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How will the electrification of vehicles affect environmental testing?

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Promotion video



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We are facing a huge technology shift in vehicle technology! Ground vehicles will

- Have electric drive
- Be autonomous

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Factory in Suzhou January 2020




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A small autonomous vehicle for theme parks




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Autonomous vehicles means


Increased demands on *reliability* for safety

- Sensor reliability
- Control system reliability
- Software reliability

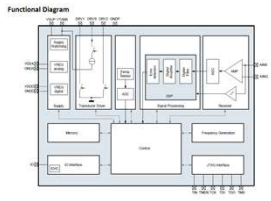
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Sensor problem



Built-in electronics



Electronics to Electronics interaction, software

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Bus passenger ride comfort measurements in Tashkent




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My course at Beijing University of Aeronautics and Astronautics, Beihang

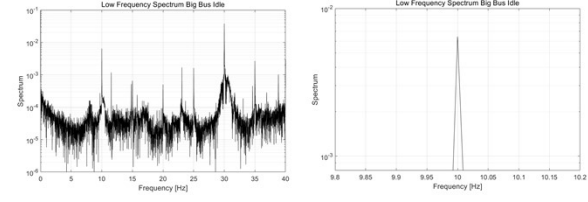
- Reliability and Environmental Engineering
- Department of Reliability and System Engineering



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When we looked at data with bus idle


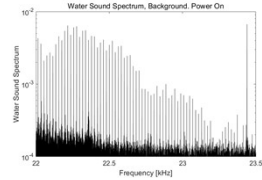


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How about EMC? This ROV should be silent

Brushless motor drive with PWM





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No problem at lab.
Problem back at garage!

Were we seeing ghosts?



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IEC TC 104 Two standard series

- 60721 Environmental conditions
- 60068 Methods of test



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Battery! There is a special safety problem!

- Li-Ion Battery Fire Hazards and Safety Strategies
- Managing the Lithium (Ion) Battery Fire Risk
- Lithium-Ion Batteries Hazard and Use Assessment
- LITHIUM BATTERY SAFETY
- Etc, etc

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60721 Shock and vibration

- Combustion Engine, Electric Motor
- Exhaust
- Transmission
- Road, Speed wind

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In a course I compared existing battery vibration test standards with reported data from field measurements

SUMMARY slide:

- The existing standards are a bit of a mess, when it comes to mechanical tests and comparison with field measurements!
- The people in the business writing reports have a lot to learn!

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60721 Climatic, biggest differences

- No "free" heat source
- Limited battery capacity
- Limited air condition
- Different temperature environment
- Different humidity environment

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From a RISE report

Table 1: Survey of standards for vibration tests of Li-ion batteries for electric and hybrid vehicles

Name	IEC 62660-2	ISO 12405-1	SAE J2380
Headline	Secondary lithium-ion cells for the propulsion of electric road vehicles	Electrically propelled road vehicles – Test specification for lithium-ion traction battery systems Part 1: High power applications	Vibration testing of electric vehicle batteries
Object	Cell	Electronic devices on the batteries	Pack (including electronics)
Cell/Module/Pack/Electronics	Same as IEC 62660-2		Pack / Module
Directions	Three directions	Three directions	Three directions
Vibration mode	Random	Random	Random
Sine/Random			
Frequencies (Hz)	10-2000	10-2000	5-200
10-200			
Acceleration (g)	3 (rms)	3 (rms)	1.44 (rms)
1.9-0.75(rms)			
Time/axis (hour)	8	8	21
>13.6			
State of Charge (SOC) before test	100 % (EV), 80 % (HEV)	N/A	50 % after two standard cycles
100 %, 80 % and 40 %			

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Table 2: Survey of standards for vibration tests of Li-ion batteries for electric and hybrid vehicles

Name	USABC	ECE R100	UN 38.3
Headline	Electric Vehicle Battery Test Procedures Manual	Regulation No. 100-2	38.3 Lithium Battery Testing Requirements
Object Cell/Module/Pack/ Electronics	Pack/Module/Cell Same as SAE J2380	Pack/Module/Cell	Module/Cell Pack/Module/Cell
Directions	Three directions	Three directions	Vertical
Vibration mode Stimulus/Random	Random	Sine	Sine
Frequencies (Hz)	10-200	10-200	7-50
Acceleration (g)	1.9-0.75(rms)	5-0.75	1-0.2
Time/axis (hour)	>13.6	6	3

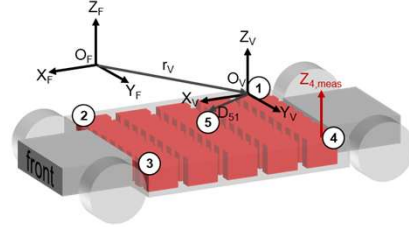
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Towards Realistic Vibration Testing of Large Floor Batteries for Battery Electric Vehicles (BEV)

Benedikt Plaumann, Hamburg University of Applied Sciences



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Field measurements to get specifications?

For small batteries we can do tailoring, as for any "small" equipment



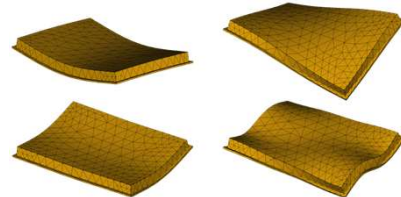
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How to test the battery?

- Separate Multi-axis/Multi-exciter test?
- Boundary conditions?
- Whole vehicle on 6 DOF rig?
- Virtual testing?



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For big batteries, we must treat the whole system



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From SEES' Fall meeting 2021

Combining Test and Simulation to tackle boundary condition mismatches in Environmental Testing

Presenter: Bart Peeters
Product Line Manager Structures & Environmental Testing



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Aberdeen Proving ground was early



- Virtual proving ground "exact" replica of physical
- Physical kept to be the same as virtual
- Essential for **validation** of methods and models
- Now many sites offer Virtual Proving Grounds

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Three year project, started January 2022

Autonomous vehicles on bad roads

Funded by National Natural Science Foundation of China



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RIDE QUALITY METER[®], RQM2

September 2011, Xielalin Consulting

- Measured road profiles from laser car
- Many different simple car models
- ISO model of seated driver
- Car driving on road time simulation
- Driver comfort evaluated, ISO standard

[Calculation of Reference Ride Quality, using ISO 2631 Vibration Evaluation Conference Paper](#)

•Sep 2001

•36th UK Group Meeting on Human Response to Vibration

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Measurement during the RQM project



- Road: Really bad NH 90 north Sollefteå
- Signed speed mostly 90 km/h
- Comfortable speed often 60 -70 km/h
- Ambulance 140 km/h with police escort
- Project leader "patient" with sensors
- Project leader not interested in lunch 😊

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27