistry, operation, and disposal; therefore, an independent test authority is not applicable.

3.21 SERVICEABLE

A device or component that can be quickly and safely and easily removed and replaced by the user without having to send the entire product or system to a repair facility. The defective device or component is found by standard troubleshooting procedures and is removed and replaced using standard non-specialized tools. Refer to SAE J2950.

NOTE: As an example, in Figure 1, per the manufacturer's specification, the battery pack could be considered serviceable, and the battery module could be considered non-serviceable.

3.22 TRACE ELEMENTS

Elements that are not a significant constituent added to the cathode or anode active material and are below one weight percent in their respective cathode or anode material.

4. DOCUMENT CONTENT

4.1 Chemistry Identifier Requirements

Special attention has been given to identifying lithium-ion batteries, as these are expected to play a large role in the transport industry's electrification. Unlike Pb-acid, NiMH, or NiCd battery systems, lithium-ion batteries have many different potential combinations of anode and cathode materials. These materials affect the value and effectiveness of the recycling process. They need to be identified before recycling to sort the batteries and prevent cross-contamination of the recycler process streams. Their cathode typically designates lithium-ion batteries (e.g., lithium cobalt oxide) or anode (e.g., lithium titanate) depending on its chemical makeup. The identification code provides more details for the lithium-ion battery cell chemistry to address the different combinations of anode and cathode materials. Cathode and anode chemistry labels are not applicable for Pb-acid, NiCd, or NiMH.

A miscellaneous properties place holder was created in the identification code to address known and future properties of concern for recyclers. Miscellaneous properties are identified in Figure 2.

The RO identification and manufacture date are included to assist the recyclers in finding out more detailed information about the battery. The RO in this application should be the vehicle or battery system manufacturer that can provide this information. This information may be too detailed and possibly too proprietary to include in the identification code or safety data sheets.

The Battery Association of Japan (BAJ) has issued guidelines for recycle label on batteries, which include a color code system for identifying the major battery systems: Pb-acid, NiCd, NiMH, and lithium-ion. This document recommends remaining consistent with the BAJ color code standards in the identification code to further assist in sorting the battery types. These recommendations are also in line with the voluntary color code of Call2Recycle labels and the color code for the proposed IEC 62902:2019. The Pantone Matching System (PMS) is available in multiple finishes (coated (C) or uncoated (U)) either is acceptable.

The identification code should be applied in a visible location on the outermost non-serviceable cover(s) of the battery system and its components. For example, in a typical pack containing modules, as shown in Figure 1, this code should be applied to the outermost battery pack housing and each module case if they are serviceable/replaceable components. For other designs, the code should be applied to be readily identifiable by the dismantler/recycler.

4.2 Li-ion Specific Requirements

Materials/elements intentionally added to a cell should be considered in classifying the cathode, anode, or miscellaneous categories. Unintentional or trace materials should not be included.

When determining cathode type for lithium-ion battery systems, select the most appropriate category, and an optional sub-identifier for the chemistries can be added to provide greater detail. These sub-identifiers are used to provide additional information to the recycler about materials of interest or changes in the raw material's hazard profile. For example, the nickel rich designator is suggested for mixed metal cathode chemistries with greater than or equal to 60 atomic percent Ni of the metals in the cathode active material (e.g., NMC 622 would be nickel rich) for this reason. The common industry abbreviations for cathode chemistries are suggested for the sub-identifiers.

When determining anode type for lithium-ion battery systems, select the most appropriate category.

Anode or cathode additives (Si, S, P) with a minimum of one weight percent content by mass of the component should be labeled. Materials falling below this threshold should be treated as trace elements and not considered in classifying material.

The identifier code should be formatted as follows:

SC()-A.M/MFG.YYMM [(1), (2), (3), (4)]

where:

Table 1 - Identifier code components

Letter	Description
S	System ID.
C()	Cathode, with optional sub-descriptors, for li-ion chemistries only.
A	Anode for li-ion chemistries only.
M	Miscellaneous; identifier selected from Figure 2. Multiple identifiers may be assigned.
MFG	Responsible organization (RO) two- to four-character alphanumeric descriptor. [(2)]
YYMM	Year and month of manufacture.

(1) The cathode and anode identifiers should be separated by a dash. The anode and miscellaneous identifiers should be separated by a period. The miscellaneous and RO identifiers should be separated by a slash (/). The RO identifier and the manufacturing date should be separated by a period.

(2) If the RO's name or logo appears elsewhere on the non-serviceable unit(s), the MFG descriptor is not a required portion of the mark. RO will determine its own unique two to four alphanumeric character identifier based on its company name.

(3) For battery systems that do not specify cathode or anode, an "X" should be used as a place holder.

(4) If the date of manufacture or other traceability mark appears elsewhere on the non-serviceable unit(s), the date descriptor is not a required portion of the mark.

Figure 2 lists the proper characters to identify the battery system, cathode, and anode, and the code background color reference consistent with the BAJ recommendations. At this time, metallic lithium is not expected to be part of the anode for production vehicles.