TÜVRheinland®

Precisely Right.

INVESTIGATING BATTERY SAFETY

Logistics and Assembly

1/23/2017

Global TÜV Rheinland 2016

70 countries **500** locations **200** laboratories **20,000** employees

Products Business Stream

TÜV Rheinland issues more than 17% of the total global number of certifications based on the standards of the International Electrical Commission (IEC).

Key Facts

- >80,000 test samples per month
- >80 Industry R&D projects annually
- Global leader in testing and certification of Li-Ion building storage systems
- Safety research project Li-Ion building storage systems, Federal Ministry for Economic Affairs and Energy, Germany
- Initiator of new European safety application standard for e-bikes

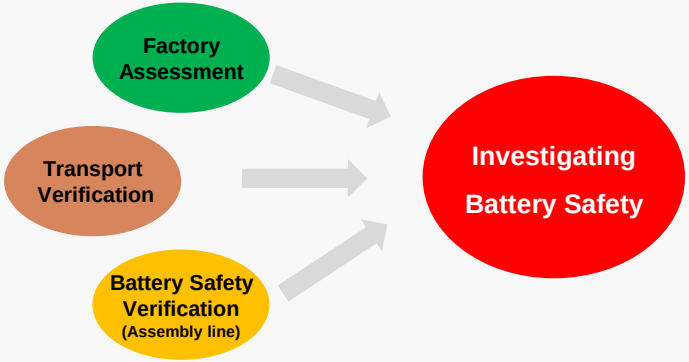
Focus Industries

- Automotive Manufacturers
- Electronics Manufacturers
- Retailers


HQ, Germany (Cologne)

Scope of Work

1. **Investigating specific and relevant factors**
   for battery safety related to the phone assembling processes
2. **Investigating possible changes**
   of battery safety after road transport
3. **Verification of investigation results** by battery sample safety tests



Detail Work Scope

Duration of Investigations

- November 2016 – January 2017

Assessed assembly lines

- Hanoi/Vietnam
- Gumi/Korea

Investigated logistics for road transport

- Dongguan/China → Hanoi/Vietnam

Factory Assessment

- Inspections have been run from November to December 2016 in the factories Samsung Electronics Vietnam and Samsung Electronics Co., Ltd., Korea
- **Work processes were inspected** by TÜV Rheinland Factory Assessment Panel from a safety viewpoint and verified by Battery Safety Verification Panel, specific to
  - ✓ Handling, touching and storage of batteries during process steps
  - ✓ Sufficient and effective battery inspection procedures
  - ✓ Status and improvements of battery safety factors
- **Inspection results of work processes showed no detection of relevant weakness, concern or any obvious danger affecting the battery safety integrity in the factories during assembly**

Verification Process






Logistics Assessment

- **Environmental and mechanical stress was measured during transport of two battery pallets** between Dongguan/China and Hanoi/Vietnam
- **Temperature, humidity, strain, acceleration, and geographical position** were monitored
- **Gathered data was analysed and elevated logistic test patterns were established**, allowing simulation of possible transportation conditions in laboratory environments

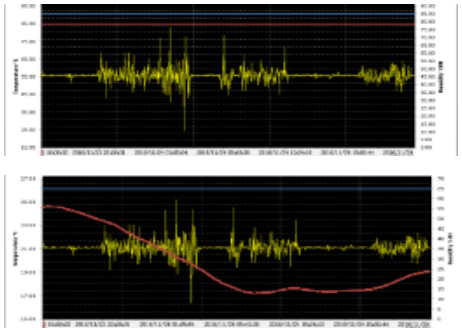
Transport Monitoring & Simulation

Logistic Observation Monitoring, Recording and Analysis of External Stress Data

Logistics Assessment - continued

- In order to cover possible maximum stress caused by temperature and humidity, **additional test patterns of HTHH* & LTHH** were developed** to cover further transportation conditions at any time and/or season of the year

Logistics Monitoring



* HTHH – High Temperature (85°C) High Humidity (85% rH)
** LTHH – Low Temperature (0°C) High Humidity (85% rH)

- **After logistic stress simulation the batteries were tested according to international safety standards and the tested batteries passed the tests.**

Verification of the results by sample testing

- For the verification of the **assembling line and logistic assessment** results TÜV Rheinland tested
  - ✓ 500 Li-ion battery samples drawn at 5 locations from the mobile phone supply chain in China, Vietnam, Korea, and 150 units from the transport route China - Vietnam
- **The drawn and tested samples passed the tests according to international safety standards in the laboratories**

Battery Safety verification (Evaluation of each process)


Accredited Battery Test Labs


Accredited Battery Test Labs

Conclusions

- Inspections and observations of **processes and workstations** in Samsung mobile phone sub-assembly line in Vietnam and main-assembly line in Korea **showed no specific detection of weakness, concern or obvious danger** affecting battery safety integrity. Recommendations for further improvements of a safe handling in processes were given.

- Investigation of possible changes in safety behavior of **batteries after road transport** between battery manufacturer / warehouse China and sub-assembly line in Vietnam showed that **after elevated environmental and mechanical stress** was applied prior to safety evaluation**, tested batteries passed relevant safety requirements.**