UN Lithium Battery Transport Tests & UL Battery Safety Standards – Status Update (April 2013)

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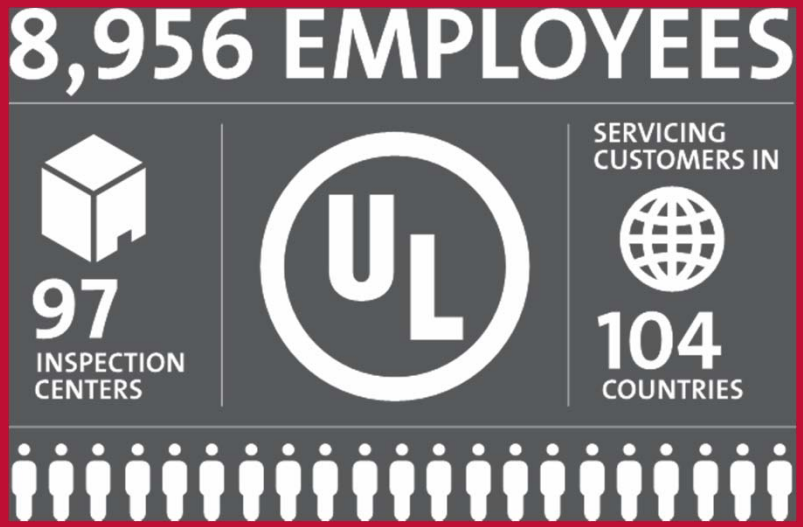
Advancing safety through careful research and investigation

Preventing or reducing loss of life and property

Promoting safe living and working environments for all people



Agenda

UN Lithium Battery Transport Tests

Overview of Transport Requirements

Battery Safety Standards

Overview of Safety Standards, Certifications and Regulations

Gaps

UN Lithium Battery Transport Tests

Overview of Transport Requirements

T1-T5 conducted in order

Test	Method Summary	Pass/fail
T1 Altitude Simulation	11.6 kPa for 6 h, ambient temp	nf, nl, nv, nd, nr, ocv ≥ 90%
T2 Thermal	72 ± 2 °C to -40 ± 2 °C, hold temp for 6 h, 10 cycles, 24 h at ambient temp	nf, nl, nv, nd, nr, ocv ≥ 90%
T3 Vibration	sinusoidal WF w log, 7 Hz→200Hz→7Hz in 15 min, 12 cycle for 3 h for 3 mutually ⊥ dir. 0.8 mm amp, Large Bat – 0.2 g peak accel, Small Bat and Cells – 0.8 g peak acc.	nf, nl, nv, nd, nr, ocv ≥ 90%
T4 Shock	half-sine, Large Cell and Bat: Peak accel 150 gn, pulse 6 msecs; Small Cell and Bat: Peak accel of 50 gn, pulse 11 msecs	nf, nl, nv, nd, nr, ocv ≥ 90%
T5 External Short Circuit	55 ± 2 °C , ≤ 0.1Ω, 1 h or until case returns to 55°C temp, Check results for 6 h	nf, nr, nd,170°C
Conditioning: Cells and small batteries: 1st cycle and 50 cycles; Large batteries: 1st cycle and 25 cycles		

Overview of Transport Requirements

Test	Method Summary	Pass/fail
T6 Impact / Crush Cell Conditioning: 1st cycle, 50% SOC	a) Impact for cylindrical ≥ 20 mm diameter only; 9.1 kg kg mass dropped 61 cm onto 15.8 mm diameter bar across cell; b) Crush for other than cylindrical with diameter ≥ 20 mm cells; 13 kN flat plate crush at 1.5 cm/s rate until: - force reached, or - 100 mV OCV drop, or - 50% deformation. Check results for 6 h	nf, nd, 170°C
T7 Overcharge Battery Conditioning: Small: 1st cycle and 50 cycle Large: 1st cycle and 25 cycles	CC at $2I_{Cmax}$, Bat ≤ 18 V: CV = 2 x V_{Cmax} or 22 V; Bat > 18 V:CV = 1.2 x V_{cmax}, Check results for 7 days	nf, nd, 170°C
T8 Forced Discharge Cell Conditioning: 1st cycle and 50 cycles	connect resistive load in series with test cell, cell forced discharged for time equal to rated capacity ÷ initial test current. Check results for 7 days	nf, nd

Overview of Transport Requirements

Need to consider what is being shipped:

What is shipped?	Required Tests
Cells (single cell batteries considered a cell)	T1, T2, T3, T4, T5, T6 and T8
Batteries (w/wo tested cells & oc protection)	T1, T2, T3, T4, T5, T7
Battery Assembly ≤ 6200 Wh (w tested batteries & if not provided with a monitoring system to prevent oc, od, sc, and oh)	T3, T4, T5 and T7
Component Cell (only shipped as a component in a battery)	T6, T8
Secondary single cell battery with overcharge protection	T7 (in addition to cell tests)

Definitions:

Small Cell ≤ 500 g < Large Cell
Small Battery ≤ 12 kg < Large Battery

UL Battery Safety Standards

Overview of Safety Standards, Certification and Regulations

Battery Safety Standards for Portable Applications:

Standard	Scope	Certification Program	Regulatory Environment
UL 1642	primary and secondary lithium cells	BBCV2	Voluntary
UL 2054	Household and commercial batteries, includes lithium batteries, portable applications	BBFS, BBFS2	Voluntary
UL 2575	Lithium ion battery systems for portable tools and appliances	BBOI	Voluntary
IEC 62133	Nickel and secondary lithium cells and batteries for portable applications	CB scheme	Voluntary/ regional (i.e. DENAN)
IEEE 1625	Lithium ion battery systems for mobile computing devices	CTIA	Wireless carriers
IEEE 1725	Lithium ion battery systems for cellular phone applications	CTIA	Wireless carriers
NEMA C18.2M Pt 2	Nickel and secondary lithium cells and batteries for portable applications	-	Voluntary

Overview of Safety Standards, Certification and Regulations

Standard	Short circuit	Abnormal/ Over charge	Forced discharge	Vibration	Shock	Crush	Cell Impact	Temperature Cycling	Heating	Altitude Simulation	Drop	Projectile/ Fire Exposure
UL 1642	X	X	X	X	X	X	X	X	X	X	-	X
UL 2054	X	X	X	*	*	*	*	*	*	*	X	*
UL 2575	X	X	X	*	*	*	-	*	*	*	X	-
IEC 62133	X	X	X	#	#	X	#	#	X	#	X	-
IEEE 1625	X	*	*	*	*	*	*	*	X	*	X	X
IEEE 1725	X	*	*	*	*	*	*	*	X	*	X	X
NEMA C18.2M Pt.2	X	X	X	X	X	X	X	X	X	X	X	-

* - Require compliance to UL 1642
# - Require compliance to UN 38.3 tests

Overview of Safety Standards, Certification and Regulations

Battery Safety Standards for Appliance and Light Electric Vehicle (LEV) Applications:

Standard	Scope	Certification Program	Regulatory Environment
UL 2575	Lithium ion battery systems for portable tools and other appliance applications	BBOI	Voluntary
UL 2271	EESAs for light electric vehicle (LEV) applications	BBCA, BBCA2	Voluntary

Overview of Safety Standards, Certification and Regulations

Standard	Short circuit	Abnormal/ Over Charge	Forced/ Over Discharge	Imbalanced Charging	Temperature	Dielectric Voltage Withstand	Isolation Resistance	Vibration	Shock	Crush	Drop	Rotation	Temperature Cycling	Immersion
UL 2575#	X	X	X	X	-	-	-	-	-	-	X	-	-	-
UL 2271	X	X	X	X	X	X	X	X	X	X	X	X	X	X
# - Horizontal standard to be used in conjunction with applicable end product standard														

Overview of Safety Standards, Certification and Regulations

Battery Safety Standards for Electric Vehicle (EV) Applications:

Standard	Scope	Certification Program	Regulatory Environment #
UL 2580	EESAs for on road vehicles and off road industrial vehicles	BBAS, BBAS2	Voluntary (NFPA 505)
UL Sub. 2271	EESAs for for on road and off road light electric vehicles (LEVs) (UL 2271 pub 2013)	BBCA, BBCA2	Voluntary
SAE J2929	Lithium ion batteries for on road vehicle applications	-	Voluntary
ISO DIS 12405-3	Lithium ion batteries for on road vehicle applications	-	Voluntary
# - US regulation is FMVSS, Sec 305 specific to EVs; EU regulations is UNECE transport regulations, Reg. No 100 specific to EVs.; UN EVS-GTRs under development will be framework for regulations in EU and other signatories			

Overview of Safety Standards, Certification and Regulations

Standards	Short Circuit	Overcharge	Over discharge	Humidity/ Isolation Res.	Thermal Control Failure	Temperature Cycling	Drop	Vibration	Mechanical Shock	Rotation	Crush	Inertial Load at Crash	Immersion	Fire Exposure	Temperature	Imbalanced Charge
UL 2580	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X
UL Sub. 2271	X	X	X	X	X	X	X	X	X	X	X	-	X	-	X	X
SAE J2929	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-	-
ISO DIS 12405-3	X	X	X	X	X	X		X	X		X	X	-	X	-	-

Overview of Safety Standards, Certification and Regulations

Battery Safety Standards for stationary and other motive applications:

Standard	Scope	Certification Program	Regulatory Environment #
UL 1973	EESSs for stationary and light electric rail applications	BBFX, BBFX2	Voluntary, NEC and other installation codes
Telcordia GR-3150-CORE	Generic requirements for secondary lithium batteries for Telecom	3rd party certification for NEBs	Telecommunication Carrier Groups (TCGs) NEBs regulations
IEC CD 62619 (SBA S1101)	Lithium ion cells and batteries for stationary and off road motive applications	CB Scheme (Japan S Mark)	Regional regulations such as EU Directives (LV, EMC) Japan S Mark

Overview of Safety Standards, Certification and Regulations

Standard	Short circuit	Overcharge	Over discharge	Imbalanced Charge	Dielectric Voltage Withstand	Continuity	Temperature	Failure of Thermal Stability System	Temperature Cycling	Vibration	Shock	Drop	Enclosure Tests	Water Exposure	External Fire	Internal Fire
UL 1973	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tel-cordia GR-3150-CORE	X	X	X	-	-	X	X	-	X	X	X	X	X	X	X	-
IEC CD 62619 (SBA S1101)	X	X	X	-	-	-	-	X	-	-	-	X	-	-	-	X

Gaps

GAPS

UN Transport Tests:

- Further refinement of requirements based upon differences between primary and secondary, revisions based upon battery/cell size, different technologies, better understanding of use/abuse scenarios during transport
- Enforcement issues

UL Standards and Certification Programs

- **Cells**
  - Standards
    - Applications, Technology
    - Verify cell operating regions
    - Internal short circuit test
- Certification
  - Improvements to ongoing production criteria, Quality requirements
- **Batteries**
  - Standards
    - Maintain cell operating regions, construction criteria
    - applications specific design challenges & abuse conditions
  - Certification
    - Improvements to certification practices

THANK YOU.