Safety of Lithium-ion Batteries and Electrified Vehicles

- Safe specification and design
- Minimise potential safety risks
- Gas/smoke - fire - electricity
- Handling and management
  - in an accident
  - during service
  - in manufacture
- What can happen during thermal runaway?
- Can extreme crash conditions create a dangerous situation?
- Spread
- Extinguishing
Testing of Lithium-metal and Lithium-ion Batteries

**Impact tests**

- Weights are dropped on to the sample

**Destructive battery tests**

- Electrical tests in accordance with e.g. SAE J2464 and FreedomCAR
- Tests of lithium-ion batteries in accordance with UN 38.3, Recommendations on the Transport of Dangerous Goods

**Fire tests**

- Maximum 170 °C surface temperature
- Toxic gases and heat release rate (HRR)
Seismic Verification of Batteries and Battery Racks

Emergency batteries must operate during and after an earthquake.

Large, heavy installation verification:

- Establish computer models
- Verify the model
- Adjust unknown parameters in the computer model if necessary
- Use the model for verification of larger installations
Seismic Verification of Batteries and Battery Racks (2)

How to prevent battery acid from destroying the test rig

- Test the rack with the cells filled with glycol
- Measure the responses of those cells exhibiting the most severe vibration
- Use these responses as the drive signal for the test rig when acid filled cells are tested separately in an acid-resistant box
Fire Testing of Battery Packs – Smoke Gas Analysis

Measurements are made using FTIR analysis, to show the gas content as a function of time.

Fire creates risks such as the formation and release of

- Carbon monoxide
- Hydrogen fluoride
- Breakdown products

Smoke gas analysis can be made for a range of fire sizes.
Determination of Heavy Metals in Batteries

Determination of heavy metals in batteries, such as

- Mercury
- Cadmium
- Lead
- Arsenic

A wide range of chemical analyses is available.

Chemical problem-solving.
Fire Testing of Battery Packs

SP offers fire testing of automotive battery packs, and has been involved in developing the Rechargeable Energy Storage Systems (REESS) draft standard.

- Exposure to a burning petrol pool fire
- Simulated fuel spillage fire after an accident
- Requirement that the battery pack must not explode
Fire Testing of Battery Packs – Safety

- System or component testing.
- Tests performed under safe and controlled conditions.
- Test durations 2 minutes 10 seconds.
- Wide range of documentation and measurements, e.g. temperature, heat release rate and fire gas analysis.
Simulation of Electrical Powertrains

Target: millisecond-responsive simulation.

Simulation of rapid evasive manoeuvres to:

- Show the capabilities of electric drivelines
- Identify and analyse weaknesses in hybrid vehicles

Combination measurements:

- Different vehicle models
- Different electric motors
- Different battery models OK
Functional Safety

Functional safety is the absence of unreasonable risks due to hazards caused by multifunctioning behaviour of electrical / electronic system.

Safety requires activities such as

- Hazard identification
- Risk assessment
- ASIL classification
- Definition of the functional safety concept
Resistance of Electronic Equipment to Environmental Conditions

Vibration testing
During its service life, equipment will be exposed to vibration and shock due to transport and use of the vehicle.

Climate testing
The product must withstand high and low temperatures, as well as rapid temperature changes.
Full-Scale Testing of Electric and Hybrid Vehicles

SP is a Technical Service for the Swedish Transport Agency

- Accredited for EMC automotive standards testing
- Full in-vehicle testing in accordance with the latest versions of legal requirements and basic standards for electric and hybrid vehicles
- Full-scale capabilities for testing complete electric and hybrid vehicles
  - during road conditions
  - transients and emission requirements during charging
- Northern Europe’s largest and most comprehensive EMC laboratory resources
Dynamic Motor Testing

Applications

- Design verification
- Optimisation of motor control regime
- Measurement of motor performance
- Development testing
System and Component Testing of Electric and Hybrid Systems

SP is a Technical Service for the Swedish Transport Agency

- Accredited for EMC automotive standards testing
- Accredited for component testing of electric and hybrid systems
- Full range of test facilities for EMC testing of HV systems and components
  - immunity and emission
- DC power units up to 600 VDC and test loads for performance testing and drive simulation
Performance Testing of Batteries

Cycling and performance testing of batteries.
Nordic Ecolabel testing of rechargeable batteries.

**Cycle testing of batteries**

- 13-channel Digatron A2, 0-18 V (cells)
- 4-channel Chroma, 0-80 V (cells and modules)
Advisory Services and Training

**Electrical safety courses**
- Electric drive systems in vehicles
- For designers
- For production personnel

**Advisory services**
- Standards and legal requirements
Thank you for your attention!