

# LITHIUM ION BATTERY CERTIFICATIONS: IEC 62133

Rich Byczek, Intertek

June 21, 2018

IEEE PSES VIRTUAL SOCIETY

# AGENDA

01 Introduction

02 Transportation regulations and tests

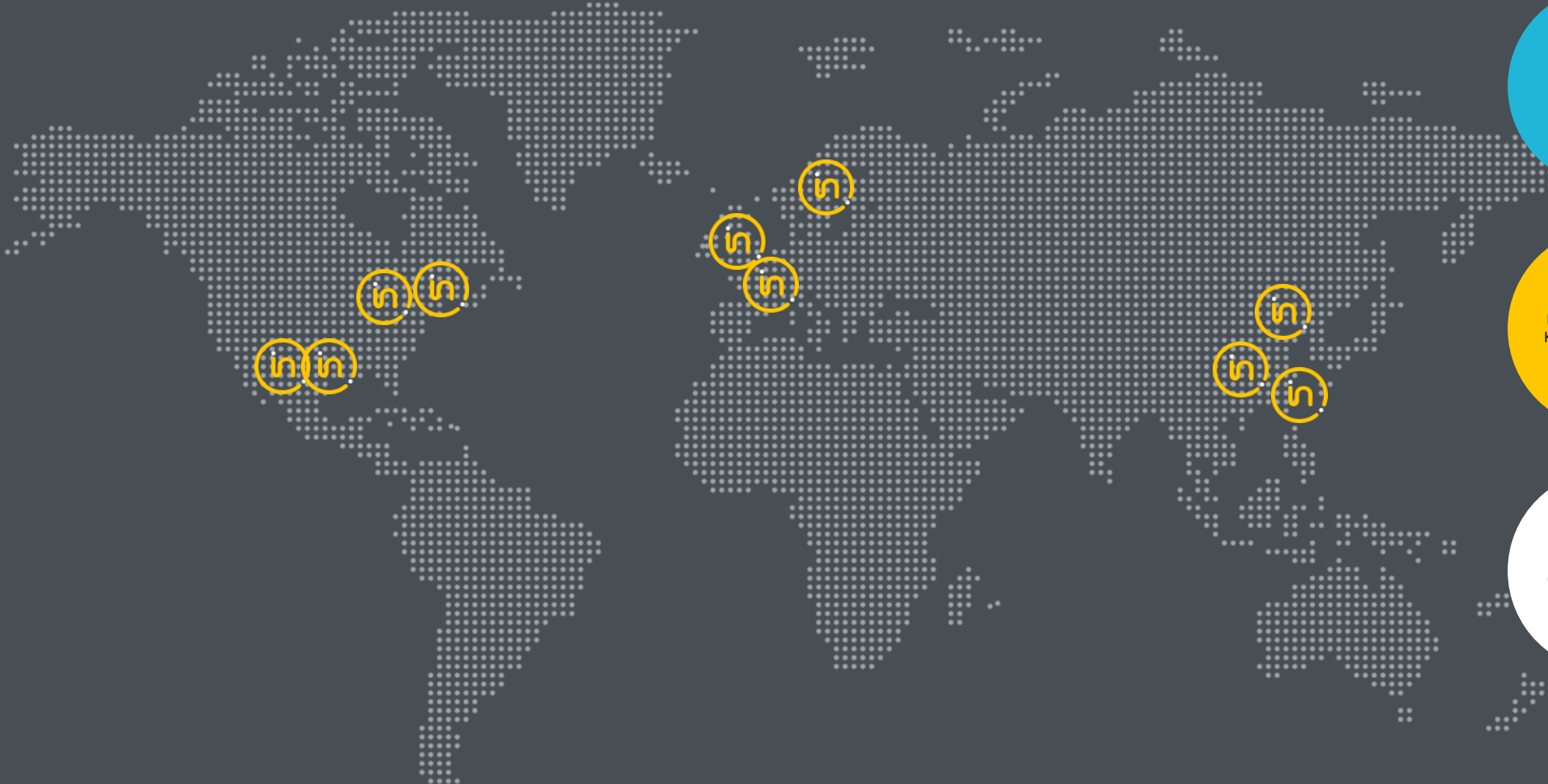
03 IEC 62133

04 Product Safety Requirements

05 Q&A



# A GLOBAL ENERGY STORAGE FOOTPRINT



**North America:**  
Detroit, MI  
Grand Rapids, MI  
San Antonio, TX  
Phoenix, AZ

**EMEA:**  
Milton Keynes, UK  
Kaufbeuren, Germ.  
Kista, Sweden

**APAC:**  
Shanghai, China  
Guangzhou, China  
Taipei, Taiwan

# BATTERY TESTING AND CERTIFICATIONS

## From hearing aids to electric busses

- UN 38.3
- CB Scheme
- IEC 62133
- ETL Safety Mark
- UL 1642 (Non-rechargeable Lithium)
- UL 2054 (Household / Commercial)
- UL 1973
- Electric Vehicle Battery
- SAE J2464
- Custom Abuse Testing
- Performance and Life Cycle Evaluation



# FAILURE ANALYSIS

## Review of battery and electronics design

- Critical examination of supporting documentation such as:
  - FMEA
  - Manufacturing controls
- Dissection and analysis of fresh and failed cells
- Material Analysis:
  - CT Scan
  - SEM-EDS
  - X-ray
  - GC-MS
- Technical Manufacturing Audits



# CLASSIFYING LITHIUM BATTERIES



## UN Battery Designations for Lithium/ Li-Ion Batteries

-Class 9 Material

- Present a hazard during transportation, but do not meet the definition of any other hazard.

-UN3090: Lithium (Lithium Metal) Batteries

-UN3091: Lithium Batteries contained in/packed with equipment

-UN3480: Lithium-Ion Batteries

-UN3481: Lithium-Ion Batteries contained in or packed with equipment

# CLASSIFYING LITHIUM BATTERIES

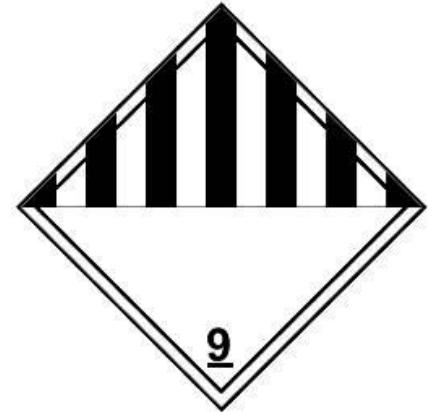


## UN Battery Designations for Lithium/ Li-Ion Batteries

- Lithium batteries are **ALWAYS** considered dangerous goods.
- Some packaging requirements are basic, but the lithium battery is still a unique situation.
- Per UN Model Regulations 2.9.4

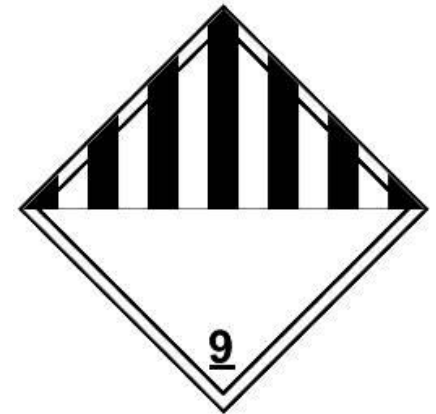
Lithium batteries..”may be transported under these entries, if they meet the following provisions.”

Otherwise, they must be shipped as fully regulated Class 9 Shipments/



## Provisions of clause 2.9.4

- a. ...proved to meet the requirements of each test of the Manual of Tests and Criteria, part III, subsection 38.3
- b. ... incorporates a safety venting device or is designed to preclude a violent rupture
- c. ...an effective means of preventing external short circuits
- d. ...parallel connected cells/cell-strings equipped with a means to prevent dangerous reverse current flow
- e. ...manufactured under a quality management system





# SHIPPING/ PACKAGING



# UN 38.3 REQUIREMENTS

## Current 38.3

Recommendations on the Transport of Dangerous Goods. Manual of Tests and Criteria.

### 6<sup>th</sup> Revised Edition

Issued 2015

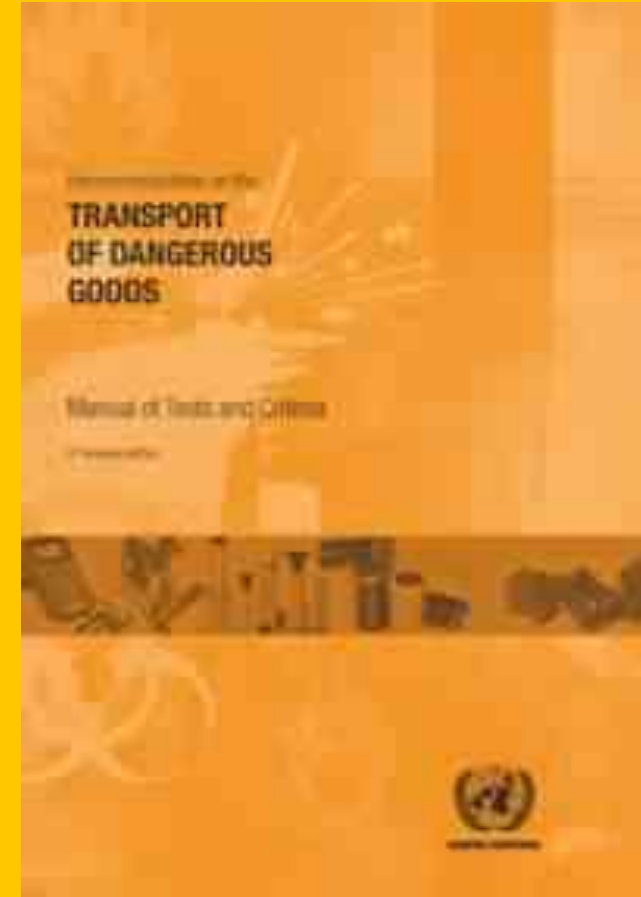
Date of Enforcement: January 1, 2017

### **Notes:**

1. Corrigendum 1 released Feb 2016.

Multiple corrections to section 38.3

2. Any testing of batteries must now reference the 6<sup>th</sup> edition.



# UN 38.3 REQUIREMENTS

## Latest and Greatest 38.3

Recommendations on the Transport of Dangerous Goods. Manual of Tests and Criteria.

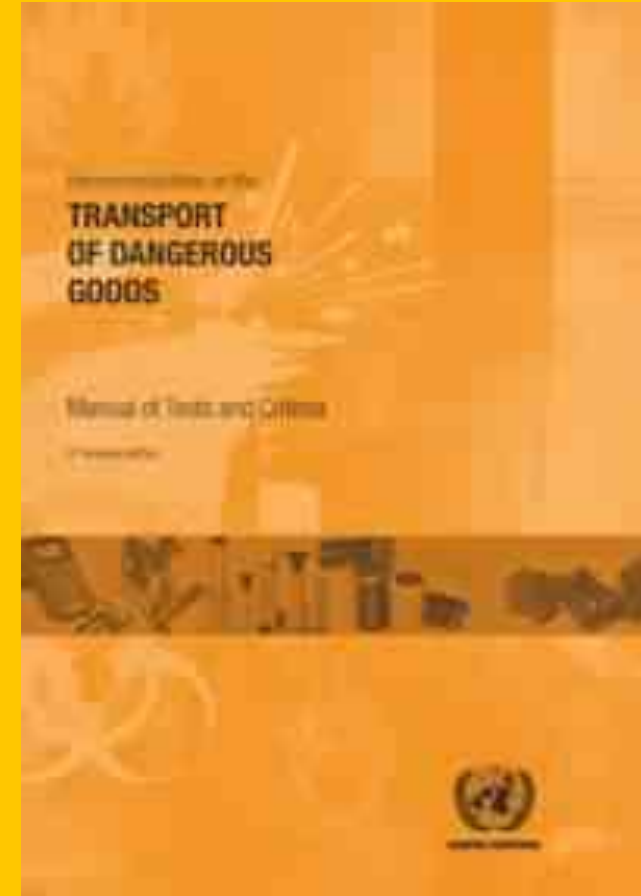
### 6<sup>th</sup> Revised Edition, Amendment 1

Issued 2017

Date of Enforcement: January 1, 2019

### Notes:

1. US DOT does not yet recognize this version.
2. Reduced pre-test cycling for batteries
3. Summary Sheet requirements included



# HISTORY OF UN 38.3 REQUIREMENTS

- Separate from Electrical Safety
- Part of Dangerous Goods Regulations
- Consider all means of transport
  - Sub-supplier to end product Mfr.
  - MFR to distributor
  - Battery in our outside of product
  - In-field/In-use
  - Product returns
  - Non Standard packaging



# SAMPLES NEEDED: SECONDARY CELLS



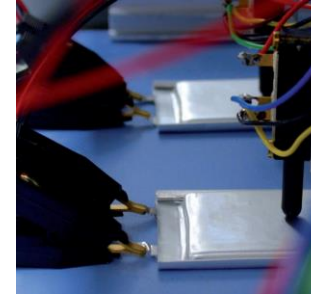
## Cylindrical

(18650, Canister)



## Prismatic

(Pouch)



	1 <sup>st</sup> Cycle FULLY CHARGED	1 <sup>st</sup> Cycle FULLY DISCHARGED	1 <sup>st</sup> Cycle 50% CHARGE	50 Cycle FULLY DISCHARGED	TOTAL
TESTS T1-T5	10				10
TEST T6			5		5
TEST T8		10		10	20
TOTAL	10	10	5	10	<b>35</b>

**Note: No difference in quantity for Large/Small or Cylindrical/ Prismatic**

# SAMPLES NEEDED: SMALL SECONDARY BATTERIES



SMALL BATTERY:  
Gross Mass up to 12 kg



	1 <sup>st</sup> Cycle FULLY CHARGED	50 Cycle FULLY CHARGED	TOTAL
TESTS T1-T5	4	4	8
TEST T7	4*	4*	8*
<b>TOTAL</b>	4 or 8*	4 or 8*	<b>8 or 16*</b>

## NOTES:

(\*) Samples may be reused for T7 or may use a separate set of samples.

(\*)For “Single Cell Batteries”: only the T7 test will apply.

# TESTS T1 – T8



## **T1-T5 (Same Samples, Tested in Order, All Types)**

T1: Altitude Simulation

T2: Thermal Test

T3: Vibration

T4: Shock

T5: External Short Circuit

**T6: Impact/Crush (Primary and Secondary Cells Only)**

**T7: Overcharge (Secondary Batteries Only)**

**T8: Forced Discharge (Primary and Secondary Cells Only)**



# SMALL BATTERY CB SCHEME CERTIFICATIONS



## IEC - Based Standards:

**IEC 61960:** Lithium Ion Battery Design and Performance.

**IEC 61951-1/2:** NiCD/NiMH Battery Design and Performance

**IEC-62133:** Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them

- Secondary Cells/Batteries (Rechargeable)
- Focus on Lithium-ion, NiMH, NiCd Batteries
- First Edition: October 2002
- Second Edition: December 2012
- **IEC 62133-2: 2017**





# IEC 62133 ADOPTION, TRANSITION



## IEC 62133 2<sup>nd</sup> Edition

Released December 2012

Added to IECEE CB Scheme in Q1, 2013

EU adopted as EN 62133 2<sup>nd</sup> edition

Date of Withdrawal : **1/10/2016**

UL 62133, 2<sup>nd</sup> ed (2017): Harmonized to IEC 62133 2<sup>nd</sup> edition

CSA E62133, 2<sup>nd</sup> ed (2017): Harmonized to IEC 62133 2<sup>nd</sup> edition



# IEC 62133 ADOPTION, TRANSITION



## IEC 62133-2 1<sup>st</sup> Edition

Released 2017

Added to IECEE CB Scheme in May 2017

EU adopted as EN 62133-2 in process of adoption

Date of Withdrawal : 2020 (for EN 62133, 2<sup>nd</sup> edition)



UL 62133 (2017): Harmonized to IEC 62133 2<sup>nd</sup> edition, not yet to 62133-2

CSA E62133 (2017): Harmonized to IEC 62133 2<sup>nd</sup> edition, not yet to 62133-2



# IEC 62133-2 CHANGES



## General Comments

- Separate Nickel (62133-1) and Lithium (62133-2) chemistries
- Includes Coin cells (if internal AC impedance is <math>< 3.0\text{ Ohm}</math>)
- Single fault conditions (SHOULD vs SHALL)
- UN 38.3 transportation moved to annex (was part of 62133, 2<sup>nd</sup> edition test requirements)
- FISC (Forced Internal Short Circuit): still applies to only Japan, Korea, France and Switzerland (consider pan-EU application and enforcement)



# IEC 62133-2 CHANGES



## CELL LEVEL REQUIREMENTS:

- External short circuit (now performed at +55C ambient)
- Thermal abuse: hold times changed
- Crush test: 10% deformation condition removed
- Forced Discharge: End conditions changed, not only time-based.

For a cell certified to IEC 62133, 2<sup>nd</sup> edition, above tests would need to be re-run



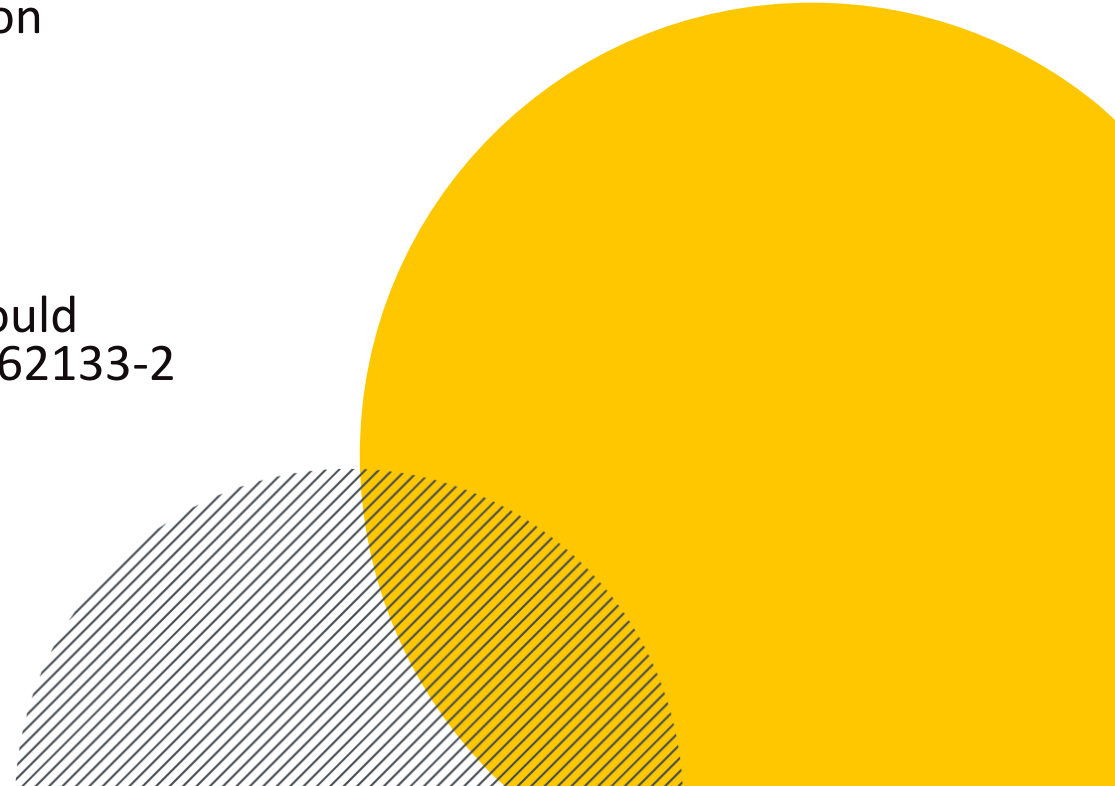
# IEC 62133-2 CHANGES



## BATTERY LEVEL REQUIREMENTS:

- External short circuit (SHOULD be performed with single fault condition)
- Overcharge: different charge conditions than previous edition
- Vibration test: added back in to standard
- Mechanical Shock test: added back in to standard

For a battery certified to IEC 62133, 2<sup>nd</sup> edition, above tests would need to be re-run.(and cells would need to be qualified to the 62133-2 version as well)



# IECEE CB SCHEME OPTIONS

## END PRODUCT LEVEL for CB SCHEME:

Battery Pack IECEE CB Scheme cert to IEC 62133 required

Requires CELL to have IECEE CB Scheme Cert or Test done by CBTL

IEC 62133 2<sup>nd</sup> edition requires evidence of UN 38.3 testing:

- Accredited test lab
- Report can be reviewed by CBTL



# NORTH AMERICAN NRTL CERTIFICATIONS

## US- Based Standards:

### UL-1642: Lithium Batteries

Focus on single-cells

Used for evaluation of Lithium-Metal (PRIMARY)

Used for evaluation of Lithium-Ion (SECONDARY)

### UL-2054: Household and Commercial Batteries

Focus on Portable Batteries

Typically Battery Packs

References UL 1642 for Lithium Cells

### UL 62133/ CSA E62133: **Harmonized to IEC 62133**

### UL 60086-4: **Harmonized to IEC 60086-4 (CSA Draft in process)**



# US CERTIFICATION OPTIONS



## IF END-PRODUCT STANDARD DOES NOT SPECIFIC BATTERY STANDARD REQUIREMENTS

- Portable/ Non-portable: Same rules as IEC/ CB Scheme
- Portable: Follow UL 2054 or UL 62133 for the Battery
  - (Includes UL 1642 or UL 62133 for the cell)
- Non-portable:
  - UL 1642 or UL 62133 for cell
  - Test battery in end product





# TESTING PATH FOR CERTIFICATION



## **CELL-> BATTERY->BATTERY ASSEMBLY->END PRODUCT**

**UN:** Un 38.3 Cell ->Un 38.3 Battery/SingleCellBattery ->Battery Assembly

**IEC/UL/CSA/EN 62133:** Cell 62133 -> Battery 62133

**UL 2054:** Cell 1642 -> Battery 2054

### **Non Portable:**

Cell 62133/1642 -> (Optional Battery 2054/62133/other) ->Test in EndProduct

# RECOMMENDATION TAKE AWAYS



## Utilize 62133 where possible:

- Acceptance in CB scheme and in Europe/Asia
- Now cETLus available for NRTL Certification in North America
- Faster turnaround time, less samples
- Look at existing cell certifications (UL1642 or 62133, or 62133-2)
- Unlisted cells can still be used, but added test cost and risk.

## UN 38.3:

- Get actual test reports from Cell vendors or sub-contract manufacturers.
- Ensure ISO17025 lab or traceability of Calibrations, to use toward 62133

## End Product:

- Always consider end-product requirements, these determine component (Battery) requirements, regardless of existing certifications.
- 60950-1 has multiple paths (useful for global products)





# QUESTIONS?

# WHERE IS THE WORDING FOR GRANDFATHERING UN 38.3 TEST DATA



Reference United States 49 CFR 173.185 (harmonized to section 2.9.4 of the UN model regulations)

Cells and batteries manufactured according to a type meeting the requirements of **sub-section 38.3 of the UN Manual of Tests and Criteria, Revision 3, Amendment 1 or any subsequent revision** and amendment applicable at the date of the type testing may continue to be transported, unless otherwise provided in this subchapter.

(ii) Cell and battery types only meeting the requirements of the UN Manual of Tests and Criteria, Revision 3, are no longer valid. However, cells and batteries manufactured in conformity with such types before July 2003 may continue to be transported if all other applicable requirements are fulfilled.

## Rich Byczek, Global Technical Director



+1 248 219 1099



[Rich.byczek@intertek.com](mailto:Rich.byczek@intertek.com)



[www.intertek.com/energy-storage](http://www.intertek.com/energy-storage)



**intertek**

**Total Quality. Assured.**