Testing of E-Vehicles

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TÜV SÜD
TÜV SÜD in numbers: Growing from strength to strength

1  One-stop technical solution provider
150  years of experience
800  locations worldwide
1,800  million Euro in sales revenue 2012
18,800  employees worldwide
Global expertise. Local experience.
TÜV SÜD’s electric mobility services offering

- Testing and certification charging infrastructure
- Battery testing: performance, reliability & safety
- Testing of e-bikes
- Testing and “accreditation” of hydrogen refueling points; fuel cell testing
- Homologation; vehicle safety; functional safety services
- Fleet management, carbon-footprint; eHU
- Training and seminars: e.g. high voltage in vehicles
Vehicle and Component Testing – Electric Vehicles

- Mandatory homologation tests
- Company internal testing requirements
- Consumer tests

Mandatory homologation tests:
- The most common categories of electric vehicles with four and more wheels:
  - L7e – heavy quadricycles – total unladen mass without battery does not exceed 400 kg resp. 450 kg (550 kg resp. 600 kg for quads intended for carrying goods)
    - No crash test
  - M1 – Passenger car
    - In small series only ECE R 12
  - M3 – buses
    - Urban busses no crash tests

- Different documents:
• Homologation
  – 3 levels according to the size of series
    ▪ Individually manufactured vehicle
    ▪ Small series (e.g. M1 up to 1000 pcs/year in the EC Countries)
    ▪ Large series

Specific UN ECE regulations for (H)EV:
  – ECE R100 safety requirements
  – ECE R101 energy consumption
  – ECE R 85 measurement of electric drive power
Which Category?
Which Category?

2002/24/EC – two or three-wheel motor vehicles, light four-wheelers (quads)

Category L7e:
- Quad
- Unladen mass without battery up to 400 kg resp. 550 kg

Unladen mass without batteries: 400 kg/882 lb
Passive Safety of L7e

- G Wiz: EuroNCAP test @ 64km/h (40 mph)

Source: dailymail.co.uk – “Crash test conducted by British car magazine Top Gear at 40mph”
Addendum 99: Regulation No. 100

Revision 2

Incorporating all valid text up to:

Supplement 1 to the 01 series of amendments – Date of entry into force: 26 July 2012
Supplement 2 to the 01 series of amendments – Date of entry into force: 15 July 2013
02 series of amendments to the Regulation - Date of entry into force: 15 July 2013

Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train

Annex 8 is defining test standards for the type approval of batteries for:

- Hybrids
- Plug-In Hybrids
- Electric vehicles

R100.02 already available

Transition period till 07/2016
Safety requirements according to ECE R 100.02

Vehicles category M a N
- Marking
  - Orange HV cables
- Electrical safety
  - Separated +/- wiring
  - protection of persons against access to hazardous parts
    - Test finger
    - Test wire
  - Isolation resistance
  - board isolation resistance monitoring system
- General requirements on Functional Safety (charging, EMC)
- //Hydrogen emissions – Pb accumulators//
- Rechargeable Energy Storage System (REESS)
9 Tests to be performed:

- Vibration test
- Thermal shock cycling
- Mechanical shock (crash simulation requires a slide test bench!)
- Mechanical integrity (crush test)
- Fire resistance (fuel fire test)
- External short circuit
- Overcharge protection
- Over-discharge protection
- Over-temperature protection

Safety testing area necessary!
Tests for Electrical Energy Storages

- **Performance- / Durability testing:**
  - Cycle testing, Temperature influences
  - Parameter determination

- **Environmental testing / Durability testing:**
  - Vibration / Shock, Dust, Humidity, Thermal Shock, EMC, immersion testing, Altitude simulation, dew, Chemical influences

- **Safety testing:**
  - Short circuit, Overcharge, Over-Discharge, Nail penetration, Crush, Gas Analysis

- **Security issues**
Test Requirements

Vibration

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<tr>
<th>Frequency [Hz]</th>
<th>Acceleration [m/s²]</th>
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<tr>
<td>7 - 18</td>
<td>10</td>
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<tr>
<td>18 - 30</td>
<td>gradually reduced from 10 to 2</td>
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<tr>
<td>30 - 50</td>
<td>2</td>
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Mechanical Shock

<table>
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<th>Point</th>
<th>Time [ms]</th>
<th>Acceleration [g]</th>
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<td></td>
<td></td>
<td>Longitudinal</td>
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<td>B</td>
<td>50</td>
<td>20</td>
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<tr>
<td>C</td>
<td>65</td>
<td>20</td>
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<tr>
<td>D</td>
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</tr>
<tr>
<td>E</td>
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<tr>
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<td>28</td>
</tr>
<tr>
<td>H</td>
<td>120</td>
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</table>
Range of Electric Vehicles

- Mandatory
  - NEDC
  - Vehicle dynamometer

- Consumer
  - TSECC (@-7, 23 and 30°C)
  - Vehicle Dynamometer
  - Simulation
Simulation of Vehicle Range

- Model validation
  - Vehicle level
  - Component level
- Consumption of AUX devices
- Different simulation scenario
  - TSECC, NEDC, City, Real data, Aggressive driver, …

![Diagram with vector notation and graphs showing velocity and energy over time]
Conclusions

• EV testing
  – Mandatory requirements
  – Company internal testing requirements
  – Consumer tests

• ECE R 100.02
  – Vehicle homologation
  – Battery as component

• Range Evaluation
  – Temperature influence
  – Dynamometer/Simulation
Thank you for your attention!