SAE International Battery Steering Committee Update on Standardization Activities: Li-ion Global Safety Standardization

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Bob Galyen
President, Battery Business Unit
Chairman, SAE International Battery Standard Steering Committee
“Technology is driven by human ingenuity and needs, of which, safety is of utmost importance.”
“It’s a complicated world after all, you know.”

- technology development
- governmental regulations
- consumer acceptance
- infrastructure improvements
Priorities of the Electric Vehicle Battery

1. Safety
2. Performance
3. Life
4. Cost
Battery Standards Steering Committee Scope

• The Steering Committee assigns Committees to specific tasks.

• The Committee is responsible for developing and maintaining SAE Standards, Recommended Practices, and Information Reports related to the field of vehicle battery technology, including both starter and traction batteries.

• Standardization should cover all aspects of the cell, module, pack or vehicle for form-fit-function, testing, validation, manufacturing, shipping, transportation, emergency response, service, recovery and recycling through the value chain in society.

• Particular emphasis is currently being placed on advanced Hybrid and Electric Vehicle traction batteries.

Culmination of expertise within our industry is exemplified by SAE

The creation of a Committee specific to the energy storage needs of the automobile
<table>
<thead>
<tr>
<th>SAE J</th>
<th>Title</th>
<th>Scope</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAE J537</td>
<td>Storage Batteries (Revision)</td>
<td>Testing procedures of automotive 12 V storage batteries and container hold-down configuration and terminal geometry.</td>
<td>Ready for Publication</td>
</tr>
<tr>
<td>SAE J240</td>
<td>Life Test for Automotive Storage Batteries</td>
<td>Life test simulates automotive service when the battery operates in a voltage regulated charging system.</td>
<td>Revised April 2007</td>
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<tr>
<td>SAE J1715/1</td>
<td>(R) Hybrid Electric Vehicle (HEV) &amp; Electric Vehicle (EV) Terminology</td>
<td>Contains definitions for HEV and EV terminology</td>
<td>WIP in Hybrid Committee</td>
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<tr>
<td>SAE J1715/2</td>
<td>Battery Specific Terminology</td>
<td>New document spawned from J1715/1. This document will contain terminology specific to energy storage systems not referenced in the parent J1715/1.</td>
<td>WIP Terminology TF</td>
</tr>
<tr>
<td>SAE J1797</td>
<td>Packaging of Electric Vehicle Battery Modules</td>
<td>Provides for common battery designs through the description of dimensions, termination, retention, venting system, and other features required in an electric vehicle application.</td>
<td>WIP Standardization TF</td>
</tr>
<tr>
<td>SAE J1798</td>
<td>Recommended Practice for Performance Rating of EV Battery Modules (Revision)</td>
<td>Common test and verification methods to determine Electric Vehicle battery module performance. Document describes performance standards and specifications.</td>
<td>WIP Hybrid Battery Testing TF</td>
</tr>
<tr>
<td>SAE J2185</td>
<td>LIFE TEST FOR HEAVY-DUTY STORAGE BATTERIES</td>
<td>Simulates heavy-duty applications by subjecting the battery to deeper discharge and charge cycles than those encountered in starting a vehicle</td>
<td>WIP Starting TF</td>
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<tr>
<td>SAE J2288</td>
<td>Life Cycle Testing of EV Battery Modules</td>
<td>Defines a standardized test method to determine the expected service life, in cycles, of electric vehicle battery modules.</td>
<td>WIP Hybrid Battery Testing TF</td>
</tr>
<tr>
<td>SAE J2289</td>
<td>Electric-Drive Battery Pack System: Functional Guidelines</td>
<td>Describes practices for design of battery systems for vehicles that utilize a rechargeable battery to provide or recover traction energy.</td>
<td>Published July 2008</td>
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<td>SAE J2344</td>
<td>GUIDELINES FOR ELECTRIC VEHICLE SAFETY</td>
<td>Identifies and defines the preferred technical guidelines relating to safety for Electric Vehicles (EVs) during normal operation and charging.</td>
<td>Published June 1998 Req. Rev.</td>
</tr>
<tr>
<td>SAE J2380</td>
<td>Vibration Testing of Electric Vehicle Batteries</td>
<td>Describes the vibration durability testing of a electric vehicle battery module or an electric vehicle battery pack.</td>
<td>Published 2009</td>
</tr>
<tr>
<td>SAE J2464</td>
<td>Electric Vehicle Battery Abuse Testing</td>
<td>Describes a body of tests for abuse testing of electric or hybrid electric vehicle batteries.</td>
<td>Published Nov. 2009</td>
</tr>
<tr>
<td>SAE J2801</td>
<td>Comprehensive Life Test for 12 V Automotive Storage Batteries</td>
<td>Life test is considered to be comprehensive in terms of battery manufacturing technology for correlation to hot climate applications</td>
<td>Published April 2007</td>
</tr>
<tr>
<td>SAE J2929</td>
<td>Electric and Hybrid Vehicle Propulsion Battery System Safety Standard (New)</td>
<td>Safety performance criteria for a battery systems considered for use in a vehicle propulsion application as an energy storage system galvanically connected to a high voltage power train.</td>
<td>Published 02/18/11</td>
</tr>
<tr>
<td>SAE J2936</td>
<td>Vehicle Battery Labeling Guidelines (New)</td>
<td>Labeling guidelines for any energy storage device labeling (such as: including cell, battery and pack level products).</td>
<td>WIP Label TF</td>
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<tr>
<td>SAE J2950</td>
<td>Shipping, Transport and Handling of Automotive-type BATTERY SYSTEM – Lithium Ion</td>
<td>Aids in the identification, handling, and shipping of un-installed battery system’s to and from specified location for the appropriate disposition of new and used items.</td>
<td>WIP Shipping and Trans. TF</td>
</tr>
<tr>
<td>SAE J2946</td>
<td>Battery Electronic Fuel Gauging</td>
<td>Reporting the vehicle’s (hybrid and pure electric) battery pack performance details to the automobile user</td>
<td>WIP Elec. Fuel Gage TF</td>
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</table>
Battery Standards Steering Committee

- Started – Nov. 2009
- Spawned Steering Committee
  - July 2011
- Current Membership
  - ~150 companies
    - OEM’s
    - Suppliers
    - Government
    - Academia
- Specific Topics
  - 16 Committees
  - Interaction
  - Inter-related

- 462 Representatives
- 102 representatives
- ~150 companies
  - OEM’s
  - Suppliers
  - Government
  - Academia

Specific Topics:
- 16 Committees
- Interaction
- Inter-related
Battery Safety Committee

- Chairman - Galen Ressler of General Motors
- Scope:
  - Create and maintain standard test procedures for all battery safety aspects
- Progress:
  - J2929 Electric and Hybrid Vehicle Propulsion Battery System Safety Standard issued March 2011
  - New revision in progress with emphasis on:
    - Expansion and enhancement of topics currently in document such as thermal propagation, etc.
Hybrid Battery Testing Committee

• Chairman: Richard Howlett of Nilar Battery Company

• Scope:
  – Publish new or update existing SAE Standards
  – Identify existing standards that meet functional testing required and identify missing testing standards

• Progress:
  – J1798 Performance Rating of Electric Vehicle Battery Modules
  – J2758-Determination of the Maximum Available Power from a Rechargeable Energy Storage System on a Hybrid Electric Vehicle
Battery Labeling Committee

- Chairman: Mark McGory of Jamac Label
- Scope:
  - Provides labeling guidelines at all levels; component, sub-component, subsystem and system-level architectures
- Progress:
  - J2936 Vehicle Battery Labeling Guidelines ready for first comments
  - Expect voting to occur in October
  - First responders section
    - Registry section (needs ownership and site)
    - Manual section (owners manual contents per legislation)
Battery Transportation Committee

• Chairman: Tom De Lucia of A123 Systems

• Scope:
  – J2950 is a recommended practice (RP) that aids in the identification, handling, and shipping of new and used un-installed lithium ion battery systems to and from specified locations. J2950 is based on and references existing US and International hazardous materials (dangerous goods) transportation regulations, which are the only methodologies to be used to establish transportability of new battery systems. This RP also provide recommendations regarding the transportability of used and damaged batteries. This RP is not a substitute for proper training, which is required by regulation, and or study of national and international regulations

• Progress:
  – J2950 will be submitted for committee vote in the beginning of October. If no issues arise it should be available for general distribution sometime in November
• Temperary Chairman: Bob Galyen

• Scope:
  – Provides for common battery designs through the description of dimensions, termination, retention, venting system, and other features

• Progress:
  – Paralleling ISO/ITEC on Li cell standards
  – SAE will develop Li module standards but some feel too proprietary to share; efforts continue
  – Change in direction to focus on cell level standard rather than module
Chairman: Robert Gruenstern of Johnson Controls

Scope:
- The Starter Battery Committee will create and maintain standards for the fitment, use and testing of all energy storage devices used in the starting function of transportation vehicles

Progress:
- Existing J-Document Update & Reissue
  - J537 Storage Batteries (reissued)
  - J2185 Life Test for Heavy-Duty Storage Batteries (Motor Vehicle Council Balloting)
  - J1495 Test Procedure for Battery Flame Retardant Venting Systems (under review by Committee)
- New J-Documents
  - J537 Storage Batteries (revised) expand scope anticipate new chemistries
  - J2981 – Creating new J Document for Starter Battery Standards
Chairman: Dan Young

Scope:
- Identify existing standards and make recommendations where new standards could be developed. Whenever possible, include truck and bus battery pack specifications into automotive standards and create new standards, when necessary.

Progress:
- A Roadmap has been created and the Committee has been separated into working groups for each of the major battery pack technical areas. Liaisons have been established with the SAE Truck & Bus Hybrid Safety and Advanced Drivetrain & Hybrid Steering Committees, as well as the CALSTART Electric Truck Users Group. A Technical Information Report (TIR) will be published in 2012.
Chairman: Joern Tinnemeyer of Cadex

Scope:
- This document covers the recommended practices associated with reporting the vehicle’s (hybrid and pure electric) battery pack performance details to the automobile user. These practices detail the accuracies, error conditions and diagnostic requirements responsible for delivering an accurate assessment of the amount of available electrochemical fuel.

Progress:
- Committee has agreed on a generalized system architecture
- Practice will include elements of the vehicle energy management system down to the cell level
- Initial draft has been written – significant areas still need more detail
- Goal is completion by Q1 2012
Chairman: Dave Prettenhofer of A&D

Scope:
- Identify and keep Battery Standards Committees abreast of new technologies which we must stay informed before market commercialization

Progress:
- Expect Information Report on upcoming technologies that require the attention of other committees, (Safety, Standards, etc.)
Battery Recycling Committee

• Chairman: Dr. Tim Ellis of RSR Technologies

• Scope:
  – Development of Technical Information, Recommendations and Standards for the recycling of automotive electrochemical cells

• Progress:
  – Enhanced labeling for improved handling and segregation of chemistries prior to recycling, in process
  – Development of uniform recycling nomenclature and definitions, in process
  – Compilation of recycling methodologies and benchmarking lifecycle costs, in progress
Small Task Oriented Vehicles (STOV)

- Chairman: Anthony Williams of E-Z-GO
- Scope:
  - Focusing on development of SAE Surface Vehicle Standards to harmonize test protocols for companies engaged in the manufacture of Small Task Oriented Vehicle (STOV) batteries, chargers, test equipment and independent laboratories. The Committee will focus on Electric Vehicle and Hybrid Electric Vehicle battery pack performance, rating, and testing standards relevant to these applications
- Progress:
  - Committee currently working on development of a SAE Certified STOV Electric Vehicle Range Testing
  - Range Testing is a major “Pain-Point” for STOV and Battery manufacturers
  - Goal is to have a draft test procedure in Q1 of 2012
Battery Test Equipment Committee

- Chairman: Terry Hartman of Bitrode Corp.
- Scope:
  - Identify minimum allowable standards for equipment used in testing energy storage systems in automotive type applications to include the definition of performance terminology and equipment safety standards
- Progress:
  - Currently gathering information from industry experts and test equipment manufacturers to document and identify key testing processes, methods, and specifications. Initial document is being generated
Battery Terminology Committee

- Chairman: Perry Wyatt of Johnson Controls
- Scope:
  - Define common terminology for energy storage systems at all levels; component, sub-component, subsystem and system-level architectures including terms pertaining to testing and measurement
- Progress:
  - J1715/2 – Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology – Energy Storage Systems
Battery Materials Testing Committee

- Chairman: Dr. Monique Richard of Toyota
- Scope:
  - Create Recommended Practices for the measurement of the key properties of the materials used in making batteries
  - It is not the purpose of the Committee to establish criteria for the test results
- Progress:
  - J2983 (in-progress): Recommended Practice for Determining Material Properties of Li-Battery Separator
Secondary Battery Use Committee

• Chairman: Arthur Holland of P3

• Scope:
  – Establish inspection standards to qualify and re-value safe batteries for re-use and compatibility

• Progress:
  – The first meeting was held 23-Aug-2011
  – Committee members are defining specific objectives and goals
Start/Stop Applications Committee

- Chairman: Tracy Strickland of Exide Corp.
- Scope:
  - Identify gaps in existing standards and recommended practices as they relate to batteries used in Start/Stop applications, including:
    - Testing, Design, Safety, Monitoring/Control, Labeling
    - Develop and maintain standards and recommended practices as appropriate based on those gaps where not assigned to or owned by other Battery Standards Steering Committees
- Progress:
  - Newest Committee
  - Developing member roster
• The Battery Standards Committee leads the way in standardization for batteries which will play a predominate roll in transportation of the future

• It will take a concerted effort of science, engineering, policy, testing and validation to assure the battery systems of the transportation sector meet performance, life and safety expectations of the general consumer and first responders

• SAE seeks to work with other Standard Development Organizations worldwide in harmonizing global standards for bettering the standards of living for generations to come.
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