The Prospect of International Standardization for Electric Vehicles

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The number of BEV·HEV in operation in Japan

Development of international standardization for EV and batteries is urgent to match the rapid spread of Electric Vehicles.

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The number of BEV in operation in Japan

Number of BEV operation has been increased rapidly in these years although the number itself is not large.

"K-class" is the Japanese classification for vehicles which are less than 3.4m long and with an engine displacement of 660cc or less.
Part 1

Standardization for Automotive Li-ion Batteries
ISO/IEC Project Structure for Li-ion Batteries

ISO/TC22/SC21
Electrically propelled road vehicles
- WG1: Safety
- WG2: Performance

IEC/TC69
Electric road vehicles and electric industrial trucks

IEC/TC21
Secondary Cell & Batteries

IEC/TC21/SC21A
Alkaline or other non-acid electrolytes

ISO/TC22/SC21 WG3 Batteries
- ISO 12405-1 (high power: HEV)
- ISO 12405-2 (high energy: BEV)

(Proposed by Germany)

IEC/TC21/TC69JWG
- IEC 62660-1 (performance)
- IEC 62660-2 (safety)

(Proposed by Japan)

SYSTEM PACK
CELL

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Distinction between cell and system/pack

Battery Control Unit

Bus

Battery Pack Battery System

HV Electric Circuit
Contactors, Fuse, Wiring

Pack/System: ISO

Service Disconnect (optional)

Cell / Module Assembly
Cells, Sensors, Cooling equipment

Normal use Impact Case

Cell: IEC

Cooling Device & Connections

Cell - Electronics

HV Connections

LV Connections

HV Connections

LV Connections

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Agreement for Automobile Li-ion Battery Standardization

IEC/TC21 Secondary batteries

IEC/TC21/SC21A Secondary cells and batteries containing alkaline or other non-acid electrolytes

IEC/TC21/SC21A/TC69JWG Secondary batteries for propulsion of electric and hybrid-electric road vehicles

IEC/TC69 Electric road vehicles & electric industrial trucks

ISO/TC22/SC21 Electrically propelled road vehicles

PT LIB Test specification for Li-ion traction battery systems

ISO/TC22/SC21/TC69JWG Secondary batteries for propulsion of electric and hybrid-electric road vehicles

[JP] 21/671/NP+21/672/NP Automobile Li-ion cell performance + safety

[FR] 21A/438/NP Stationary + motive Li-ion battery performance + safety

[DE] 21A/437/NP Automobile Li-ion battery safety

[DE] WD12405 Automobile Li-ion system performance + safety

Separated approach to tests on system/pack (ISO) and cell (IEC) Accepted by ISO/TC22/SC21

Li-ion cells for automobile application

Li-ion pack/systems for automobile application

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Proposed Framework for the Standardization of Automobile Li-ion Battery Testing

IEC 62660-1 and IEC 62660-2 aim to provide specific cell level testing standards to be coupled with system/pack level testing standards. Automobile manufacturers’ participation is indispensable to develop effective standards for Li-ion batteries for automobile application.

ISO/TC22/SC21/WG3
ISO 12405
Part 1 (High Power: HEV)
Part 2 (High Energy: EV)

IEC/TC21/SC21A/TC69 JWG
IEC 62660
Part 1 (Performance)
Part 2 (Reliable & abuse test)

Coordination by mutual experts’ participation

Car manufacturers
Battery suppliers
System suppliers
Li-ion experts etc.

4 of these standards have been already published.
Other standards of Li-ion Batteries for EV Under Development

【 ISO/TC22/SC21/WG3 】
Pack/System: ISO12405-3 (Safety Requirement)

【 IEC/TC69/TC21/SC21A/JWG 】
Cell: IEC62660-3 (Safety Requirement) (Planned)

【 ISO/TC22/SC21/WG3 】
IEC/TC69/TC21/SC21A/JWG
Cell: IEC/ISO PAS16898 (Cell size)

International Standardization of batteries for EV is still going on. Participation of Asian stakeholders is most important.
Part 2

JARI Safety Approach for Li-ion Batteries
Safety Research for FC·EV
- Hy-SEF activities

Safety Evaluation for EV, FCV and Hydrogen
- Li-ion Batteries (EV safety)
- Safety of Vehicle & Hydrogen Storage
  (Property of released hydrogen flame,
   Safety release method of hydrogen)
- Manuals for vehicle fire accidents
  (Fire fighting, Rescue, Safety distance)
- FCV Crash Test Procedures
  (Hydrogen leakage limit, etc.)
Safety Research for Li-ion Battery

1) Investigation of the safety evaluation test items

2) Safety evaluation tests
Focusing on the test procedure: Relationship between test conditions and the results. Overcharge, overdischarge, short circuit, penetration, crush, vibration, bonfire, etc.

3) Proposal for safety evaluation test methods to ISO/IEC

<table>
<thead>
<tr>
<th>Specification</th>
<th>Battery charge/discharge test unit</th>
<th>Penetration/crush test unit</th>
<th>Environmental test chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage: Max. 500 V Current: Max. 300 A Short circuit current: Max. 5,000 A Voltage and temperature measurement: Each 20 ch.</td>
<td>Penetration Stroke: 150 mm Load: Max. 20 kN Speed: 30 to 250 mm/s Crush Stroke: 300 mm Load: Max. 50 kN</td>
<td>Temperature: -40 to 150 ºC Humidity: 20 to 98 %RH</td>
<td></td>
</tr>
</tbody>
</table>

Photograph
# The safety evaluation items

<table>
<thead>
<tr>
<th>Safety evaluation test items</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical tests</strong></td>
</tr>
<tr>
<td>Overcharge</td>
</tr>
<tr>
<td>Overdischarge</td>
</tr>
<tr>
<td>Short circuit</td>
</tr>
<tr>
<td>Overvoltage</td>
</tr>
<tr>
<td><strong>Mechanical tests</strong></td>
</tr>
<tr>
<td>Penetration</td>
</tr>
<tr>
<td>Controlled crush</td>
</tr>
<tr>
<td>Vibration</td>
</tr>
<tr>
<td>Mechanical shock</td>
</tr>
<tr>
<td>Drop</td>
</tr>
<tr>
<td>Dynamic crush</td>
</tr>
<tr>
<td>Curb crash</td>
</tr>
<tr>
<td><strong>Environmental tests</strong></td>
</tr>
<tr>
<td>Immersion</td>
</tr>
<tr>
<td>High temperature</td>
</tr>
<tr>
<td>Thermal shock</td>
</tr>
<tr>
<td>Temperature cycles</td>
</tr>
<tr>
<td>Dewing</td>
</tr>
<tr>
<td><strong>Fire test</strong></td>
</tr>
<tr>
<td>Bonfire</td>
</tr>
<tr>
<td>Vehicle fire</td>
</tr>
</tbody>
</table>

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Global Technical Regulation for Safety

Those data taken at JARI were also provided into UN-ECE and gtr.

【UN-ECE/ TRANS /WP.29/GRSP】
(http://www.unece.org/trans/main/welcwp29.html)

Vehicle Regulations
- EV, HEV etc. ECE R100, ECE R94&R95 etc. (58 agreement)
- FCV: HFCV gtr (98 agreement: Under deliberations)

Components
- RESS (Rechargeable Energy Storage Systems):
  ECE R100 Part2 (Under deliberations)

JARI will be able to provide these technical expertise as a testing agency.

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Part 3

Standardization for Battery Charging and JARI's Certification of Charging System
Infrastructure for EVs in Japan

【Nomal Charger】
1-phase 100V:1.5kW
1-phase 200V:3kW

【Quick Charger】
3-phase 200V:20-50kW
# AC charging interfaces standardization

<table>
<thead>
<tr>
<th></th>
<th>IEC 62196-2</th>
<th></th>
<th></th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase</strong></td>
<td>Single</td>
<td>Single/Three</td>
<td>Single/Three</td>
<td>Single/Three</td>
</tr>
<tr>
<td><strong>Rated Current</strong></td>
<td>32A (single phase) / 80A (single, US only)</td>
<td>70A (single phase) / 63A (three phase)</td>
<td>32A→63A ? (single/three phase)</td>
<td>70A (single phase) / 63A (three phase)</td>
</tr>
<tr>
<td><strong>Rated Voltage</strong></td>
<td>250V (300V US only)</td>
<td>480V</td>
<td>250V</td>
<td>220V (single phase)/ 380V (three phase)</td>
</tr>
<tr>
<td><strong># of pins</strong></td>
<td>5</td>
<td>7</td>
<td>4 or 5 (single phase) / 7 (three phase)</td>
<td>7</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Coupler</td>
<td>Coupler, Plug &amp; Socket</td>
<td>Coupler, Plug &amp; Socket</td>
<td>Coupler, Plug &amp; Socket</td>
</tr>
<tr>
<td><strong>Compatibility</strong></td>
<td>SAE J1772</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Connector Design</strong></td>
<td>![Type1 image]</td>
<td>![Type2 image]</td>
<td>![Type3 image]</td>
<td>![China image]</td>
</tr>
<tr>
<td><strong>Locking</strong></td>
<td>Option</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Shutter</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

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Quick Charger Specifications
(for Japanese Market)

Charger Specifications
- Input: 3-phase 200V
- Maximum DC output power:
  50kW
- Maximum DC output voltage:
  500V
- Maximum DC output current:
  125A

5 minute charge for 40km (25 miles) driving range
10 minute charge for 60km (37 miles) driving range
## DC charging system / interface standardization

### DC charging system

<table>
<thead>
<tr>
<th>Japan (CHAdeMO) / China</th>
<th>Germany / US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated charging system</td>
<td>AC/DC combined (&quot;Combo&quot;) system</td>
</tr>
</tbody>
</table>

### Vehicle Coupler

- **Japan (CHAdeMO)**
  - Pure DC
  - Additional DC terminals

- **China**
  - Pure DC

- **US**
  - Low power: AC/DC common
  - High power: AC/DC Combo

- **Germany**
  - Low power: AC/DC common
  - High power: AC/DC Combo

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DC charging system / interface standardization

“Combo” vehicle inlet concept of US and Germany

Vehicle Inlet (Type 1)

Vehicle Inlet (Type 2)

Type 1 and Type 2 “combo” vehicle inlets use a common structure for both AC and DC charging.
Aspect of standardization for this field

- IEC has not reached the single specification for both AC and DC couplers.

- There are many stakeholders in this field, unlike other technical fields.
  - Interests among the automotive industry, electric power suppliers.
  - Differences in the power situation in national and regional areas

Consensus challenges.

It is essential to build a relationship of mutual trust among stakeholders.
Interoperability for Charging System

- As for charging system, it needs to have certain interoperability to match each EV and charger.

- It needs to have certification system to establish infrastructure for EV charging system. Otherwise, each charger needs to be checked for each EV.

- JARI has started the certification system for AC charging in Japan. We will be able to support these activities.
Thank you for your attention.

If you have any comments and questions, please feel free to contact me: Hidenori TOMIOKA. 
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