GENERAL MOTORS

ELECTRIFICATION NON-EMISSION

STANDARDS & REGULATIONS OVERVIEW

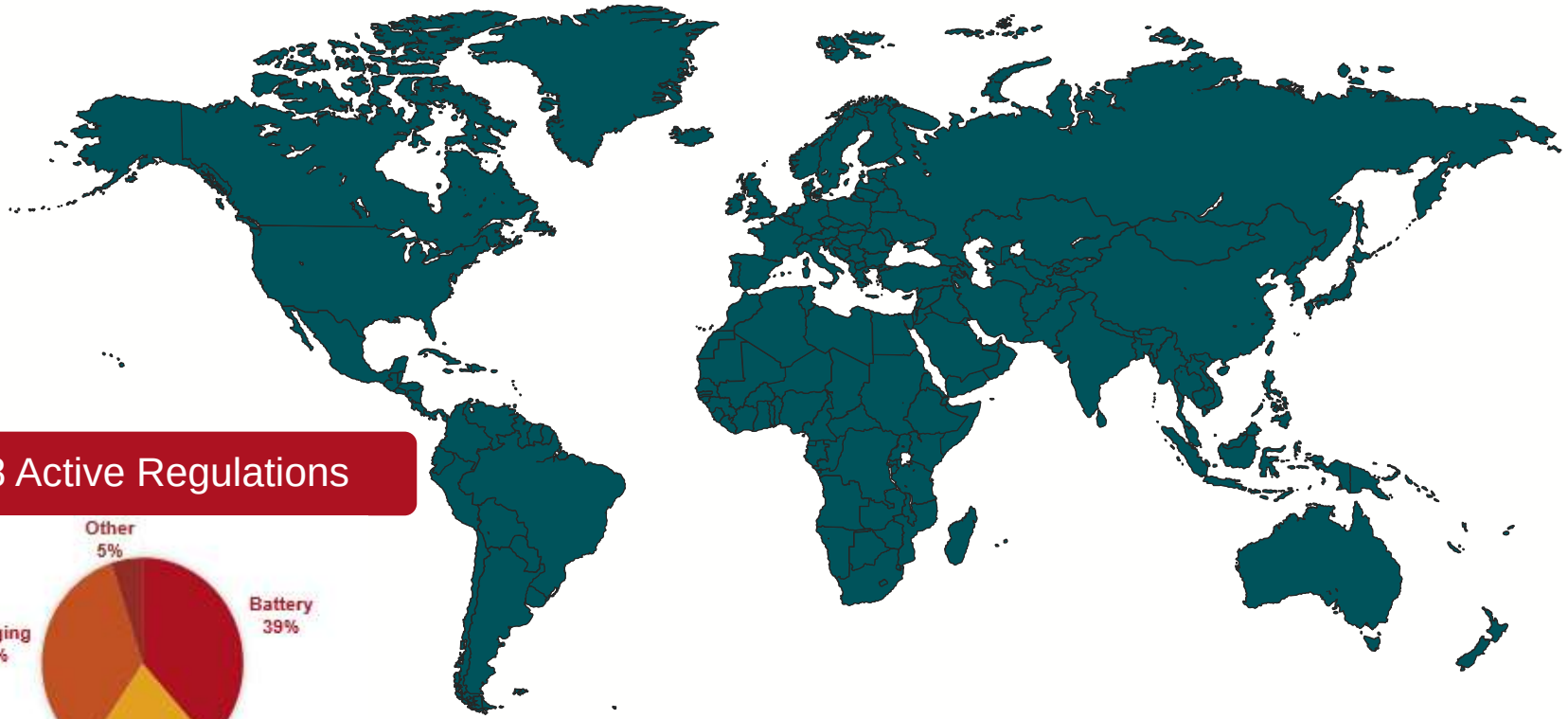
TODD MACKINTOSH
TECHNICAL SPECIALIST & PROCESS LEAD -
ELECTRIFICATION STANDARDS & REGULATIONS

2019 NAATBATT ANNUAL MEETING & CONFERENCE

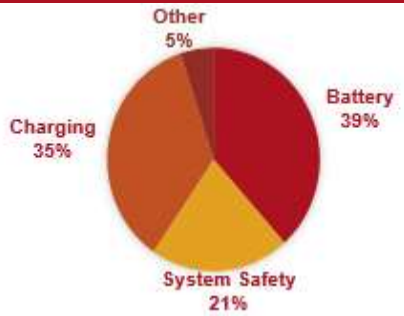
MARCH 13, 2019, LITCHFIELD PARK, AZ

AGENDA

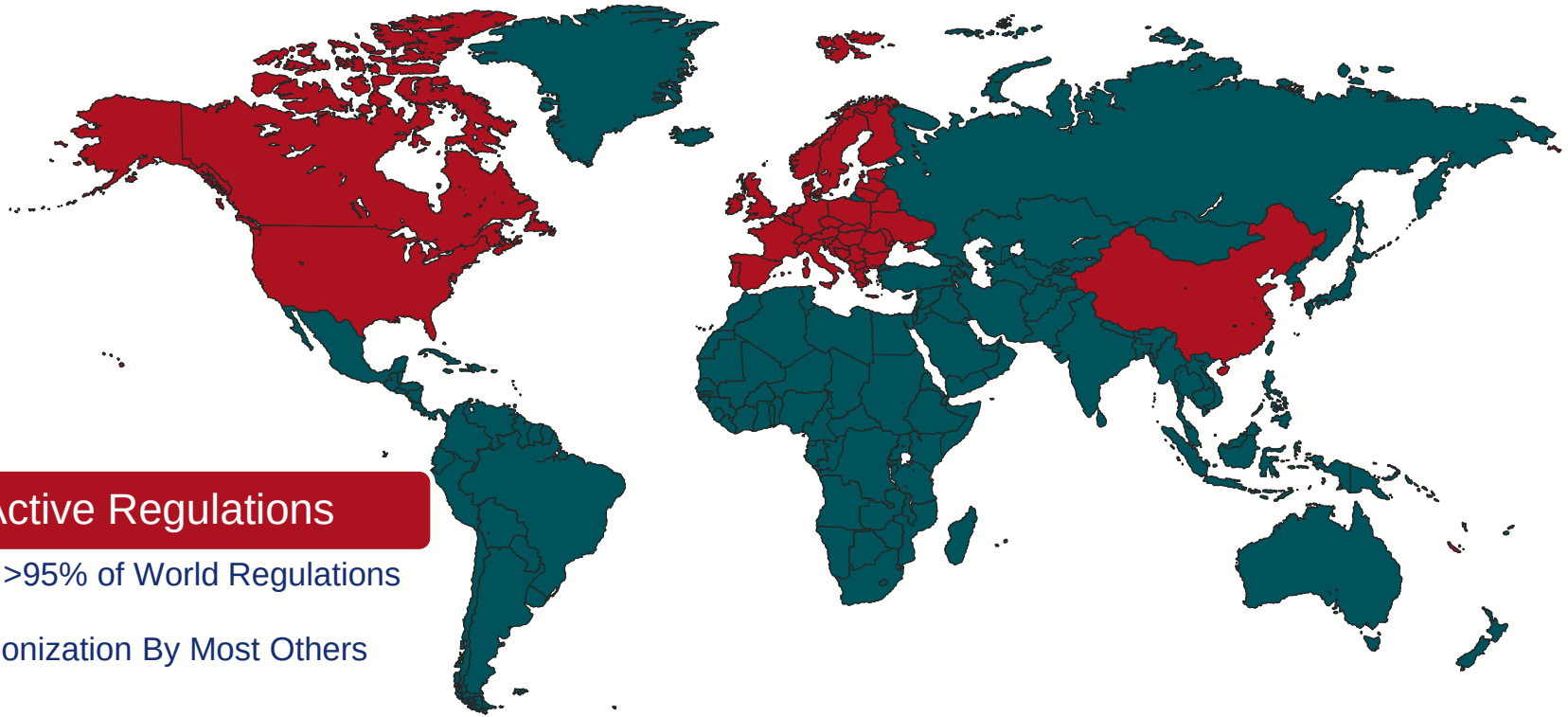
GLOBAL ELECTRIFICATION NON-EMISSION REGULATIONS



98 Active Regulations



THE “BIG 5” REGIONS

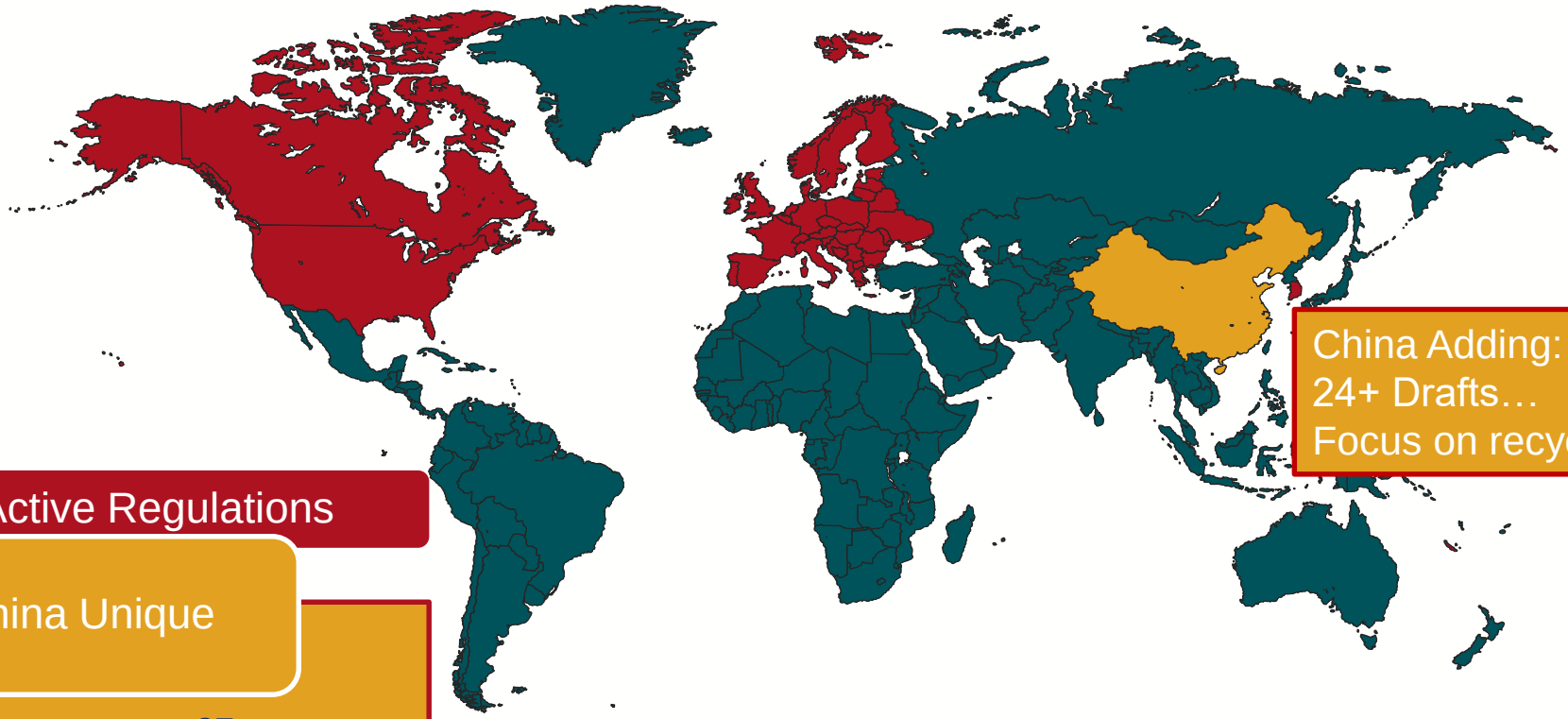


62 Active Regulations

Meet >95% of World Regulations

Harmonization By Most Others

THE “BIG 5” REGIONS



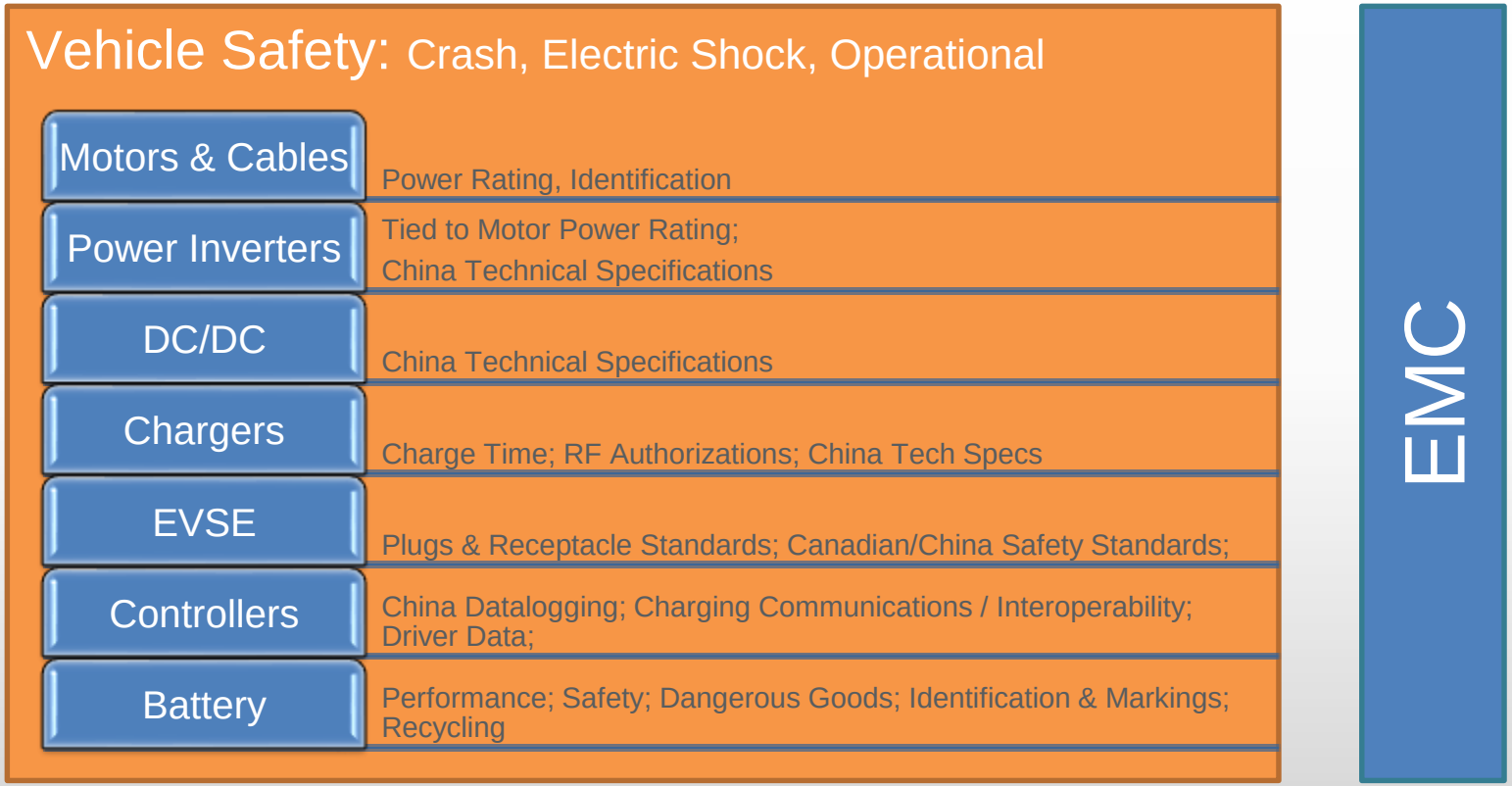
China Adding:
24+ Drafts…
Focus on recycling

62 Active Regulations

China Unique

China	37
Big “4”	25

ELECTRIFICATION REGULATION AREAS



EV LI BATTERY "BIG 5" SAFETY REGULATIONS

Test	USA	Canada	Korea	China	ECE R100	UN38.3
Vehicle Crash	YES	YES	YES	YES	YES	NO
Vibration/Shock	UN38.3	UN38.3	UN38.3	YES	YES*	YES
Drop	NO	NO	YES	NO	NO	NO
Crush	UN38.3	UN38.3	UN38.3	YES	YES*	Cell Only
External Fuel Fire	NO	NO	YES	YES	YES	NO
Salt Water Immersion	NO	NO	YES	YES	NO	NO
External Short Circuit	UN38.3	UN38.3	YES	YES	YES	YES
Over-discharge	UN38.3	UN38.3	YES	YES	YES	Cell Test, Battery Design
Overcharge	UN38.3	UN38.3	YES	YES	YES	YES

* may substitute vehicle crash test data

DANGEROUS GOODS REGULATIONS

Lithium Batteries

UN 3480

https://www.ecfr.gov/graphics/pdfs/er30mr17.032.pdf

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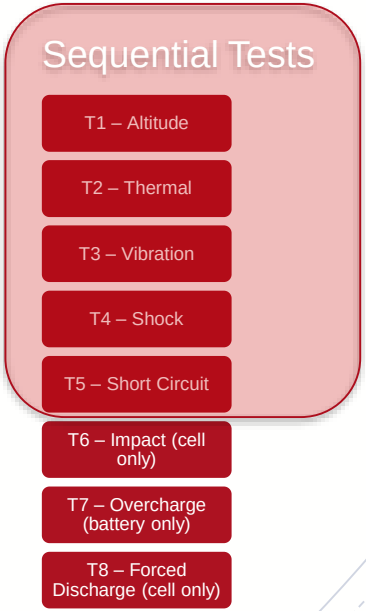
UN38.3 CERTIFICATION

Mature Safety Tests for Lithium Batteries

- Required for Transport
  - Batteries & xEV's
- Self-Certification

Global Recognition of UN38.3 Certificate

- Except for China Exports
  - Approved China Labs Only



UN38.3 TEST SUMMARY

Standard information all shippers of lithium batteries must make available confirming UN38.3 Tests

Required by 2020

Retroactive

- Applicable to all previously tested batteries produced after June 30, 2003

Summary sheet can be stored on a public website but not required

DAMAGED & DEFECTIVE BATTERIES

Clearly defined requirements in US regulations

- Simple to comply

Poorly defined requirements globally

- Need approval from each region
- Dangerous Evolution of Heat Determination
  - Difficult without special tools
  - Interaction by engineering
  - Case by Case

Heavy, large, expensive containers for automotive batteries

- Handling Issues
- Car dealerships don’t typically have fork lifts

FUTURE REGULATIONS / STANDARDS

Thermal Propagation Tests

THERMAL PROPAGATION – NEW REGULATORY FOCUS

- **CHINA EV Safety & EV Battery Safety Regulation (GB DRAFTS)**
  - Initiate cell thermal runaway
  - 5 min. warning to passenger before flame/smoke in passenger compartment
  - Expect effective date July, 2020
- **UN GTR-20 - EV Safety**
  - Includes generic requirement to protect the occupants from thermal propagation
  - Informative test procedure similar to China, but no pass/fail requirements
  - Model Regulation effective today
- **SAE G27 / AS6413 (DRAFT)**
  - To qualify packages for air transport of lithium cells/batteries which protect the aircraft from the hazards of a thermal runaway event.
- **UN 38.3**
  - Classify based on actual hazard of cell type in thermal runaway
  - Thermal propagation propensity – one of new hazard under discussion

AUTOMOTIVE THERMAL INCIDENT WARNING

- China Lead Advocate
  - Lead efforts at UN to adopt testing protocol in GTR
  - First country adopting requirement in regulation

- 5 Minute Warning
  - Initiate thermal runaway
  - Detect and alert occupants
  - Allow occupants to safely exit vehicle within 5 minutes

AS6413 - LI BATTERY PACKAGING PERFORMANCE STANDARD

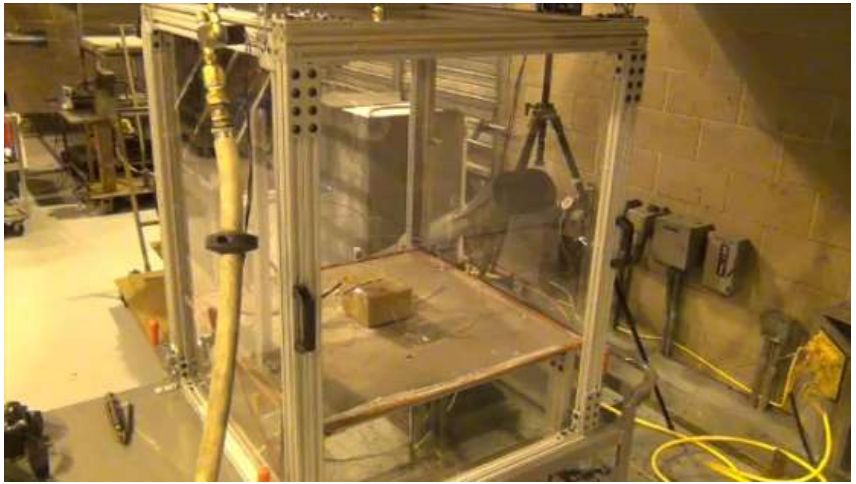
Test Overview

- Test Object: Battery/Cells **AND** Package
- Variables
  - State of Charge
  - Package Design
  - Initiation Method
- Initiate thermal runaway

Contain all hazards to aircraft

- Fire 
- Fragments 
- Gas 
- High Temperatures 
- Maintain Package Integrity

AS6413 - LI BATTERY PACKAGING PERFORMANCE STANDARD



SAE G27 Writing Team Meeting, May, 2016
FAA Technical Center, Atlantic City, NJ

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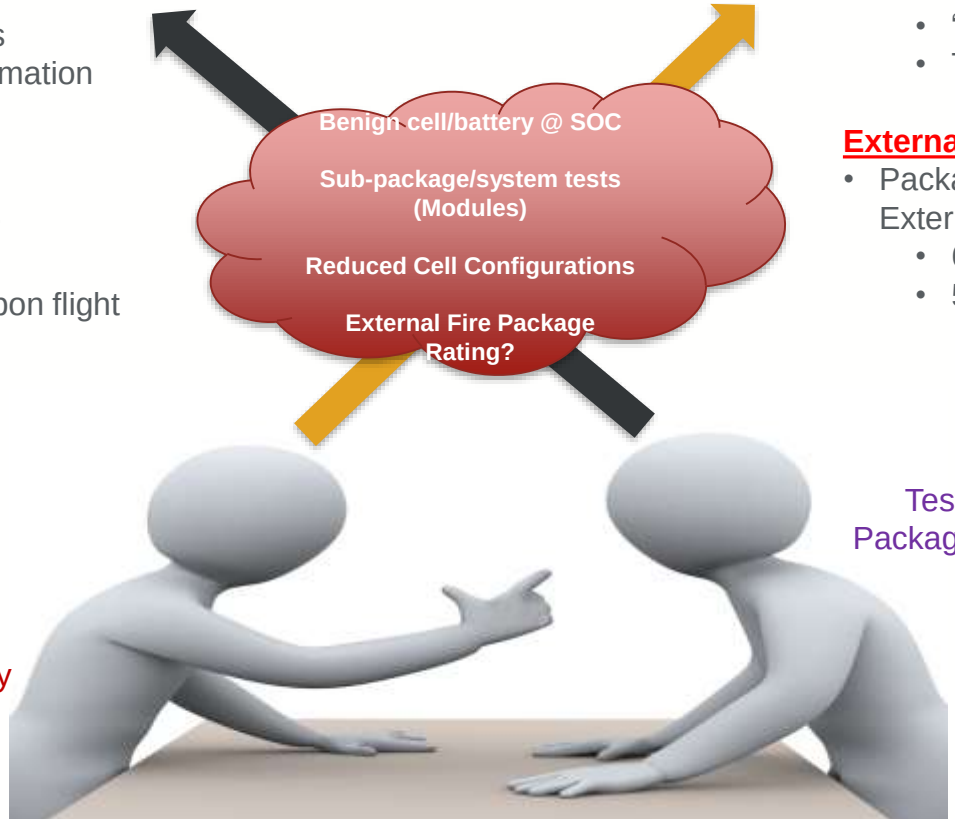
SAE G27 COMMITTEE PERSPECTIVES

Thermal Propagation
- Simplify / Optimize
- Minimize # of Tests
- Similarity / Approximation
- Efficiency

External Fire Risk
- System approach?
  - Cargo covers
  - Risk based upon flight



Thermal Propagation
- No trust & Audit trail
  - "How do you know….?"
  - Test everything

External Fire Risk
- Package MUST withstand External Fire
  - 6 Hour Duration @200°C
  - 5 Min Oil Burner Flame

Test Labs & Packaging Industry

Airline Pilots
Aircraft Industry
Regulators

Battery Industry

FIRE CODES & OTHER STANDARDS

INTERNATIONAL FIRE CODE

2018 -New “Chapter 12 Energy Systems” Proposed

Proposal for Used and Off-Spec Lithium Ion Batteries

- Limits on storage quantities
- Requirements for indoor fire ratings
- Proposal for exemption for <30% SOC batteries

October, 2018 - Failed Ballot

Work Continues Next Triennium: 2019-2021

- 2024 Publication

19

SAE J2950 – SHIPPING TRANSPORT AND HANDLING OF AUTOMOTIVE-TYPE BATTERY SYSTEM – LITHIUM ION

Five Year Review In Process

- Refresh Recommendations
- Update Damaged/Defective Section
- Update Regulatory References

- Proposing to Add Section on Handling & Storage
  - Address off-spec/used batteries
  - Provide Industry Best Practice to balance IFC Codes

Industry Participation Always Welcome!

J2990 – XEV RECOMMENDATIONS FOR 1ST AND 2ND RESPONDERS

Five Year Review In Process

Updating Recommendations & References

- ISO standards published
- Submerged Vehicles
- Colored Airbags Discussions/Recommendations
- Identifying Camouflaged xEVs

Key Technical Issues to be Resolved:

- Split Battery Packs – High Voltage Exposure
- Fire Access to Battery – Difficult to Extinguish
- Re-Ignition Events – Stranded Energy

Industry Participation Always Welcome!