Annex D: Summary of Day One Presentations

All of the Day One speakers that addressed specific topic areas used brief PowerPoint presentations (not including welcoming remarks or closing comments). All of those that have been made available for this report are included in this Annex on the following pages. The following is a summary of the Summit Day One speakers, to serve as an index for the presentations included in this Annex:

Keynote Presentation

1) **Electric Vehicle Safety Integration** – *Robert C. Lange, Vice President for Vehicle Engineering, Exponent*

Session: The Big Picture

2) **Review of U.S. National Electric Vehicle Safety Standards Summit: October 2010** – *Casey Grant, Fire Protection Research Foundation*
3) **Update on Federal Regulatory Policy** – *Phil Gorney, National Highway Traffic Safety Administration*
4) **Trends with the Electric Vehicle Market** –*Aaron Tweadey, PwC's PRTM Management Consultants*

Session One: Vehicles/Batteries

5) **Progress & Gaps on Vehicle Battery Safety Standards** – *Rajesh Nagappala, General Motors Corporation*
6) **Vehicle Battery Safety Standards Update** – *Bob Galyen, Magna e-car*
7) **Progress & Gaps on Vehicle Research** –*Ted Bohn, Argonne Laboratories*
   Standards Implications of Current Battery Research – *Alvaro Masias, Ford Motor Company*

Session Two: Emergency Responders

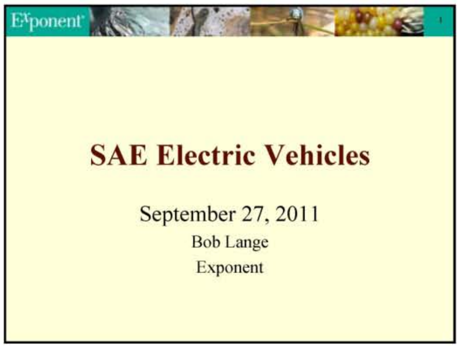
8) **Electric Vehicle Safety Training for Emergency Responders** – *Andrew Klock, Emergency Responder Electric Vehicle Training Project*
9) **Case Study Review of Multiple Electric Vehicle Fire** – *Bob Duval, NFPA Senior Fire Investigator*
10) **Enforcement Officials Update** –*Jon Nisja, Office of Minnesota State Fire Marshal*

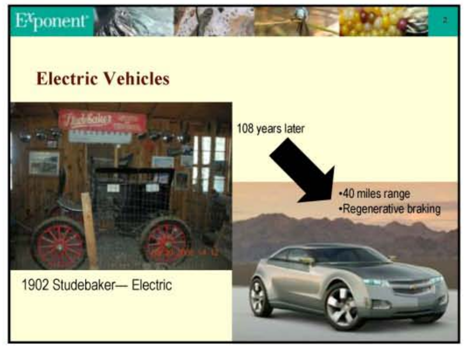
Session Three: Built Infrastructure

11) **The ANSI Electric Vehicle Standards Panel: Importance of Linking Standards Together**– *Jim Pauley, Schneider Electric, EVSP Co-Chair*
12) **Electric Vehicle Charging and Electrical Safety Codes and Standards** –*Lonny Simonian, California Polytechnic State University*
13) **National Electrical Code Update** – *Mark Earley, National Fire Protection Association*
14) **Utility Perspectives** – *Seth Gerber, Consumer Energy*
15) **Electric Vehicle Supply Equipment (EVSE) Standardization** – *Ken Boyce, Underwriters Laboratories*

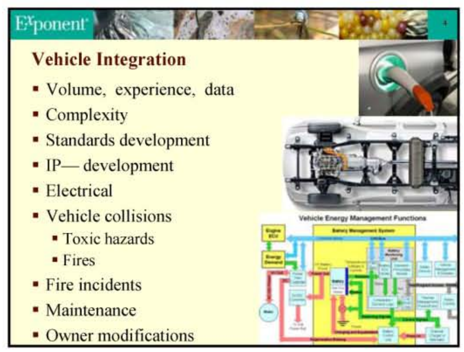
Session Four: Support Services and User Perspective

16) **Electric Vehicle Towing, Road Service and Recovery** – *Bill Giorgis, Michigan Towing Association*
17) **Lithium Ion Batteries: Property Insurance Perspective** – *Rich Gallagher, Zurich Services Corporation*
18) **Clean Cities and Electric Vehicles** – *Carl Rivkin, National Renewable Energy Laboratory*


Exponent
1
SAE Electric Vehicles
September 27, 2011
Bob Lange
Exponent


Exponent
2
Electric Vehicles
108 years later
•40 miles range
•Regenerative braking
1902 Studebaker— Electric


Exponent
3
The Difference between Yesterday and Today
1902 STUDEBAKER ELECTRIC
WESTINGHOUSE MOTOR 48 VOLT
40 MILE RANGE AT 13 MPH
MADE IN SOUTH BEND IND.
STEERING: RIGHT-SIDE TILLER
4-PASSENGER CONVERTABLE
1902 STUDEBAKER ELECTRIC
WESTINGHOUSE 48-VOLT MOTOR
1750 RPM DATED MAY.11 - '97
REGENERATIVE BRAKING STANDARD
TOP SPEED 13 MILES PER HOUR
FIELD-WEAKENING FOR PASSING


Exponent
4
Vehicle Integration
▪ Volume, experience, data
▪ Complexity
▪ Standards development
▪ IP— development
▪ Electrical
▪ Vehicle collisions
▪ Toxic hazards
▪ Fires
▪ Fire incidents
▪ Maintenance
▪ Owner modifications
Vehicle Energy Management Functions


Exponent
5
Most Battery Failures
BMU Failure
Manufacturing/Assembly
External Mechanical Stress
External Thermal Attach
Arcing/Resistive
Maintenance
Wiring External Short Circuit
Wiring Internal Short Circuit
Unauthorized Modifications


Exponent
6
Some Electric Vehicle Manufacturers
▪ Italy
▪ Fiat
▪ Pininfarina/Bolloré
▪ India
▪ REVA Electric Car
▪ South Africa
▪ Optimal Energy
▪ US
▪ Tesla
▪ Fisker
▪ Aptura
▪ GM
▪ Ford
▪ Chrysler
▪ France
▪ Heuliez
▪ Venturi Automobiles
▪ Venturi/PSA Peugeot Citroen
▪ MGO
▪ Netherlands
▪ DuraCar
▪ Japan
▪ Subaru
▪ Toyota
▪ Nissan
▪ Honda
▪ Mitsubishi
▪ China
▪ BYD Auto
▪ Brilliance
▪ Germany
▪ BMW
▪ Mercedes Benz
▪ VW
▪ Norway
▪ Think Global
▪ Elbil Norge AS

Exponent

Motor vehicle Safety & Public health

Parties with Interest

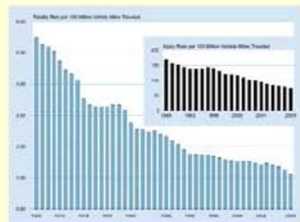
- Roadway users
- Motor vehicle manufacturers, safety researchers, & practitioners
- Government institutions (legislative, administrative, judicial, law enforcement, transport and health officials)
- Non-governmental institutions (NGOs)
- First responders
- Medical community
- Roadway designers and builders
- Taxpayers

The Public Health Model

- Injury Triangle
  - Environment
  - Host
  - Vehicle
- Public Health Process
  - Injury Data Collection & Analysis
  - Countermeasure Concepts – Research & Technology Inventory or Invention
  - Countermeasure Development & Vehicle Integration
  - Countermeasure Deployment
  - Feedback

Exponent

Motor Vehicle Safety 1966 to 2009 – 80% Improvement



Exponent

Motor Vehicle Injury Reduction Technologies

Exponent

Vehicle Requirements, Systems & Integration

Common Requirements – All Systems and Components

- Reliable *function* over the entire vehicle life
- Regulatory and Internal performance & Design Conditions
- Control external influences (road, external environment, service use loads, customer actions, etc.)
- Control system level interface / interactions
- Minimize mass for fuel economy
- Be feasible to manufacture
- Be feasible to assemble
- Be feasible to service
- Satisfy requirements for unit-to-unit uniformity and variability

What is New about Electric vehicles?

- Energy storage methods
- High voltage sources
- Battery chemistry
- Battery crashworthiness
- High power electrical lines and connections
- Service considerations
- Energy recharging process
- Information and knowledge transfer to affected parties

Exponent

Summary

- Lithium ion battery technology is complex
- Not all the potential failure causes are known
- Experience is lacking with large-format batteries
  - Field experience
  - Real-world exposure risk data
  - Real-world environmental risk data
    - During use
    - End of original life cycle
    - End of life disposal

Exponent

New Considerations in the EV VDP

Fire protection and suppression

- battery storage and handling,
- incident response in the event that a battery goes into thermal runaway
- fire suppression
- control of a fire

Industrial health

- sensing and mitigation of hazardous gas potentially vented from
  - stored batteries,
  - batteries undergoing thermal runaway or
  - batteries exposed to fire.

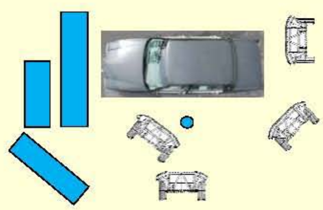
New Considerations in the EV VDP

- Storage facility
  - Racking/shelving type and protocols
    - Volume of batteries
    - State of charge considerations
    - Modules and packs
  - Storage of potentially damaged batteries
    - Batteries from crash tested vehicles
    - other
  - Ventilation
  - Detection systems
    - Fire
    - Toxic off-gassing
- High Voltage Exposure
- Fire Suppression and response systems
  - Fire/explosion management
    - Storage facility
    - Test facility
    - Charging/discharging facility
  - Toxic gas detection and mitigation
    - Storage facility
    - Test facility
    - Charging/discharging facility

New Considerations in the EV VDP

- Operator & Responder Training
- Incident response
  - Equipment
    - Personal protection
    - Fire fighting
  - Protocols
    - Fire fighting
    - Hazardous fumes/vapors/gases
    - Fluid/material spills

Engineering Criteria Development – Some Collision Load Cases: Fixed Barriers, Moving Barriers, Rigid Barriers, Deformable Barriers, Full Alignment, Overlap Alignment, etc.



What Is a Safety-Related Defect?

- **A safety defect is defined as a problem that exists in a motor vehicle or item of motor vehicle equipment that:**
  - poses an unreasonable risk to motor vehicle safety, and
  - exists in a group of vehicles of the same design or manufacture, or items of equipment of the same type and manufacture.

Safety Act – Manufacturers' Responsibilities

- Report:
  - consumer complaints on some systems,
  - property and injury claims,
  - fatal injuries
- Remedy Safety Defects
- Remedy Non-Compliance Conditions
- Provide remedy at no cost to consumers
- Remedy Without Charge – Three Options for Manufacturers
  - Replace product
  - Repair product
  - Repurchase

3

Review of the U.S. National Electric Vehicle Safety Standards Summit

21-22 October 2010
Detroit, Michigan

Presented at 2nd Annual EV Safety Standards Summit
Tuesday 26 September 2011; Detroit, MI

Casey C. Grant, P.E.
Research Director
Fire Protection Research Foundation
Quincy, MA USA

THE FIRE PROTECTION RESEARCH FOUNDATION

U.S. National Electric Vehicle Safety Standards Summit

- Two day Summit
  - Dates: 21 & 22 October 2010
  - Location: Detroit, MI
- Co-Hosted by NFPA and SAE

NFPA SAE International

U.S. National Electric Vehicle Safety Standards Summit

- Purpose of Summit
  - Identify relevant fire and electrical safety codes, standards and specifications.
  - Identify gaps within these codes, standards and specifications.
  - Identify related gaps in research, training or communications which stem from OEM safety manual development and deployment.
  - Develop base elements for an action plan for standards development and deployment activities.

U.S. National Electric Vehicle Safety Standards Summit

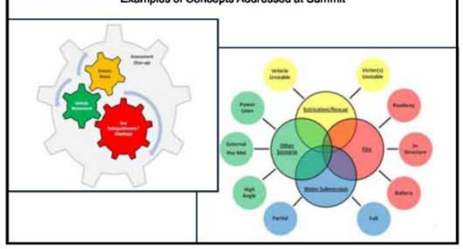
- Areas addressed at the summit:
  - Codes and Standards and OEM Manuals addressing safety in the vehicle.
  - Codes and Standards addressing the infrastructure surrounding the electric vehicle (recharging stations, home recharging, battery storage, etc…).
  - Codes and Standards addressing emergency response to vehicle emergency events.
  - Other related Codes and Standards (user community specifications, insurance industry standards, etc…).

U.S. National Electric Vehicle Safety Standards Summit

- Final Action Plan Considerations
  - Vehicle Charging Infrastructure
  - Battery Hazards Identification and Protection
  - Training for Emergency Responders and Enforcement Officials
- Report Available at:
  - www.EVSafetyTraining.org
  - www.NFPA.org/Foundation

U.S. National Electric Vehicle Safety Standards Summit

Examples of Concepts Addressed at Summit



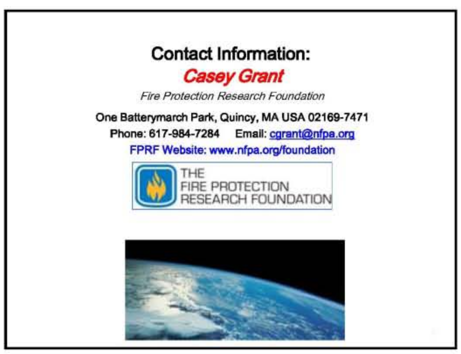
1


U.S. National Electric Vehicle Safety Standards Summit
VEHICLES
Regulations: More on Federal Level
Codes/Standards: SAE and others
Vehicles
Emergency Responders
Built Infrastructure
EMERGENCY RESPONDERS
Regulations: Self Regulated
Codes/Standards: NFPA and others
BUILT INFRASTRUCTURE
Regulations: More on State/Local Level
Codes/Standards: NFPA and others


U.S. National Electric Vehicle Safety Standards Summit
Key Areas Identified in Summary Observations
Key Issues
Charging Infrastructure
Battery Technology
Vehicle Features that Address Concerns of Emergency Responders
Permitting and Inspection
Training and Education
Aftermarket Vehicles and Components


U.S. National Electric Vehicle Safety Standards Summit
Topics Identified for Action Plan Consideration
1) Vehicle Charging Infrastructure
2) Battery Hazards Identification and Protection
3) Training for Emergency Responders and Enforcement Officials


U.S. National Electric Vehicle Safety Standards Summit
NEXT: Detroit, MI; 27-28 September 2011
• Recap of First Summit from Oct 2010
– Identified standard gaps are being filled by ANSI member organizations like SAE, UL, NFPA, NECA and NEMA.
– Strong partnerships have been formalized between the auto manufactures, standards development organizations and the inspection, enforcement and safety agencies.
2nd Annual Electric Vehicle Safety Standards Summit


Contact Information:
Casey Grant
Fire Protection Research Foundation
One Batterymarch Park, Quincy, MA USA 02169-7471
Phone: 617-984-7284 Email: cgrant@nfpa.org
FPRF Website: www.nfpa.org/foundation
THE FIRE PROTECTION RESEARCH FOUNDATION

Li-ion Based Rechargeable Energy Storage System Safety Performance Measurement in Automotive Applications

NHTSA Office of Applied Vehicle Safety
Crashworthiness Division

Phillip Gorney

The National Highway Traffic Safety Administration (NHTSA) is an agency within the Department of Transportation (DOT)

NHTSA's mission

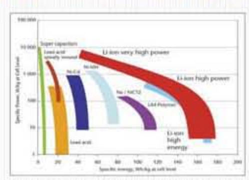
... to save lives, prevent injuries and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement activity.

Electric propulsion represents a measureable and growing technology segment necessary for achieving reduced U.S. dependence on foreign oil, reducing green house gas emissions from mobile sources, and may be used by the vehicle manufacturers to meet increasingly stringent fuel economy standards.

Electric Powered Vehicles ... New Technology?

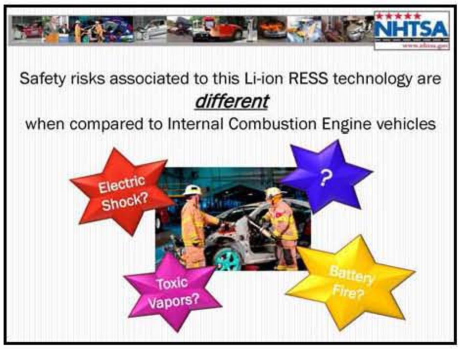
No ...

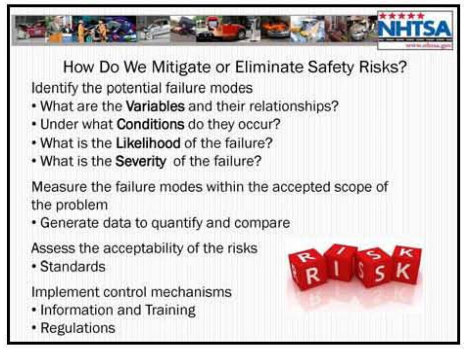
But there are many new challenges based on recent advancements in Rechargeable Energy Storage Systems (RESS) based on Lithium-ion Technology

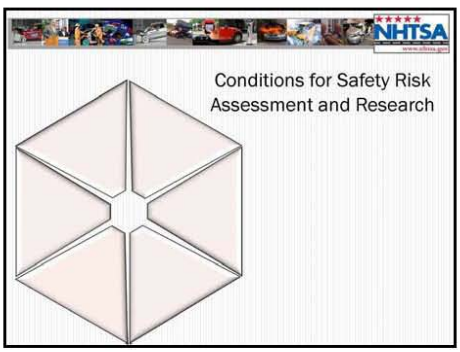


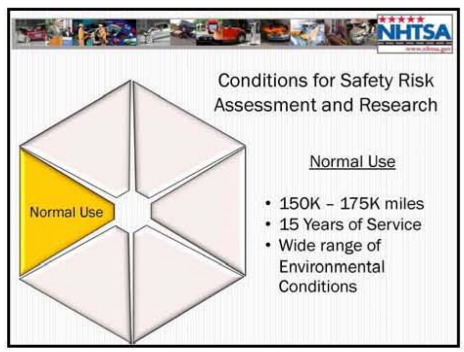
Lithium-ion (Li-ion) offers both greater energy and power density than previously developed rechargeable batteries, which is necessary for automotive applications. However, as power and energy are increased so does the exposure to certain safety risks.

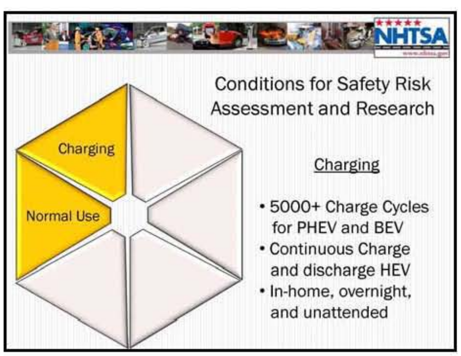
1

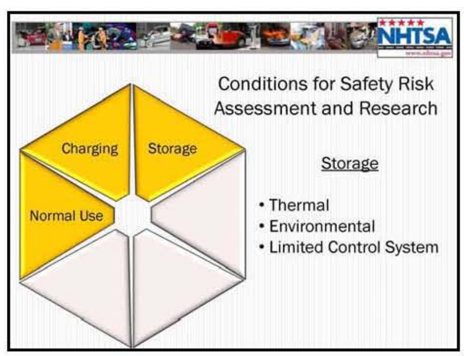

NHTSA
Safety risks associated to this Li-ion RESS technology are
different
when compared to Internal Combustion Engine vehicles
Electric Shock?
?
Toxic Vapors?
Battery Fire?

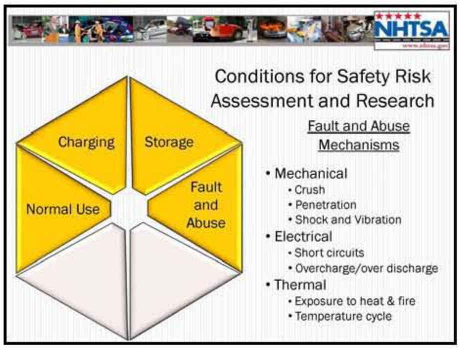

NHTSA
How Do We Mitigate or Eliminate Safety Risks?
Identify the potential failure modes
• What are the Variables and their relationships?
• Under what Conditions do they occur?
• What is the Likelihood of the failure?
• What is the Severity of the failure?
Measure the failure modes within the accepted scope of the problem
• Generate data to quantify and compare
Assess the acceptability of the risks
• Standards
Implement control mechanisms
• Information and Training
• Regulations
RISK

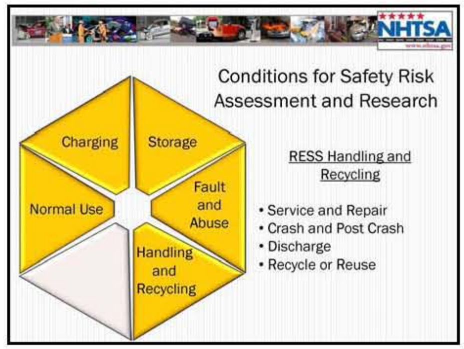

NHTSA
Conditions for Safety Risk Assessment and Research

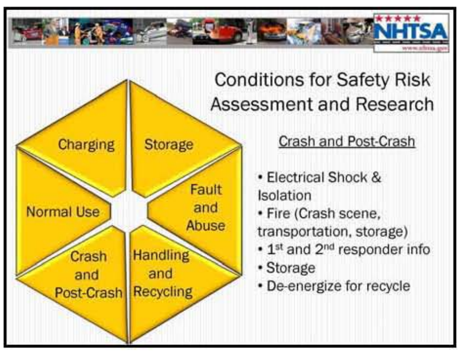

NHTSA
Conditions for Safety Risk Assessment and Research
Normal Use
Normal Use
• 150K – 175K miles
• 15 Years of Service
• Wide range of Environmental Conditions

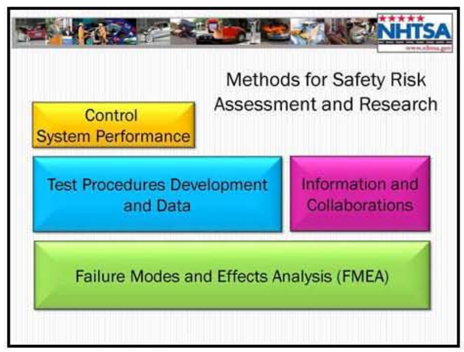

NHTSA
Conditions for Safety Risk Assessment and Research
Charging
Normal Use
Charging
• 5000+ Charge Cycles for PHEV and BEV
• Continuous Charge and discharge HEV
• In-home, overnight, and unattended

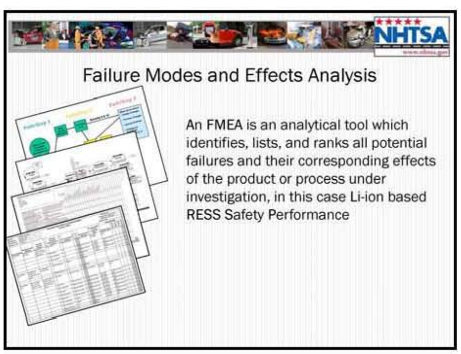

NHTSA
Conditions for Safety Risk Assessment and Research
Charging
Storage
Normal Use
Storage
• Thermal
• Environmental
• Limited Control System

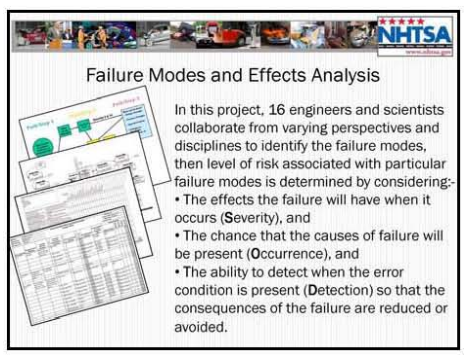

NHTSA
Conditions for Safety Risk Assessment and Research
Charging
Storage
Normal Use
Fault and Abuse
Fault and Abuse Mechanisms
• Mechanical
• Crush
• Penetration
• Shock and Vibration
• Electrical
• Short circuits
• Overcharge/over discharge
• Thermal
• Exposure to heat & fire
• Temperature cycle


NHTSA
Conditions for Safety Risk Assessment and Research
Charging
Storage
Normal Use
Fault and Abuse
Handling and Recycling
RESS Handling and Recycling
• Service and Repair
• Crash and Post Crash
• Discharge
• Recycle or Reuse

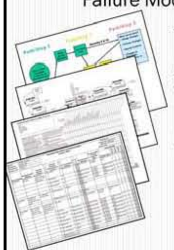

NHTSA
Conditions for Safety Risk Assessment and Research
Charging
Storage
Normal Use
Fault and Abuse
Crash and Post-Crash
Handling and Recycling
Crash and Post-Crash
• Electrical Shock & Isolation
• Fire (Crash scene, transportation, storage)
• 1st and 2nd responder info
• Storage
• De-energize for recycle


NHTSA
Methods for Safety Risk Assessment and Research
Control System Performance
Test Procedures Development and Data
Information and Collaborations
Failure Modes and Effects Analysis (FMEA)


NHTSA
Failure Modes and Effects Analysis
An FMEA is an analytical tool which identifies, lists, and ranks all potential failures and their corresponding effects of the product or process under investigation, in this case Li-ion based RESS Safety Performance


NHTSA
Failure Modes and Effects Analysis
In this project, 16 engineers and scientists collaborate from varying perspectives and disciplines to identify the failure modes, then level of risk associated with particular failure modes is determined by considering:-
• The effects the failure will have when it occurs (Severity), and
• The chance that the causes of failure will be present (Occurrence), and
• The ability to detect when the error condition is present (Detection) so that the consequences of the failure are reduced or avoided.

Failure Modes and Effects Analysis



The results of this FMEA will be used to perform a gap analysis to existing standards and test procedures (including the work plans of the NHTSA research program) for thoroughness. It will also be used as a base component for NHTSA's control system performance project.

Battelle Memorial Institute
Columbus, OH

Draft Report December 2011
Calendar Year 2012
- Industry Review
- Peer Review

Test Procedures Development

Develop and document repeatable vehicle level safety performance tests procedures.
- Addressing critical potential failure modes
- Building upon the body of existing standards

Data generated from these test procedures will be used to establish comparable conditions to accurately measure the effects of the failure modes generated by both normal and abnormal abuse conditions.
- Repeatable
- Quantifiable
- Comparable
- Directly associated to safety risks for accurate analysis

Test Procedure Development

HONDA, NISSAN, GM, SAE, DAIMLER, TOYOTA

Ford, RICARDO

2 Contract Awards Finalized (Sept 2011)
24 Month Performance: October 2011 – October 2013

Analytical Tools Development
Control System Performance Modeling

Develop a high-level analytical tool set to evaluate and/or define potential minimal control system performance requirements. Use these analytical tools, conceptually based on probability or criticality functions, to measure control redundancy and passive protection performance for each of the control sequences which may result in a failure mode identified in the FMEA.

- Development partnership – not yet finalized
- Timing – kick-off in 2012(24 months)
  - Based upon probability and/or criticality functions derived from fault tree analysis (FTA) and control logic flow diagrams
  - Separate tools for HEV, PHEV, and BEV applications
  - Potential for adaptation to HIL analyzer for testing/comparing OEM systems

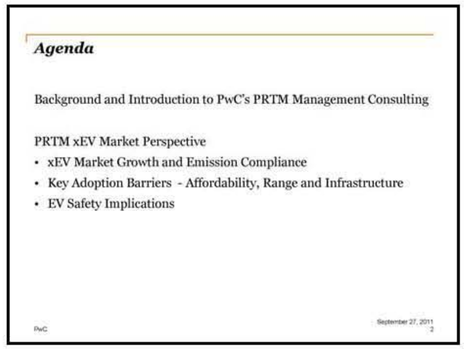
Other Information and Collaboration Efforts

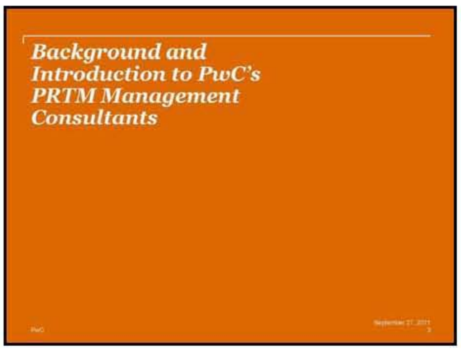
- Informational research from OEMs on design features and safety processes
- Special testing and assessment with DOE/National Labs/DOD
- Coordination activities with DOE EERE and DOD TARDEC and NHTSA Traffic Injury Control on public information and training

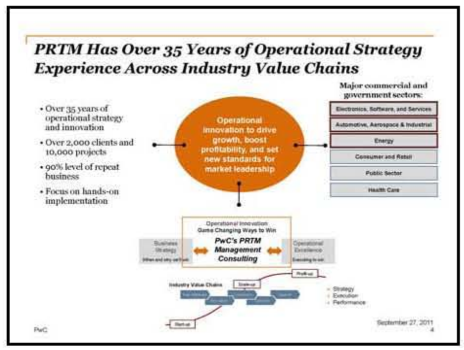
Questions?

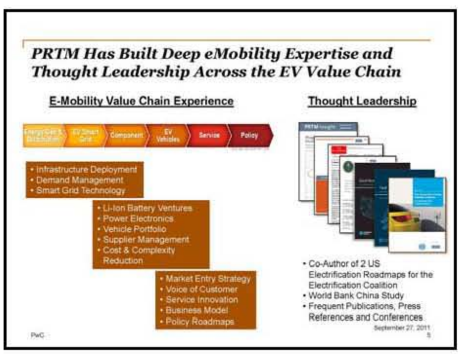
Thank You

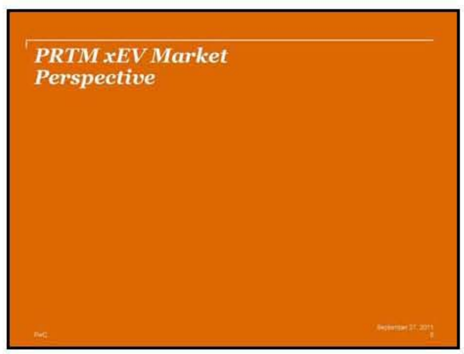

2nd Annual EV Safety Standards Summit
Trends with the Electric Vehicle Market
PwC's PRTM Management Consulting
September 27, 2011
pwc

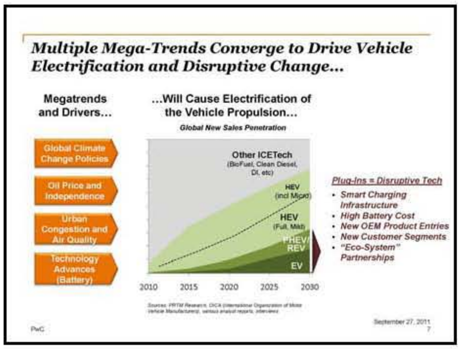

Agenda
Background and Introduction to PwC's PRTM Management Consulting
PRTM xEV Market Perspective
• xEV Market Growth and Emission Compliance
• Key Adoption Barriers - Affordability, Range and Infrastructure
• EV Safety Implications
PwC
September 27, 2011
2


Background and Introduction to PwC's PRTM Management Consultants
PwC
September 27, 2011
3

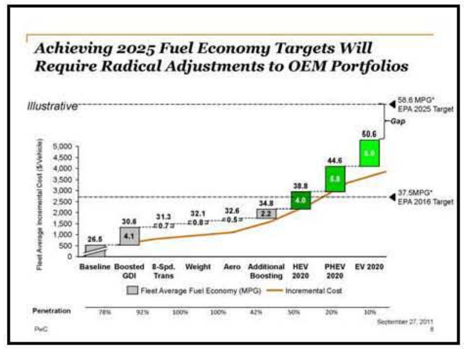

PRTM Has Over 35 Years of Operational Strategy Experience Across Industry Value Chains
• Over 35 years of operational strategy and innovation
• Over 2,000 clients and 10,000 projects
• 90% level of repeat business
• Focus on hands-on implementation
Operational innovation to drive growth, boost profitability, and set new standards for market leadership
Major commercial and government sectors:
Electronics, Software, and Services
Automotive, Aerospace & Industrial
Energy
Consumer and Retail
Public Sector
Health Care
Operational Innovation
Game Changing Ways to Win
PwC's PRTM Management Consulting
Industry Value Chains
Strategy
Execution
Performance
PwC
September 27, 2011
4


PRTM Has Built Deep eMobility Expertise and Thought Leadership Across the EV Value Chain
E-Mobility Value Chain Experience
Component
EV Vehicles
Service
Policy
• Infrastructure Deployment
• Demand Management
• Smart Grid Technology
• Li-Ion Battery Ventures
• Power Electronics
• Vehicle Portfolio
• Supplier Management
• Cost & Complexity Reduction
• Market Entry Strategy
• Voice of Customer
• Service Innovation
• Business Model
• Policy Roadmaps
Thought Leadership
• Co-Author of 2 US Electrification Roadmaps for the Electrification Coalition
• World Bank China Study
• Frequent Publications, Press References and Conferences
PwC
September 27, 2011
5


PRTM xEV Market Perspective
PwC
September 27, 2011
6



Multiple Mega-Trends Converge to Drive Vehicle Electrification and Disruptive Change...
Megatrends and Drivers...
...Will Cause Electrification of the Vehicle Propulsion...
Global New Sales Penetration
Global Climate Change Policies
Oil Price and Independence
Urban Congestion and Air Quality
Technology Advances (Battery)
Other ICETech (BioFuel, Clean Diesel, DI, etc)
HEV (incl Micro)
HEV (Full, Mild)
PHEV/ REV
EV
2010 2015 2020 2025 2030
Plug-Ins = Disruptive Tech
Smart Charging Infrastructure
High Battery Cost
New OEM Product Entries
New Customer Segments
"Eco-System" Partnerships
PwC
September 27, 2011
7



Achieving 2025 Fuel Economy Targets Will Require Radical Adjustments to OEM Portfolios
Illustrative
58.6 MPG* EPA 2025 Target
Gap
37.5MPG* EPA 2016 Target
Fleet Average Incremental Cost ($/Vehicle)
26.5
30.6
4.1
31.3
32.1
32.6
34.8
2.2
38.8
4.0
44.6
5.8
50.6
6.0
Baseline
Boosted GDI
8-Spd. Trans
Weight
Aero
Additional Boosting
HEV 2020
PHEV 2020
EV 2020
Fleet Average Fuel Economy (MPG)
Incremental Cost
Penetration
PwC
September 27, 2011
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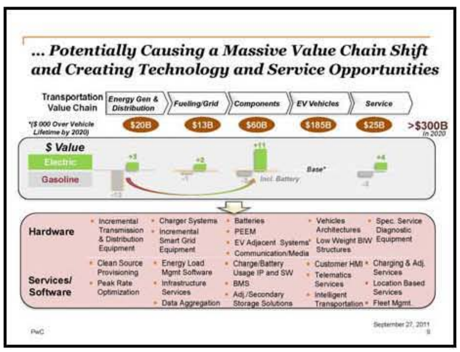

... Potentially Causing a Massive Value Chain Shift and Creating Technology and Service Opportunities
Transportation Value Chain
Energy Gen & Distribution
Fueling/Grid
Components
EV Vehicles
Service
$20B
$13B
$60B
$185B
$25B
>$300B in 2020
$ Value
Electric
Gasoline
Incl. Battery
Hardware
Services/ Software
Incremental Transmission & Distribution Equipment
Charger Systems
Incremental Smart Grid Equipment
Batteries
PEEM
EV Adjacent Systems
Communication/Media
Vehicles Architectures
Low Weight BIW Structures
Spec. Service Diagnostic Equipment
Clean Source Provisioning
Peak Rate Optimization
Energy Load Mgmt Software
Infrastructure Services
Data Aggregation
Charge/Battery Usage IP and SW
BMS
Adj./Secondary Storage Solutions
Customer HMI
Telematics Services
Intelligent Transportation
Charging & Adj. Services
Location Based Services
Fleet Mgmt.
PwC
September 27, 2011
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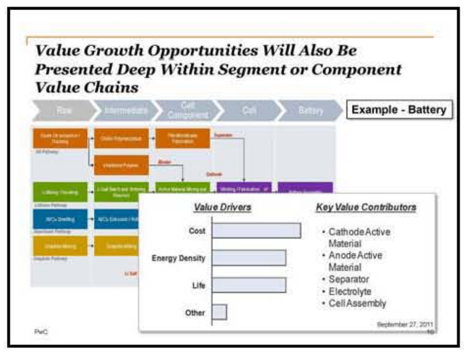
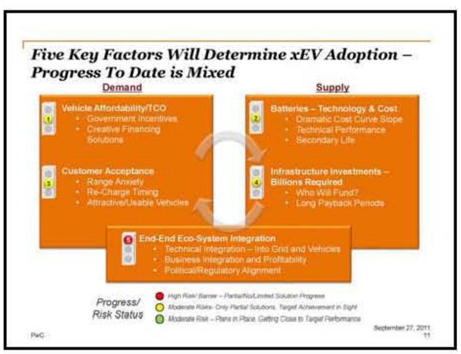


Value Growth Opportunities Will Also Be Presented Deep Within Segment or Component Value Chains
Raw
Intermediate
Cell Component
Cell
Battery
Example - Battery
Value Drivers
Key Value Contributors
Cost
Energy Density
Life
Other
Cathode Active Material
Anode Active Material
Separator
Electrolyte
Cell Assembly
PwC
September 27, 2011



Five Key Factors Will Determine xEV Adoption – Progress To Date is Mixed
Demand
Supply
Vehicle Affordability/TCO
Government Incentives
Creative Financing Solutions
Batteries – Technology & Cost
Dramatic Cost Curve Slope
Technical Performance
Secondary Life
Customer Acceptance
Range Anxiety
Re-Charge Timing
Attractive/Usable Vehicles
Infrastructure Investments – Billions Required
Who Will Fund?
Long Payback Periods
End-End Eco-System Integration
Technical Integration – Into Grid and Vehicles
Business Integration and Profitability
Political/Regulatory Alignment
Progress/ Risk Status
PwC
September 27, 2011
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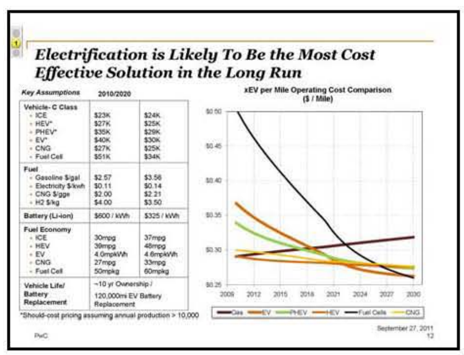

Electrification is Likely To Be the Most Cost Effective Solution in the Long Run
Key Assumptions
2010/2020
xEV per Mile Operating Cost Comparison ($ / Mile)
Vehicle- C Class
ICE $23K $24K
HEV* $27K $25K
PHEV* $35K $28K
EV* $40K $30K
CNG $27K $25K
Fuel Cell $51K $34K
Fuel
Gasoline $/gal $2.57 $3.56
Electricity $/kwh $0.11 $0.14
CNG $/gge $2.00 $2.21
H2 $/kg $4.00 $3.50
Battery (Li-ion) $600 / kWh $325 / kWh
Fuel Economy
ICE 30mpg 37mpg
HEV 39mpg 48mpg
EV 4.0mpkWh 4.6mpkWh
CNG 27mpg 33mpg
Fuel Cell 50mpkg 60mpkg
Vehicle Life/ Battery Replacement ~10 yr Ownership / 120,000mi EV Battery Replacement
*Should-cost pricing assuming annual production > 10,000
$0.50
$0.45
$0.40
$0.35
$0.30
$0.25
Gas
EV
PHEV
HEV
Fuel Cells
CNG
PwC
September 27, 2011
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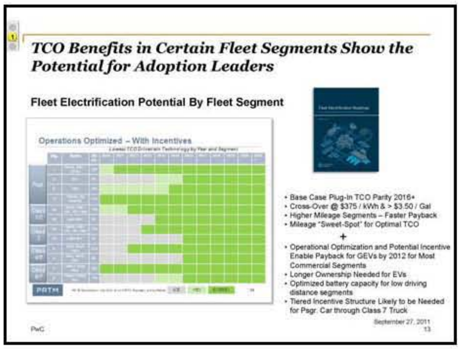

TCO Benefits in Certain Fleet Segments Show the Potential for Adoption Leaders
Fleet Electrification Potential By Fleet Segment
Operations Optimized – With Incentives
Base Case Plug-In TCO Parity 2016+
Cross-Over @ $375 / kWh & > $3.50 / Gal
Higher Mileage Segments – Faster Payback
Mileage "Sweet-Spot" for Optimal TCO
Operational Optimization and Potential Incentive Enable Payback for GEVs by 2012 for Most Commercial Segments
Longer Ownership Needed for EVs
Optimized battery capacity for low driving distance segments
Tiered Incentive Structure Likely to be Needed for Psgr. Car through Class 7 Truck
PwC
September 27, 2011
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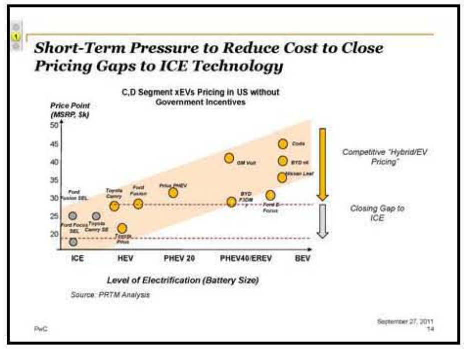

Short-Term Pressure to Reduce Cost to Close Pricing Gaps to ICE Technology
C,D Segment xEVs Pricing in US without Government Incentives
Price Point (MSRP, $k)
Competitive "Hybrid/EV Pricing"
Closing Gap to ICE
ICE
HEV
PHEV 20
PHEV40/EREV
BEV
Level of Electrification (Battery Size)
Source: PRTM Analysis
PwC
September 27, 2011
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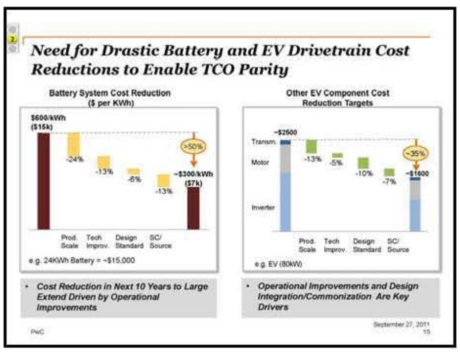

Need for Drastic Battery and EV Drivetrain Cost Reductions to Enable TCO Parity
Battery System Cost Reduction ($ per KWh)
Other EV Component Cost Reduction Targets
$600/kWh ($15k)
-24%
-13%
-6%
-13%
>50%
~$300/kWh ($7k)
Prod. Scale
Tech Improv.
Design Standard
SC/ Source
e.g. 24KWh Battery = ~$15,000
~$2500
Transm.
Motor
Inverter
-13%
-5%
-10%
-7%
~35%
~$1600
e.g. EV (80kW)
Cost Reduction in Next 10 Years to Large Extend Driven by Operational Improvements
Operational Improvements and Design Integration/Commonization Are Key Drivers
PwC
September 27, 2011
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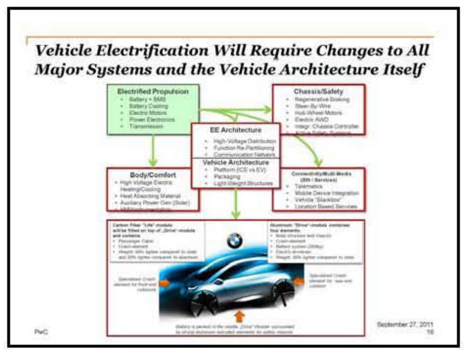

Vehicle Electrification Will Require Changes to All Major Systems and the Vehicle Architecture Itself
Electrified Propulsion
Chassis/Safety
EE Architecture
Vehicle Architecture
Body/Comfort
Connectivity/Multi Media
PwC
September 27, 2011
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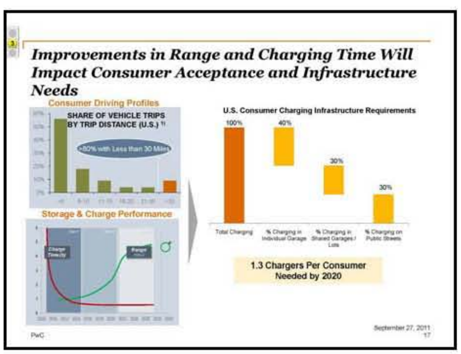
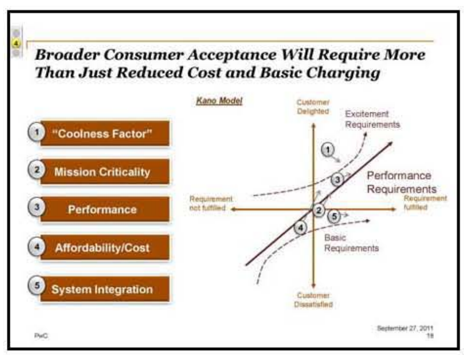


Improvements in Range and Charging Time Will Impact Consumer Acceptance and Infrastructure Needs
Consumer Driving Profiles
SHARE OF VEHICLE TRIPS BY TRIP DISTANCE (U.S.)
Storage & Charge Performance
U.S. Consumer Charging Infrastructure Requirements
100%
40%
30%
30%
1.3 Chargers Per Consumer Needed by 2020
PwC
September 27, 2011
17



Broader Consumer Acceptance Will Require More Than Just Reduced Cost and Basic Charging
Kano Model
1 "Coolness Factor"
2 Mission Criticality
3 Performance
4 Affordability/Cost
5 System Integration
Customer Delighted
Excitement Requirements
Performance Requirements
Requirement not fulfilled
Requirement fulfilled
Basic Requirements
Customer Dissatisfied
PwC
September 27, 2011
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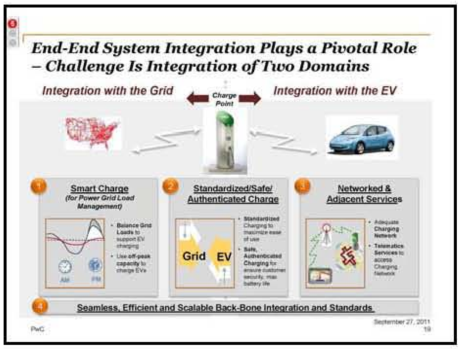
End-End System Integration Plays a Pivotal Role – Challenge Is Integration of Two Domains
Integration with the Grid
Charge Point
Integration with the EV
1 Smart Charge
(for Power Grid Load Management)
• Balance Grid Loads to support EV charging
• Use off-peak capacity to charge EVs
AM
PM
2 Standardized/Safe/ Authenticated Charge
Grid
EV
• Standardized Charging to maximize ease of use
• Safe, Authenticated Charging for ensure customer security, max battery life
3 Networked & Adjacent Services
• Adequate Charging Network
• Telematics Services to access Charging Network
4 Seamless, Efficient and Scalable Back-Bone Integration and Standards
PwC
September 27, 2011
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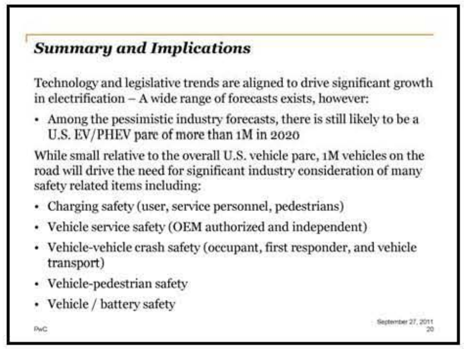
Summary and Implications
Technology and legislative trends are aligned to drive significant growth in electrification – A wide range of forecasts exists, however:
• Among the pessimistic industry forecasts, there is still likely to be a U.S. EV/PHEV pare of more than 1M in 2020
While small relative to the overall U.S. vehicle parc, 1M vehicles on the road will drive the need for significant industry consideration of many safety related items including:
• Charging safety (user, service personnel, pedestrians)
• Vehicle service safety (OEM authorized and independent)
• Vehicle-vehicle crash safety (occupant, first responder, and vehicle transport)
• Vehicle-pedestrian safety
• Vehicle / battery safety
PwC
September 27, 2011
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Progress and Gaps in Vehicle Battery Safety Standards

September 27, 2011
Rajesh Nagappala, General Motors Company

2[ND] ANNUAL ELECTRIC VEHICLE SAFETY STANDARDS SUMMIT

Purpose:

- Provide an update, on battery safety standards and regulations applicable to electric vehicles

GM General Motors Company

Global Automotive Regulations

- FMVSS305 – Update published June 2010
  - High Voltage Electrical Isolation
  - Retention of HV components
- UN DOT: Transportation Requirements
  - Based on type of technology
- ECE R100 – Update 2012
- China QC/T 743 – Lithium-Ion Batteries for electric vehicles
- Korea – Article 18-3
  - Driving Battery Safety Test

GM General Motors Company

Battery Standards

- SAE J2929 - Electric and Hybrid Vehicle Propulsion Battery System Safety Standard - Lithium-based Rechargeable Cells

Published: February 2011

– Defines a minimum set of acceptable safety criteria for a lithium-based rechargeable battery system to be considered for use in a vehicle propulsion application as an energy storage system connected to a high voltage powertrain.

– Primary focus: Conditions which can be evaluated utilizing the battery system alone.

– A battery system is a completely functional energy storage system consisting of the pack(s) and necessary ancillary subsystems for physical support and enclosure, thermal management, and electronic control.

GM General Motors Company

SAEJ2929 contd..

General Requirements and Considerations:

- During Normal operation:
  - Vibration
  - Thermal Shock
  - Humidity / Moisture Exposure
- Drop Test
- Immersion Test
- Mechanical Shock
- Exposure to Simulated Vehicle Fire
- Electrical Short Circuit
- Single Point Overcharge Protection System failure
- Single Point Over Discharge Protection System failure
- Single Point Thermal Control System failure
- Fault Analysis
- Protection against High Voltage Exposure
  - Automatic Disconnects
  - Manual Disconnects

GM General Motors Company

Battery Standards

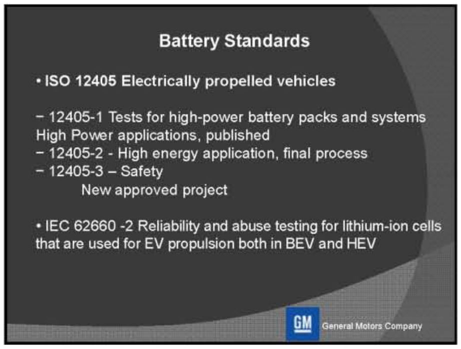
- SAEJ2929 - Future Considerations:

  In process in the near future

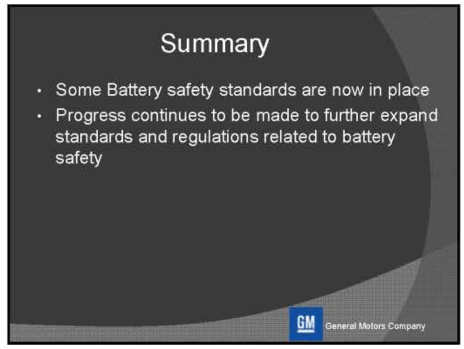
  Publish late 2011 or early 2012, updates related to vent system requirements, compatibility with other related global standards and EMC

- UL2580 Batteries for Use in Electric Vehicles
  - In Process, Expected completion in 2011

GM General Motors Company



Battery Standards
• ISO 12405 Electrically propelled vehicles
– 12405-1 Tests for high-power battery packs and systems High Power applications, published
– 12405-2 - High energy application, final process
– 12405-3 – Safety
New approved project
• IEC 62660 -2 Reliability and abuse testing for lithium-ion cells that are used for EV propulsion both in BEV and HEV
General Motors Company



Summary
• Some Battery safety standards are now in place
• Progress continues to be made to further expand standards and regulations related to battery safety
General Motors Company

2nd Annual Electric Vehicle Safety Standards Summit

Hosted by SAE International and National Fire Protection Association

September 27-28, 2011
Detroit Marriott Renaissance Center - Detroit, Michigan-Cabot Room

Vehicle Battery Standards Update:
"Progress & Gaps on Battery Safety Standards"

Robert L. Galyen, Chairman
SAE International Battery Standards Steering Committee

President Global Battery Business Magna E-Car Systems

SAE — Magna E-car SYSTEMS

Scope

- The Battery Standards Steering Committee reports to the SAE Motor Vehicle Council. Particular emphasis is currently being placed on advanced Hybrid and Electric Vehicle traction batteries due to rapidly growing market demand.
- The Steering Committee is responsible for creation, managing and coordinating the activities of all the Committees for transportation sector and includes both starter and traction batteries.
- Each individual Committee is responsible for developing and maintaining SAE Standards, Recommended Practices, and Information Reports related to that Committee's field of specialty within the transportation battery technology area for which it is assigned.
- Standardization should cover all aspects of the system, pack, battery, module and the cell, for the interfaces to various types of transportation applications.

SAE

Transportation Sector

- Automobile
- Heavy truck & bus
- Rail
- Off road
- Agriculture

SAE

Battery Standards Steering Committee

Identification Code – Committee Name – Committee Chair

TEVVBC1 – Safety Committee – G. Ressler
TEVVBC2 – Testing Committee – R. Howlett
TEVVBC3 – Labeling Committee – M. McGory
TEVVBC4 – Battery Transportation Committee – T. DeLucia
TEVVBC5 – Battery Size Standardization Committee – R. Marks
TEVVBC6 – Starter Battery Committee – R. Gruenstern
TEVVBC7 – Truck and Bus Battery Committee – G. Fritz
TEVVBC8 – E- Fuel Gauge Committee – J. Tinnemeyer
TEVVBC9 – Advanced Battery Concepts Committee – D. Prettenhofer
TEVVBC10 – Battery Recycling Committee – T. Ellis
TEVVBC11 – Small Task Battery Committee – A. Williams
TEVVBC12 – Battery Test Equipment Committee – T. Hartman
TEVVBC13 – Battery Terminology Committee – P. Wyatt
TEVVBC14 – Battery Materials Testing Committee – M. Richards
TEVVBC15 – Secondary Battery Use Committee – A. Holland
TEVVBC16 – Start/Stop Applications Committee – T. Strickland

SAE

Battery Safety Committee

- Chairman - Galen Ressler of General Motors
- Scope:
  - Create and maintain standard test procedures for all battery safety aspects
- Progress:
  - J2929 Electric and Hybrid Vehicle Propulsion Battery System Safety Standard issued March 2011
  - New revision in progress with emphasis on:
    - Expansion and enhancement of topics currently in document such as thermal propagation, etc.

SAE

Hybrid Battery Testing Committee

- Chairman: Richard Howlett of Nilar Battery Company
- Scope:
  - Publish new or update existing SAE Standards
  - Identify existing standards that meet functional testing required and identify missing testing standards
- Progress:
  - J1798 Performance Rating of Electric Vehicle Battery Modules
  - J2288-Life Cycle Testing of Electric Vehicle Battery Modules
  - J2758-Determination of the Maximum Available Power from a Rechargeable Energy Storage System on a Hybrid Electric Vehicle
  - J2289-Electric-Drive Battery Pack System: Functional Guidelines

SAE

1

Battery Labeling Committee

- Chairman: Mark McGory of Jamac Label
- Scope:
  - Provides labeling guidelines at all levels; component, sub-component, subsystem and system-level architectures
- Progress:
  - J2936 Vehicle Battery Labeling Guidelines ready for first comments
  - Expect voting to occur in October
  - First responders section
    - Registry section (needs ownership and site)
    - Manual section (owners manual contents per legislation)

SAE

Battery Transportation Committee

- Chairman: Tom De Lucia of A123 Systems
- Scope:
  - J2950 is a recommended practice (RP) that aids in the identification, handling, and shipping of new and used un-installed lithium ion battery systems to and from specified locations. J2950 is based on and references existing US and International hazardous materials (dangerous goods) transportation regulations, which are the only methodologies to be used to establish transportability of new battery systems. This RP also provide recommendations regarding the transportability of used and damaged batteries. This RP is not a substitute for proper training, which is required by regulation, and or study of national and international regulations.
- Progress:
  - J2950 will be submitted for committee vote in the beginning of October. If no issues arise it should be available for general distribution sometime in November.

SAE

Standardization Committee

- Chairman: Richard Marks of Environmental Transportation Solutions
- Scope:
  - Provides for common battery designs through the description of dimensions, termination, retention, venting system, and other features
- Progress:
  - Paralleling ISO/ITEC on Li cell standards
  - SAE will develop Li module standards but some feel too proprietary to share; efforts continue
  - Almost 50 members meeting for 1+ yrs.

SAE

Starter Battery Committee

- Chairman: Robert Gruenstern of Johnson Controls
- Scope:
  - The Starter Battery Committee will create and maintain standards for the fitment, use and testing of all energy storage devices used in the starting function of transportation vehicles
- Progress:
  - Existing J-Document Update & Reissue
    - J537 *Storage Batteries* (reissued)
    - J2185 *Life Test for Heavy-Duty Storage Batteries* (Motor Vehicle Council Balloting)
    - J1495 *Test Procedure for Battery Flame Retardant Venting Systems* (under review by Committee)
  - New J-Documents
    - J537 *Storage Batteries* (revised) expand scope anticipate new chemistries
    - J2981 – Creating new J Document for Starter Battery Standards

SAE

Truck and Bus Battery Committee

- Chairman: Greg Fritz
- Scope:
  - Identify existing standards and make recommendations where new standards could be developed. Whenever possible, include truck and bus battery pack specifications into automotive standards and create new standards, when necessary.
- Progress:
  - A Roadmap has been created and the Committee has been separated into working groups for each of the major battery pack technical areas. Liaisons have been established with the SAE Truck & Bus Hybrid Safety and Advanced Drivetrain & Hybrid Steering Committees, as well as the CALSTART Electric Truck Users Group. A Technical Information Report (TIR) will be published in 2012.

SAE

Electronics Battery Fuel Gauge Committee

- Chairman: Joern Tinnemeyer of Cadex
- Scope:
  - This document covers the recommended practices associated with reporting the vehicle's (hybrid and pure electric) battery pack performance details to the automobile user. These practices detail the accuracies, error conditions and diagnostic requirements responsible for delivering an accurate assessment of the amount of available electrochemical fuel.
- Progress:
  - Committee has agreed on a generalized system architecture
  - Practice will include elements of the vehicle energy management system down to the cell level
  - Initial draft has been written – significant areas still need more detail
  - Goal is completion by Q1 2012

SAE

Advanced Battery Concepts Committee

- Chairman: Dave Prettenhofer of A&D
- Scope:
  - Identify and keep Battery Standards Committees abreast of new technologies which we must stay informed before market commercialization.
- Progress:
  - Expect Information Report on upcoming technologies that require the attention of other committees, (Safety, Standards, etc.)

SAE

Battery Recycling Committee

- Chairman: Dr. Tim Ellis of RSR Technologies
- Scope:
  - Development of Technical Information, Recommendations and Standards for the recycling of automotive electrochemical cells.
- Progress:
  - Enhanced labeling for improved handling and segregation of chemistries prior to recycling , in process
  - Development of uniform recycling nomenclature and definitions, in process
  - Compilation of recycling methodologies and benchmarking lifecycle costs, in progress

SAE

Small Task Oriented Vehicles (STOV)

- Chairman: Anthony Williams of E-Z-GO
- Scope:
  - Focusing on development of SAE Surface Vehicle Standards to harmonize test protocols for companies engaged in the manufacture of Small Task Oriented Vehicle (STOV) batteries, chargers, test equipment and independent laboratories. The Committee will focus on Electric Vehicle and Hybrid Electric Vehicle battery pack performance, rating, and testing standards relevant to these applications.
- Progress:
  - Committee currently working on development of a SAE Certified STOV Electric Vehicle Range Testing
  - Range Testing is a major "Pain-Point" for STOV and Battery manufacturers
  - Goal is to have a draft test procedure in Q1 of 2012

SAE

Battery Test Equipment Committee

- Chairman: Terry Hartman of Bitrode Corp.
- Scope:
  - Identify minimum allowable standards for equipment used in testing energy storage systems in automotive type applications to include the definition of performance terminology and equipment safety standards.
- Progress:
  - Currently gathering information from industry experts and test equipment manufacturers to document and indentify key testing processes, methods, and specifications. Initial document is being generated.

SAE

Battery Terminology Committee

- Chairman: Perry Wyatt of Johnson Controls
- Scope:
  - Define common terminology for energy storage systems at all levels; component, sub-component, subsystem and system-level architectures including terms pertaining to testing and measurement.
- Progress:
  - J1715/2 – Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology – Energy Storage Systems

SAE

Battery Materials Testing Committee

- Chairman: Dr. Monique Richard of Toyota
- Scope:
  - Create Recommended Practices for the measurement of the key properties of the materials use in making batteries.
  - It is not the purpose of the Committee to establish criteria for the test results
- Progress:
  - J2983 (in-progress): Recommended Practice for Determining Material Properties of Li-Battery Separator

SAE

Secondary Battery Use Committee

- Chairman: Arthur Holland of P3
- Scope:
  - Establish inspection standards to qualify and re-value safe batteries for re-use and compatibility
- Progress:
  - The first meeting was held 23-Aug-2011
  - Committee members are defining specific objectives and goals.

Start/Stop Applications Committee

- Chairman: Tracy Strickland of Exide Corp.
- Scope:
  - Identify gaps in existing standards and recommended practices as they relate to batteries used in Start/Stop applications, including:
    - Testing, Design, Safety, Monitoring/Control, Labeling
  - Develop and maintain standards and recommended practices as appropriate based on those gaps where not assigned to or owned by other Battery Standards Steering Committees
- Progress:
  - Newest Committee
  - Developing member roster

Summary

- The Battery Standards Committee leads the way in transportation batteries standardization which will play a predominate roll in safe, cost effective transportation of the future
- It will take a concerted effort of science, engineering, policy, testing and validation to assure the battery systems of the transportation sector meet performance, life and safety expectations of the general consumer and first responders

Contact Information

Bob Galyen – Battery Standards Steering Committee Chairman

robert.galyen@magnaecar.com

248-836-1120 office 248-225-2794 mobile

4121 N. Atlantic Blvd. Auburn Hills, MI 48326 USA

Progress & Gaps on Vehicle Research

(Issues with PEV Stds)

Theodore Bohn

Argonne National Laboratory

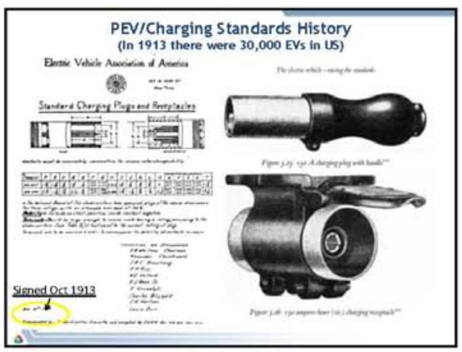
U.S. National Electric Vehicles Safety Standards Summit

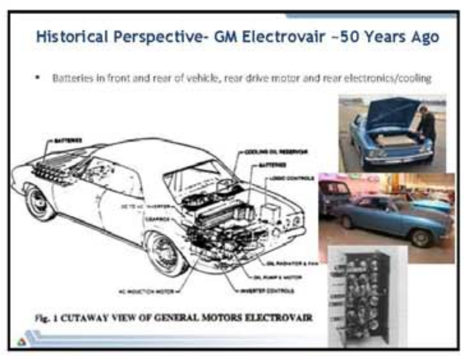
SAE International — September 27, 2011

Overview: Vehicle Research Safety Gaps

(Energy Storage and Vehicle Safety Covered Elsewhere)

- History of PEVs, Charging Infrastructure
- PEV Related Components in Vehicles:
  - Motor rating methods; not all motors are created equally
  - Rating motors/components as part of a system
  - Charging couplers; Conductive, inductive, now wireless
  - Summary of Charging levels (proper nomenclature)
  - Communication requirements (PLC over Pilot wire)
  - Energy consumption metrology, on and off vehicle
  - Vehicle charging/coupler diagnostics- (SAE J2836, J2847/4)





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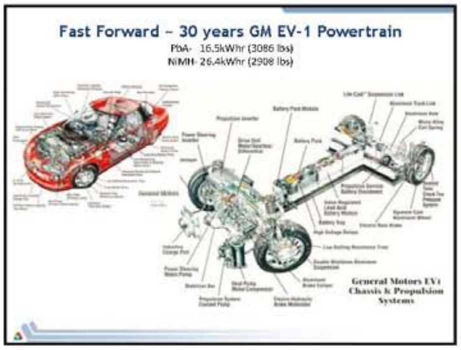
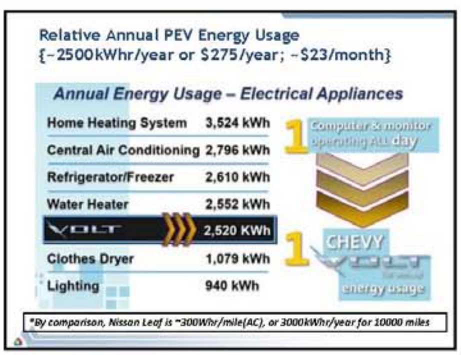


Fast Forward ~ 30 years GM EV-1 Powertrain
PbA- 16.5kWhr (3086 lbs)
NiMH- 26.4kWhr (2908 lbs)
General Motors EV1 Chassis & Propulsion Systems

Fast Forward to 2010: Chevy Volt
Engine driven 53kW generator
111 kW/ 273 lb-ft traction drive inverter
Chevy Volt traction/generator electronics
Engine Generator
Lithium-Ion Battery
Electric Drive Unit
Charge Port

2012 Focus EV- Interesting Maintenance Comparison
Focus electric vehicle stand to save $449/7.5 hours on oil changes, during the projected 10-year, 150,000-mile (241,400-km) life of the vehicle.
Eliminated: 5 air filters ($24.95 ea), 2 cooling system flushes ($109 ea), 1 drive belt ($130 ea), get one transmission service for $179, 4 spark plugs ($69.95 ea)
Still need to maintain proper tire pressure and replacing windshield-wiper blades.
The only EV-exclusive maintenance item is a Ford-recommended flushing of the lithium-ion battery pack's cooling system at 100,000 miles (161,000 km).

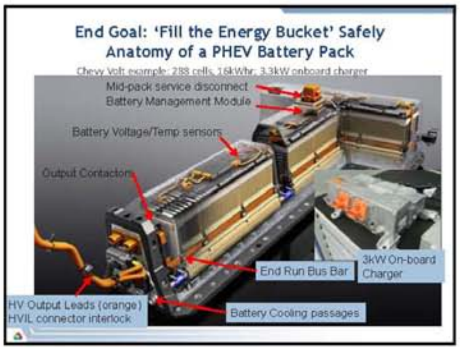
Unique Charging Needed for Each Vehicle Type
– Plug in Hybrid Electric Vehicle (PHEV)
– Extended Range Electric Vehicle (EREV)
Charge power up to 6 kW
– Battery Electric Vehicle (BEV)



Relative Annual PEV Energy Usage
{~2500kWhr/year or $275/year; ~$23/month}
Annual Energy Usage – Electrical Appliances
Home Heating System 3,524 kWh
Central Air Conditioning 2,796 kWh
Refrigerator/Freezer 2,610 kWh
Water Heater 2,552 kWh
VOLT 2,520 KWh
Clothes Dryer 1,079 kWh
Lighting 940 kWh
Computer & monitor operating ALL day
CHEVY VOLT
energy usage
*By comparison, Nissan Leaf is ~300Whr/mile(AC), or 3000kWhr/year for 10000 miles

Electric Motor Ratings Standards (SAE J2907)
PEV industry lacks consensus based definitions of electric motor usage cycles - impulse, peak, transient, steady state
Each manufacturer uses an 'adjustment factor' on ratings used for industrial or other motor applications, based on the non-steady state use of the motor (i.e. 'Toyota Watts' are different than Ford Watts, Honda Watts and James Watt)
Drive cycles are defined for vehicles but motor usage varies by topology/mass.
Cooling loop inlet temperature greatly impacts motor peak/steady state ratings
SAE J2908 addresses motor rating as part of a system
Motors may have higher component rating than battery power rating, cooling system capacity or power electronics. System rating is the minimum of the set.

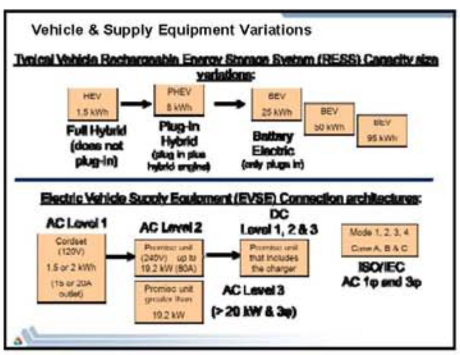
2

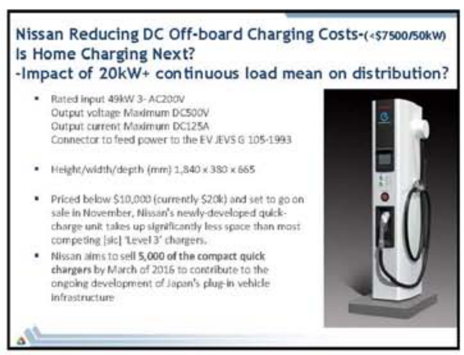

End Goal: 'Fill the Energy Bucket' Safely
Anatomy of a PHEV Battery Pack
Chevy Volt example: 288 cells, 16kWhr, 3.3kW onboard charger
Mid-pack service disconnect
Battery Management Module
Battery Voltage/Temp sensors
Output Contactors
End Run Bus Bar
3kW On-board Charger
HV Output Leads (orange)
HVIL connector interlock
Battery Cooling passages


Battery Packaging/Safety Systems:
Fused Mid-Pack Service Disconnect Minimizes Exposed Voltages
(1/2 pack voltage), contactors- contact weld detect, (Ford Focus EV, Nissan Leaf batteries)


Historical Perspective on EV Charging Equipment
1900 to Today ....and Tomorrow
1913- 150A/48vdc coupler
(30,000 EVs in 1913)
1990's J1772 Conductive
SAE J1773 Inductive
2010 SAE J1772 Level 2
240vac/<80A (32A typ.)
2011 SAE J2954
Wireless Charging

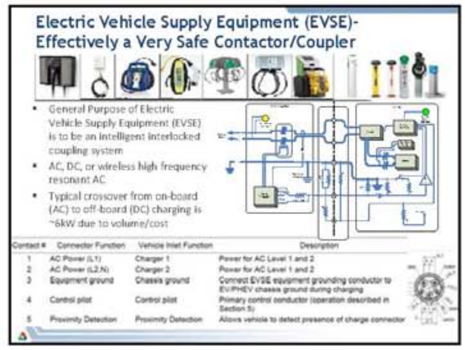

DC Fast Charging Couplers:
JARI-ChAdEMO->SAE J1772-Hybrid
Look mom, no lever!
Due to fewer Comm. Pins
Level Volts Amps
AC-1 120 20
AC-2 240 <80
DC-1 <450 <80
DC-2 <450 <200
DC-3 <600 <400
Nissan Leaf uses two connectors
(DC-JARI and AC-J1772)
CAN Pins avoided via J2931
PLC over Pilot
SAE/ISO AC+DC
Combo J1772)


Vehicle & Supply Equipment Variations
Typical Vehicle Rechargeable Energy Storage System (RESS) Capacity size variations:
HEV 1.5 kWh
Full Hybrid (does not plug-in)
PHEV 8 kWh
Plug-in Hybrid (plug in plus hybrid engine)
BEV 25 kWh
BEV 50 kWh
BEV 95 kWh
Battery Electric (only plugs in)
Electric Vehicle Supply Equipment (EVSE) Connection architectures:
AC Level 1
Cordset (120V) 1.5 or 2 kWh (15 or 20A outlet)
AC Level 2
Premises unit (240V) up to 19.2 kW (80A)
Premises unit greater than 19.2 kW
DC Level 1, 2 & 3
Premises unit that includes the charger
AC Level 3 (> 20 kW & 3φ)
Mode 1, 2, 3, 4
Case A, B & C
ISO/IEC
AC 1φ and 3φ

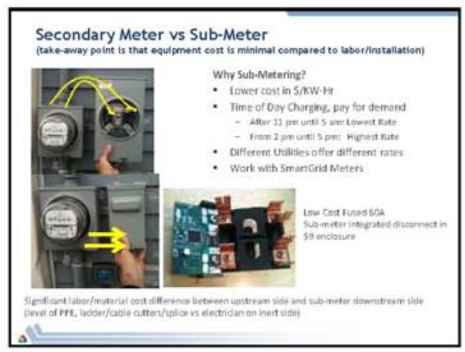

Nissan Reducing DC Off-board Charging Costs-(<$7500/50kW)
Is Home Charging Next?
-Impact of 20kW+ continuous load mean on distribution?
Rated input 49kW 3- AC200V
Output voltage Maximum DC500V
Output current Maximum DC125A
Connector to feed power to the EV JEVS G 105-1993
Height/width/depth (mm) 1,840 x 380 x 665
Priced below $10,000 (currently $20k) and set to go on sale in November, Nissan's newly-developed quick-charge unit takes up significantly less space than most competing [sic] 'Level 3' chargers.
Nissan aims to sell 5,000 of the compact quick chargers by March of 2016 to contribute to the ongoing development of Japan's plug-in vehicle infrastructure

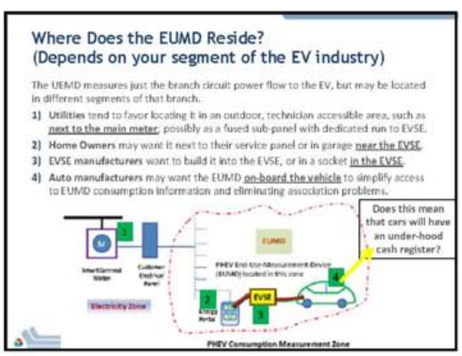
3

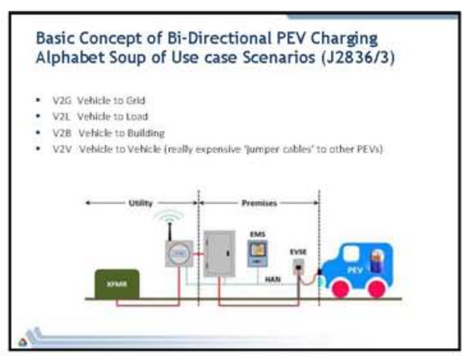

Off-board DC Charging Stations
Currently only Nissan Leaf and Mitsubishi iMIEV have DC charging inlets (50kW)- JEVS
SAE/IEC combination DC-AC charging standards are coming in 2012- vehicles 2014?
Allegedly fast charging stations assume $20 minimum fee, 20 minute limit
- 50kW=50/3=12.6kWhr-> $1.26 of electricity at $0.10/kWhr;
- Including service fee $20/12.6kWhr=$1.59/kWhr)
Blink
Coulomb-Acker Wade
Nissan
Epyon- Holland,
Aerovironment
All of the above use the JEVS105-1993 (JARI) DC coupler


Electric Vehicle Supply Equipment (EVSE)-
Effectively a Very Safe Contactor/Coupler
General Purpose of Electric Vehicle Supply Equipment (EVSE) is to be an intelligent interlocked coupling system
AC, DC, or wireless high frequency resonant AC
Typical crossover from on-board (AC) to off-board (DC) charging is ~6kW due to volume/cost
Contact # | Connector Function | Vehicle Inlet Function | Description
1 | AC Power (L1) | Charger 1 | Power for AC Level 1 and 2
2 | AC Power (L2,N) | Charger 2 | Power for AC Level 1 and 2
3 | Equipment ground | Chassis ground | Connect EVSE equipment grounding conductor to EV/PHEV chassis ground during charging
4 | Control pilot | Control pilot | Primary control conductor (operation described in Section 5)
5 | Proximity Detection | Proximity Detection | Allows vehicle to detect presence of charge connector

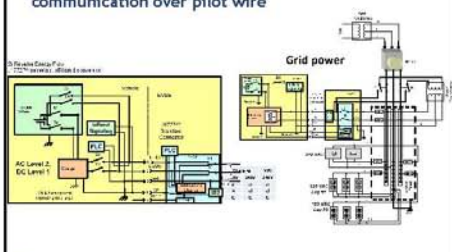

SAE J2953-PEV-EVSE Compatibility
EVSE-PEV-EUMD-Utility Test Fixture/Tools
Many Combinations of EVs, EVSE and Utility Region Installations
Utilities
Occasional use cable
EVSE
DC off board charger
? Interoperability ?


Secondary Meter vs Sub-Meter
(take-away point is that equipment cost is minimal compared to labor/installation)
Why Sub-Metering?
Lower cost in $/KW-Hr
Time of Day Charging, pay for demand
After 11 pm until 5 am: Lowest Rate
From 2 pm until 5 pm: Highest Rate
Different Utilities offer different rates
Work with SmartGrid Meters
Low Cost Fused 60A
Sub-meter integrated disconnect in $9 enclosure
Significant labor/material cost difference between upstream side and sub-meter downstream side
(level of PPE, ladder/cable cutters/splice vs electrician on inert side)


Where Does the EUMD Reside?
(Depends on your segment of the EV industry)
The UEMD measures just the branch circuit power flow to the EV, but may be located in different segments of that branch.
1) Utilities tend to favor locating it in an outdoor, technician accessible area, such as next to the main meter; possibly as a fused sub-panel with dedicated run to EVSE.
2) Home Owners may want it next to their service panel or in garage near the EVSE.
3) EVSE manufacturers want to build it into the EVSE, or in a socket in the EVSE.
4) Auto manufacturers may want the EUMD on-board the vehicle to simplify access to EUMD consumption information and eliminating association problems.
Does this mean that cars will have an under-hood cash register?
EVSE
PHEV Consumption Measurement Zone

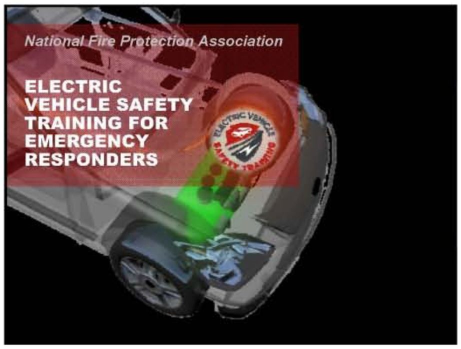

Basic Concept of Bi-Directional PEV Charging
Alphabet Soup of Use case Scenarios (J2836/3)
V2G Vehicle to Grid
V2L Vehicle to Load
V2B Vehicle to Building
V2V Vehicle to Vehicle (really expensive 'jumper cables' to other PEVs)
Utility
Premises
EMS
EVSE
HAN
PEV

J1772-Level 1 DC (draft)- passes DC on AC leads Off-board Charger (lower right)- requires PLC communication over pilot wire



Conclusions

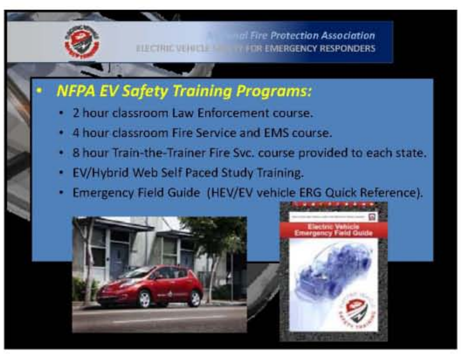
- Electric Vehicles have been around Detroit and the world for over 100 years, with many generations of infrastructure
- PEV Charging Safety is a major concern
- Off-board Unidirectional fast chargers are evaluating incremental cost for bi-directional option.
- PLC over pilot communication is required for utility and DC charging messages (several parts of J2837/3, J2847/3 and J2931 are in draft form, published soon)
- SAE J1772-DC coupler will offer greater power transfer, both ways;
  Level 1-DC 36kW(80A), Level 2-DC 90kW(200A), Level 3-DC 180kW (400A)

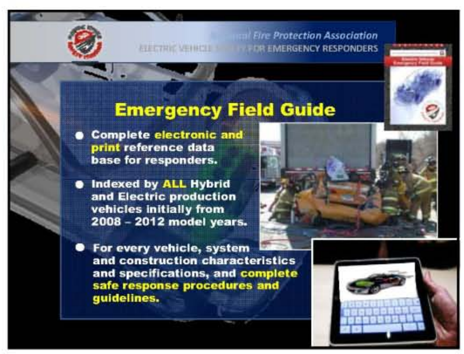

National Fire Protection Association
ELECTRIC VEHICLE SAFETY TRAINING FOR EMERGENCY RESPONDERS


Advanced EV/Hybrid Training Goals:
Implement comprehensive ILT & Self Paced Study Programs for Electric/Hybrid Drive Vehicles to keep first responders prepared and the public safe.
Develop an Emergency Responder Web Portal & Quick Reference EV Field Guide for on-scene safety info.
Produce Vehicle Specific Online Training & Videos.
NFPA

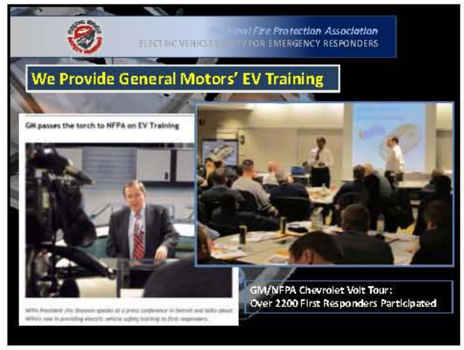

Auto Manufacturers Partnerships
Alliance of Auto Manufacturers (AAM)
Association of Intl Auto Manuf. (AIAM)
Auto Manufacturers
General Motors
Nissan
Ford
Toyota
Kia
Hyundai
Tesla
BMW
Volkswagen
Audi
Porsche


Training Scope
Plug in Hybrids
Electric
Hybrids
Charging Stations


NFPA EV Safety Training Programs:
2 hour classroom Law Enforcement course.
4 hour classroom Fire Service and EMS course.
8 hour Train-the-Trainer Fire Svc. course provided to each state.
EV/Hybrid Web Self Paced Study Training.
Emergency Field Guide (HEV/EV vehicle ERG Quick Reference).
Electric Vehicle Emergency Field Guide

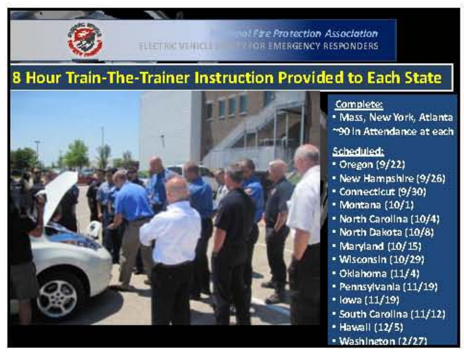

Emergency Field Guide
Complete electronic and print reference data base for responders.
Indexed by ALL Hybrid and Electric production vehicles initially from 2008 – 2012 model years.
For every vehicle, system and construction characteristics and specifications, and complete safe response procedures and guidelines.

Fire Protection Association
ELECTRIC VEHICLE FOR EMERGENCY RESPONDERS
EV Web Portal – Responder Central Repository
ELECTRIC VEHICLE
SAFETY TRAINING
Resources
• 43,000 Web Page Visits
• 9,500 Blog Hits
• 22,000 EV Monthly Newsletter Circulation
Website: EVsafetytraining.org



Fire Protection Association
ELECTRIC VEHICLE FOR EMERGENCY RESPONDERS
We Provide General Motors' EV Training
GM passes the torch to NFPA on EV Training
GM/NFPA Chevrolet Volt Tour:
Over 2200 First Responders Participated

Fire Protection Association
ELECTRIC VEHICLE FOR EMERGENCY RESPONDERS
Online EV/Hybrid Overview &
Vehicle Specific Instruction
Chevy Volt Online Training:
10,000 First Responders Trained



Fire Protection Association
ELECTRIC VEHICLE FOR EMERGENCY RESPONDERS
8 Hour Train-The-Trainer Instruction Provided to Each State
Complete:
• Mass, New York, Atlanta
~90 in Attendance at each
Scheduled:
• Oregon (9/22)
• New Hampshire (9/26)
• Connecticut (9/30)
• Montana (10/1)
• North Carolina (10/4)
• North Dakota (10/8)
• Maryland (10/15)
• Wisconsin (10/29)
• Oklahoma (11/4)
• Pennsylvania (11/19)
• Iowa (11/19)
• South Carolina (11/12)
• Hawaii (12/5)
• Washington (2/27)

Fire Protection Association
ELECTRIC VEHICLE FOR EMERGENCY RESPONDERS
For More Information Contact:
NFPA:
Andrew Klock
Sr. Project Manager
Quincy MA
Email: Aklock@nfpa.org
(617) 984-7089
Angela Burke
Project Coordinator
Quincy MA
Email: Aburke@nfpa.org
(617) 984-7051

CT EV FIRE – APRIL 14, 2011

Robert Duval – NFPA
Sr Fire Investigator
NE Regional Director

Details

- Date: April 14, 2011
- Time: 0412hrs
- Location: Single Family Home – Barkhamsted, CT
- Resulting Damage: Two car garage (with shop) and exposure damage to home.
  - Two Electric Vehicles (one converted EV and one consumer EV)

News Account

View from Driveway

Garage Exterior (East)

Overhead View

1

Conclusions

- Area of Origin: The area of origin, based upon witness statements, burn patterns, demarcation lines and areas of greatest damage, is believed to have been in the area of the center of the garage closer to the vehicle parked in the south bay, closest to living space of residence

- Cause: Undetermined

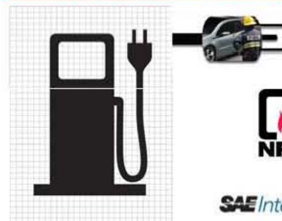
(CT State Police Fire Marshal's Office Report)

2

Electrical Vehicle Safety Standards Summit

Enforcement Officials Standpoint

How Does Code Enforcement Fit Into Electric Vehicle Usage?



2nd Annual Electric Vehicle Safety Standards Summit

NFPA

SAE International

Presenter

Jon Nisja, Fire Safety Supervisor

Minnesota Department of Public Safety
State Fire Marshal Division

Overall Concerns

- Vehicle Concerns:
  - Power-down procedures,
  - Labeling of components,
  - Some standardization (or at least make it intuitive),
  - Color coding / labeling of high voltage cables,
  - Fail-safes (what happens when Mr. Murphy visits).

Overall Concerns

- Infrastructure Concerns:
  - Charging disconnects,
  - Auto shut-down (prevent runaway or over-charging),
  - Physical damage protection,
  - Fail-safes (what happens when Mr. Murphy visits).

Overall Concerns

- Other Concerns:
  - Vehicle towing & recovery,
  - Vehicle salvage,
  - Battery storage and installations,
  - Battery removal and rebuilding,
  - Fail-safes (what happens when Mr. Murphy visits).

1

How the Code Process Works

- The term "code" in this presentation will be used in a general sense.
- Could be used to apply to:
  - Fire Code,
  - Building Code,
  - National Electrical Code.

How the Code Process Works

- The codes are often written in response to one or more tragic experiences.
- It has been said that the codes are written with the blood of the victims.
- The codes are trying to prevent similar occurrences from repeating.

Code Process

- Historically, codes were ***developed*** at a national level.

Code Process

- Recently, more code development has been multi-national.

Code Process

- Codes are typically ***adopted*** at a state-wide level.

Code Process

- Codes are typically ***enforced*** on a local level (city, county, township, district).

2

Code Purpose

- "… prescribe ***minimum requirements*** necessary to establish a ***reasonable level*** of fire and life safety …".
  - NFPA 1 (Fire Prevention Code) – Section 1.2.
- Important points:
  - Codes are "minimums" (not the ultimate).
  - Intended to be "reasonable".

Transportation vs. Storage vs. Use

- In most codes vehicles, equipment, and commodities are exempt from code requirements during transportation.
  - Codes generally assume they are under other regulatory framework (DOT, NHTSA, etc.).

Transportation vs. Storage vs. Use

- Once no longer in transportation, storage and use often fall under state and local codes.
- Some examples of how that might apply on next few slides.

Transportation vs. Storage vs. Use

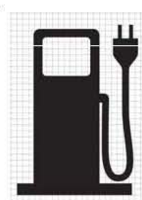
- In the case of electric vehicles:
  - Charging of batteries would be considered a use.

Transportation vs. Storage vs. Use

- In the case of electric vehicles:
  - New battery storage would be considered storage.

Code Impact on Electric Vehicles

- The codes will likely impact electric vehicles in these areas:
  - Charging stations:
    - Residential,
    - Public,
    - Private commercial.



3

Code Impact on Electric Vehicles

- The codes will likely impact electric vehicles in these areas:
  - Battery storage:
    - Auto parts warehouses,
    - Auto parts stores,
    - Auto repair garages & dealerships,
    - Battery exchange depots.

Code Impact on Electric Vehicles

- The codes will likely impact electric vehicles in these areas:
  - Batteries awaiting recycling or disposal,
  - Battery re-building,
  - Battery recycling,
  - Battery disposal,
  - Dormant vehicles (towed, abandoned).
- Concern: remove electrical problems.

Code Impact on Electric Vehicles

- The codes will likely impact electric vehicles in these areas:
  - May require permits (typically a local issue):
    - Installation of new systems (electrical permit, construction permit),
    - Operational permit (usually controls how system is used).

Code Impact of Electric Vehicles

- Equipment will also need to be maintained,
- Are there safety features to restrict improper use of charging equipment?

Moving Forward

- Continue dialogue and discussion with code officials.
- Continue training with emergency responders (how to deal with EVs):
  - Law Enforcement,
  - Fire,
  - Emergency medical services,
  - Towing & recovery services.

ELECTRIC VEHICLE SAFETY TRAINING

Questions

2nd Annual Electric Vehicle Safety Standards Summit
September 27, 2011

The ANSI EV Standards Panel - Importance of Linking the Standards Together

Presented by:
Jim Pauley
Sr. VP – Schneider Electric
Co-Chair – ANSI EVSP

ANSI Electric Vehicles Standards Panel Charge – Develop Standardization Roadmap for U.S. market by end 2011

- Catalog existing standards (published, in development, under revision)
- Define where gaps exist / identify priorities for needed standards, organizations that may be able to perform the work, and target dates
- Identify harmonization / coordination issues of concern and make recommendations for addressing them
- Do the same for related conformity assessment programs, codes and regulations as needed and appropriate
- Idea is to capture what is taking place in various initiatives and compile it in one place to provide greater clarity
- EVSP will not develop standards
- EVSP will not "re-invent the wheel" or duplicate the work of others

More info at www.ansi.org/evsp

ANSI Electric Vehicles Standards Panel — Slide 2

Roadmaps Are Already Being Developed in Other Countries

Title | Location — Slide 3

Participating Organizations

- Alliance of Automobile Manufacturers
- Assn of Global Automakers
- Audi AG
- ATIS
- Better Place
- California Public Utilities Commission
- Con Edison
- Corning
- Coulomb Technologies, Inc.
- CSA America
- Duke Energy
- Eaton
- Edison Electric Institute
- Electric Power Research Institute
- General Electric
- General Services Administration
- Green Dot (Transportation) Inc.
- Hubbell
- IEEE
- International Assn of Electrical Inspectors
- International Code Council
- Intertek
- ITT Interconnect Solutions
- Magna E-Car
- Mercedes-Benz USA
- Mitsubishi Electric Research Labs
- Mitsubishi Motors Corporation
- Nanotube Technologies
- National Electrical Contractors Assn
- National Electrical Manufacturers Assn
- National Fire Protection Assn
- National Institute of Standards and Technology
- Qualcomm
- ReCharge Power
- Rocky Mountain Institute
- SAE International
- Schneider Electric
- SEW-Eurodrive
- Siemens
- Sony Electronics
- Southern California Edison
- TDI Power
- Underwriters Laboratories, Inc.
- U.S. Department of Energy
- VdTUV
- Virginia Tech Transportation Institute

ANSI Electric Vehicles Standards Panel — Slide 4

Architecture – 3 Domains / 7 Working Groups

- Vehicle Domain
  - Energy Storage Systems WG
  - Vehicle Components WG
  - Vehicle User Interface WG
- Infrastructure Domain
  - Charging Systems WG
  - Infrastructure Communications WG
  - Infrastructure Installation WG
- Support Services Domain
  - Education and Training WG

ANSI Electric Vehicles Standards Panel — Slide 5

Infrastructure Safety Issues

- General
  - Connectivity of chargers with the built infrastructure
  - Voltage levels / speed of charge / flow of electricity through the system
  - Impact of Environmental conditions
- Residential Locations
  - Installation of charging stations, meters, plugs
  - Power capacity assessment / Permitting
  - Upgrades to Comply with National Electrical Code
  - Qualifications of installers and inspectors
- Public Charging Locations
  - Signage, Lighting, Security, Accessibility
  - Protection and Maintenance of EVSE (Security, Vandalism, Collisions)
  - Cord Management
  - Battery storage / warehousing

ANSI Electric Vehicles Standards Panel — Slide 6

Timeline

Milestone	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Deliverables
Kickoff Webinar	17								Review Scope, Architecture, Timeline, Organizational Matters
Plenary Meeting		20-21							Organize WGs, Identify Issues
WG Con Calls									Identify Existing Standards / Standards in Development / Gaps
Steering Committee Call				18					Review Progress, Process and Timeline for Roadmap Development
WG Con Calls									Prioritize Gaps, Harmonization and Conformance Issues
WG Con Calls									Draft / Discuss Recommendations
Comment Period / JWG coordination calls						17-31			Vetting of Draft Roadmap with Panel and Non-Panel Members
Plenary / Steering Committee Meeting							Week of 14		Address Comments / Approve Roadmap, Discuss Work Needed Going Forward
Final Edit / Design							14-28		Final Content Edit
Publication								Week of 12	Publish "Version 1" of Roadmap

Roadmap Outline / Initial Content Development Responsibility

Section	Contents	Responsible Persons
Executive Summary		Staff
1. Introduction	Goal, Audience, Philosophy (address gaps, reduce overlap, etc.), Core Values (Safety, Interoperability, Efficiency, Harmonization, Security), Roadmap Boundaries (U.S. near term focus, eye on international and future)	Staff
2. Background	National Overview, Situational Assessment for EVs, Entities Operating in EV standards space	Staff
3. Roadmap Architecture	Story, Rationale, Supporting Graphics; Domains (Vehicle, Infrastructure, Support Services) / Issue / Sub Issue	WG volunteers
4. Standards, Harmonization and Conformance Activities	Domains (Vehicle, Infrastructure, Support Services) / Issue / Sub Issue	WG volunteers
5. Gaps	Same Structure as Section 4 - Gap, No Gap, Partial Gap and Explanation	WG volunteers
6. Conclusions and Recommendations	Summary Table upfront with high priorities, time tables, and recommended lead(s)	Staff
7. Next Steps	Coordination with SDOs / oversight bodies (domestic and foreign); "Living Document" strategy for maintaining roadmap moving forward	Staff
Compendium – Details of Section 4	Separate document; mirrors roadmap structure; upfront matrix of coordinating bodies and standards	Staff

Electrical Vehicle Charging and NFPA Electrical Safety Codes and Standards

2nd Annual Electric Vehicle Safety Standards Summit
Sept 27-28, 2011

Lonny Simonian, PE — Associate Professor, Principal Investigator
Dr. Thomas Korman, PE — Associate Professor, Co Investigator
Dr. Frederick W. Mowrer — Professor-in-Residence / Director Fire Protection Engr.
David Phillips — Graduate Student, Fire Protection Engr.

Project Background

In 2010, NFPA and SAE held a joint Summit on the safety aspects of the widespread introduction of electric vehicles to the marketplace. A critical outcome of that Summit was the identification of the need to assess the implications of electric vehicle charging for NFPA electrical safety codes and standards and to communicate that to the inspection community and other audiences.

NFPA technical committees are currently addressing these impacts and will benefit from additional information from the EV community on emerging technologies which may impact safety.

Project Tasks

1. Technology Review and Safety Assessment: Working with the automotive industry and battery and battery charging technology companies, assess the current and emerging charging station technical specifications (Level 2 and 3 charging) to determine the implications for electrical infrastructure including wiring, overcurrent protection, load management, etc.
2. Standards Review and Gap Assessment: using the outcome from Task 1, the NFPA standards identified above will be reviewed in the context of these safety impacts and a straw-man assessment of gaps and inconsistencies will be prepared.
3. Workshop Presentation: The contractor will present interim findings to the NEC EV task force and other stakeholders at a ½ day meeting at an east coast location. The strawman will then be revised based on this input.
4. Report of all Tasks: A final report of all tasks will be prepared and a presentation made at the NFPA/SAE Electric Vehicle Summit in Detroit.

Project Technical Panel

Panel Members

Gery Kissel	General Motors Corporation
John Kovacik	Underwriters Laboratories
Alan Manche	Schneider Electric
Gil Moniz	NEMA
Frank Tse	Leviton
Mark Earley	NFPA Staff Liaison

Growth of US Electric Vehicle Charging Stations

Projections for the amount of growth of US Charging Stations varies widely, as do the forecasting entities:

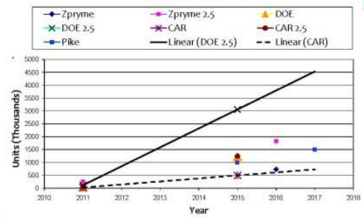
- US Department of Energy's (DOE) Alternative Fuels and Advanced Vehicles Data Center (AFDC) website has data DOEs National Renewable Energy Laboratory (NREL)
- Zpryme is an independent research and consulting firm which provides market research in developing industries
- The Center for Automotive Research (CAR) is a nonprofit organization focused on trends and changes related to the automobile industry
- Pike Research is a market research and consulting firm that provides analysis of global clean technology markets

Growth of US Electric Vehicle Charging Stations

- Using data from these sources, along with their projections for the total amount of charging stations, yields a range of 1.04 to 2.52 Plug-in Electric Vehicles (PEVs) per station based on the Pike Research estimate of total charging locations
- This range is validated by Accenture, a global management consulting, technology services and outsourcing company, which projects 2 stations per vehicle at full deployment
- Using the number of cars from each organization as a base, and then multiplying this by 2.5 charging stations per vehicle establishes an upper boundary for the number of charging stations
- The Pike Research data is used without modification

Growth of US Electric Vehicle Charging Stations

Charging Station Forecast



THE FIRE PROTECTION RESEARCH FOUNDATION — CAL POLY FIRE PROTECTION ENGINEERING

Characteristics of PHEVs, EREVs, and BEVs[1]

	Plug-in hybrid electric vehicle (PHEV)	Extended range electric vehicle (EREV)	Battery electric vehicle (BEV)
Wheels powered by	Gasoline engine and/or electric motor	Electric motor	Electric motor
In-car electricity source	Battery	Battery and/or generator	Battery

1 http://www.goelectricdrive.com

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Manufacturer Release of PEVs and PHEVs[1]

Manufacturer/Model	Year				
	2010	2011	2012	2013	2016
Plug-in Electric Vehicles (PEV)					
• Mitsubishi i	X				
• Nissan LEAF	X				
• Ford TRANSIT connect electric	X				
• Tesla Motors Roadster Sport 2.5	X				
• Zero Motorcycles Zero S	X				
• Brammo Enertia	X				
• TH!NK City		X			
• Coda Automotive Sedan		X			
• Tesla Motors Model S		X			
• Ford Focus electric		X			
• BMW ActiveE		X			
• Fiat 500 minicar			X		
• Audi e-tron			X		
• Honda Fit EV			X		
• Audi R8 EV			X		
• Mercedes SLS E-Cell AMG				X	
• Volkswagen Golf Blue-e-motion				X	
• BMW i3				X	
• Tesla Motors EV					X

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Manufacturer Release of PEVs and PHEVs[1]

Manufacturer/Model	Year				
	2010	2011	2012	2013	2016
Plug-in Hybrid Electric Vehicles (PHEV)					
• Chevy Volt Extended Range EV	X				
• Toyota Plug-in Hybrid	X				
• BYD F3DM Plug-in Hybrid		X			
• Toyota Prius Plug-in Hybrid			X		
• Bright Automotive IDEA Plug-in Hybrid			X		
• Ford Escape Plug-in Hybrid			X		
• Ford C-MAX Energi			X		
• BMW Vision				X	
• BMW i8					X
• Cadillac Converj					X

1 http://www.electricdrive.org

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Potential NEC Impact of Charging Stations

- Battery meter (for charging rate and voltage) installation requirements
- Meters for power consumption
- Protection against overcharging energy storage systems to prevent failures
- Charging and discharging of PHEVs, PEVs, and other on-site energy storage systems
- Energy management systems
- Cord and Plug connection of the supply equipment (not the car connection) – should there be a limit on the amperage (50A, 100A, etc.)
- EV Ready building infrastructure for a charging station (including conduit/wiring from the electrical panelboard to the charging location); this may include a larger branch circuit capacity to support Level 2 charging
- Maintenance that must be done for public charging stations to keep them safe
- Worker and public safety during charging/discharging (whether at home, work, or a public charging station) could be an active smart grid component through Demand Response; requiring some form of public indication

THE FIRE PROTECTION RESEARCH FOUNDATION — CAL POLY FIRE PROTECTION ENGINEERING

Potential NEC Impact of Vehicle-to-Grid Distribution

- Charging and discharging of Vehicle-to-Grid storage systems
- Cord and plug connection between the utility and the EVSE (i.e., the male end of the plug would be hot)
- Public and electrical worker safety when working on other parts of the electrical system
- Placement of appropriate isolation switches in the system to ensure safety

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Current Industry Specifications

Lvl	Standard: EPRI	SAE (AC)	SAE (DC)	IEC	CHAdeMO
1	120 VAC, 12A or 16A	120V single phase, Configuration current 12A≥16A Configuration power 1.44≥1.92 kW	200-450 V Rated current ≤ 80A Rated power ≤ 36 kW	4 charging "modes" with VAC up to 690V and VDC up to 1,000V	VDC up to 500V and 125A
2	240VAC, 40A	240V single phase Rated current ≤ 80A Rated power ≤ 19.2 kW	200-450 V Rated current ≤ 200A Rated power ≤ 90 kW		
3	480 VAC	Not Finalized*	Not Finalized**		

* > 20 kW, single phase and 3 phase proposed

** the current standard has the potential for 200-600 VDC at a maximum of 400 amps and 240 kW

Summary of PEV Vehicle Specifications

Vehicle	Type	Battery Capacity	Charge Power (max rated capacity / stated charge time)	Charge Time	Range
Zero S	Motorcycle	4.4kWhr	(1.9) kW	2.3 hrs	43 mi
Leaf	Sedan	24kWhr	3.3 to 6.6 (3 to 6.8) kW	3.5to 8hrs	62 to 138 mi
Transit Connect EV	Van	28kWhr	(3.5 to 4.7) kW	6 to 8 hrs	50 to 80 mi
Tesla	Sports Car	56kWhr	(16)kW	3.5 hrs	245 mi

Summary of PHEV Vehicle Specifications

Vehicle	Type	Battery Capacity (useable)	Charge Power [max rated capacity / stated charge time] (based on useable)	Charge Time (AC Level 1)	Total Range per Tank (Electric Only) [EPA]
Volt	Sedan	16 (10.4) kWhr	3.3 [4 (2.6)] kW	4 hrs	375 ([35]) mi
Prius	Sedan	5.2 (3.8) kWhr	[3.47 (2.53)] kW	1.5 hrs	475 (14) mi
F3DM[1,2]	Sedan	16kWhr	[2] kW	(8) hrs	360 (40-60) mi

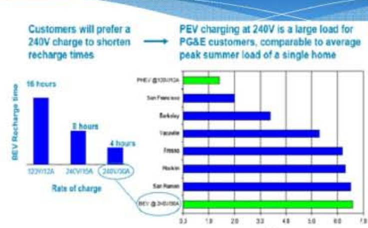
[1] http://www.nytimes.com/2011/02/20/automobiles/autoreviews/byd-f3-dm-review.html?pagewanted=1&_r=1

[2] http://en.wikipedia.org/wiki/BYD_F3DM

Comparison of PEV Registration in Two Locations

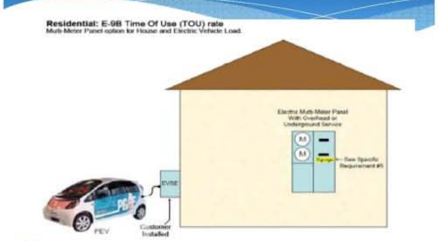
Location	Amount of New Registrations	Amount of PEV Registrations	Percentage of PEV to new registrations	Median amount of PEV registrations within Zip Code
Fresno, CA	83,000	2,000	2.4%	11
Berkeley, CA	14,000	2,500	18%	212

PEV Charging and Increase in Electrical Load for PG&E Customers[1]



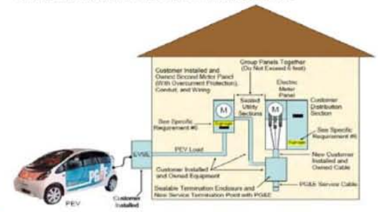
1 http://www.electricdrive.org

Residential Single Meter Option



Residential Two Meter Option

Residential: E-9B Time Of Use (TOU) rate
Second Meter Panel Option Connected to Existing Meter Panel, Underground Service



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Effect of Increased Deployment of PEVs & PHEVs

The geographical clustering of charging stations, charging voltage/duration preferences, single versus multiple EV charging, and rate structure/metering options collectively result in the potential for a wide range of implications for electrical infrastructure wiring, overcurrent protection, and load management

Hopefully, clarity will develop as battery technology improves, utility costs are determined, and customer desires become more defined

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Impact of Increased Deployment of PEVs & PHEVs

- Dramatic increase in load relative to typical residential usage
- Dramatic increase in load relative to typical commercial usage in some cases, such as where charging is offered to customers and/or employees
- Infrastructure upgrades necessitated by geographic grouping of PEVs & PHEVs
- Increased communication wiring, especially if two-way power exchange becomes common
- Interface between charging stations and smart meters or EMS
- Revised venting requirements due to different battery chemistries
- Overcurrent protection
- Load management
- Harmonics induced by charging stations
- Voltage flicker due to charging station load
- DC charging installations, especially where DC generation or storage, such as where Photovoltaic Cells (PV) are present

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Specific NFPA Articles Which May Be Affected

- NFPA 70 articles include:
  - Article 210 Branch Circuits
  - Article 215 Feeders
  - Article 220 Branch Circuit, Feeder, and Service Calculations
  - Article 230 Services
  - Article 240 Overcurrent Protection
  - Article 250 Grounding and Bonding
  - Article 625 Electric Vehicle Charging Stations
- NFPA 70E articles include:
  - Article 120 Establishing an Electrically Safe Work Condition
  - Article 320 Safety Requirements Related to Batteries and Battery Rooms

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Identification of Other Standards

- Underwriters Laboratories, Inc (UL)
  - UL 2202 Standard for Electric Vehicle (EV) Charging System Equipment
  - UL 2231, Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits
  - UL 2251 Standard for Plugs, Receptacles and Couplers for Electric Vehicles
  - UL 2271 Batteries for use in Light Electric Vehicle (LEV) Applications
  - UL 2594 Electric Vehicle Supply Equipment
- The Society of Automotive Engineers (SAE)
  - J1772 – SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler

THE FIRE PROTECTION RESEARCH FOUNDATION — CAL POLY FIRE PROTECTION ENGINEERING

Electrical Vehicle Charging and NFPA Electrical Safety Codes and Standards

THANK YOU!

THE FIRE PROTECTION RESEARCH FOUNDATION — CAL POLY FIRE PROTECTION ENGINEERING

National Electrical Code Update

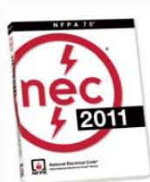
Mark W. Earley, P.E.
Chief Electrical Engineer
National Fire Protection Association

What is the National Electrical Code?

- Also known as the NEC ® or ANSI/NFPA 70
- There are two electrical codes that govern electrical installation
  - The National Electrical Safety Code®–governs electrical and communications utility installations
  - The National Electrical Code®–governs electrical installations in the built environment

History

- First edition issued in 1897
- There have been 52 editions
- Since 1953, the NEC has been issued every three years
- Adopted into law



National Electrical Code® Articles on Alternative Energy

- Article 480–Batteries
- Article 625–Electric Vehicle Charging Systems
- Article 690–PV Systems
- Article 692–Fuel Cells
- Article 694–Small Wind Systems
- Article 625–Electric Vehicles
- Article 705–Interconnected Electrical Power Production Sources

Involvement with Electric Vehicles

1994

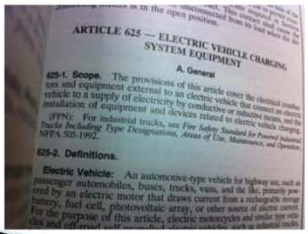
Today

National Electrical Code®

- Does not contain requirements for electric vehicles
- Does contain requirements for the charging infrastructure

1

Article 625–Code-Making Panel 12



National Electrical Code®–2014

- Electric Vehicles Task Group
  - Chair, Gery J. Kissel –General Motors
  - Thomas R. Brown, Intertek Testing Services
  - Thomas L. Hedges, Hedges Electric
  - Jeffrey L. Homes, IBEW Local Union 1 JATC
  - John R. Kovacik, Underwriters Laboratories
  - Todd Lottmann, Cooper Bussmann
  - Jeffrey Menig, General Motors
  - Jose Salazar, Southern California Edison (EEI)
  - David Sher, City of Bellevue
  - Lori Tennant, Square D Company/Schneider

Current Activity

- Two Tentative Interim Amendments
- Proposed rewrite of Article 625 for 2014 Edition

625.13 Electric Vehicle Supply Equipment Connection

NFPA 70®-2011
National Electrical Code®
TIA Log No. 1037
Reference: 625.13
Comment Closing Date: September 9, 2011
Submitter: Gery Kissel, General Motors Corp.

1. Revise 625.13 as follows:

625.13 Electric Vehicle Supply Equipment Connection. Electric vehicle supply equipment shall be permitted to be cord and plug connected to the premises wiring system in accordance with one of the following:

(A) Electric vehicle supply equipment intended for connection to receptacle outlets rated at 125 volts, single phase, 15 and 20 amperes.
(B) Electric vehicle supply equipment that is rated 250 volts maximum and complies with all of the following:
(1) It ~~is installed indoors and or~~ part of ~~a system identified and~~ listed system ~~as suitable for the purpose and~~ meeting the requirements of 625.18, 625.19, and 625.29 ~~shall be permitted to be cord-and-plug connected.~~
(2) It is intended for connection to receptacle outlets rated no more than 50 amperes.
(3) It is installed to facilitate any of the following:
a. Ready removal for interchange
b. Facilitate maintenance and repair
c. Repositioning of Portable, movable, or EVSE fastened in place
(4) Power supply cord length for electric vehicle supply equipment fastened in place is limited to 6 ft (1.8 m).
(5) Receptacles are located to avoid physical damage to the flexible cord.

All other electric vehicle supply equipment shall be permanently connected to the premises wiring system ~~and fastened in place.~~ ~~This~~ The electric vehicle supply equipment shall have no exposed live parts.

625.14 Rating

NFPA 70®-2011
National Electrical Code®
TIA Log No. 1038
Reference: 625.14
Comment Closing Date: September 9, 2011
Submitter: Gery Kissel, General Motors Corp.

1. Revise 625.14 as follows:

625.14 Rating. Electric vehicle supply equipment shall have sufficient rating to supply the load served. ~~For the purposes of this article, e~~Electric vehicle charging loads shall be considered to be continuous loads for the purposes of this article. Where an automatic load management system is used, the maximum electric vehicle supply equipment load on a service or feeder shall be the maximum load permitted by the automatic load management system.

Status of TIAs

- Have passed all committee balloting
  - CMP 12
  - National Electrical Code® Technical Correlating Committee
- If issued the TIAs become proposals for the 2014 code

Active EV Task Group Activities

- 625.9 Electric Vehicle coupler
- 625.15 Markings
- 625.17 Cables
- 625.22 Personal Protection System
- 625.26 Interactive Systems
- 625.29 Indoor sites
- 625.30 Outdoor sites
- Proposed Article reformat
- 625.XX EVSE Level 1 and Level 2 Ready Circuits

National Electrical Code® Proposals

- Closing date is Friday November 4 at 5PM EST
- Anyone may submit a proposal
- If you believe that a change is necessary, please submit a proposal.

Critical Points in NEC Processing Schedule

Note: The individual CMP meeting dates have not yet been established.

Thank you!

It can't happen without your input!

Consumers Energy
Count on Us

Utility Perspectives

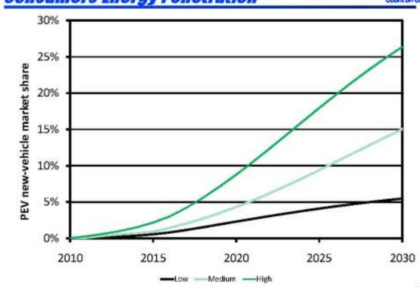
Electric Vehicle Safety Standards Summit 2011

Company Profile

- The Utility
  - Principal subsidiary of CMS Energy
  - 7,000+ employees
  - $6.8B in annual sales
- Electric and Gas Service
  - 1.8 million electric customers
  - 1.7 million gas customers
  - 70,000 miles of electric lines
  - 27,000 miles of pipelines
- Generation
  - 37,000 GWh (49% purchased)
  - Fleet of 28 facilities/plants
  - Mix of coal, natural gas and hydro
- Serving Michigan families and businesses since 1886
- Serving all 68 Lower Peninsula counties

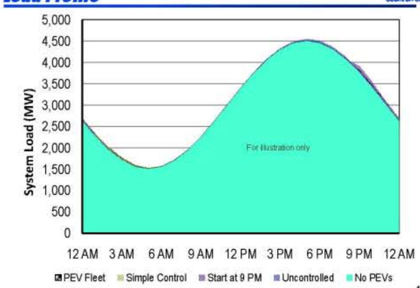
2

Consumers Energy Penetration



3

Load Profile



4

Statewide Public Charging Stations

Consumers Energy is installing charging stations at select service centers across the state. Locations Include: Corporate HQs in Jackson and service centers in Jackson, Lansing, Grand Rapids, Royal Oak and Kalamazoo.

5

Consumers Energy's Approach

- Customer Support
  - PEV expert network
  - Call Center/ Interactive Voice Recognition (IVR)
  - Web Site
- PEV Rate Development
- PEV Incentive Plan Development
- Internal processes/workflow
  - Customer account setup
  - Time of Use (TOU) metering and meter reading
  - Correct billing
- Grid Impacts
- Michigan PEV Taskforce

Customers will contact us either by phone or email
- Phone: (877) 904-9246
- E-mail: electricvehicleinfo@cmsenergy.com
- Website : www.consumersenergy.com/pev

Consumers Energy will provide up to $2500 to cover the cost of purchase, installation and home wiring of a charging station

6

Michigan PEV Readiness

- Michigan is a leader in PEV development, manufacture and readiness
- MPSC PEV Preparedness Taskforce
  - Promote Michigan as a leader, seamless customer transition
  - Diverse stakeholders: auto manufacturers, MPSC staff, various utilities, electrical inspectors and contractors, environmental groups, not-for-profit groups
  - Developing recommendations for statewide implementation

Plug-In Michigan

www.pluginmichigan.org

7

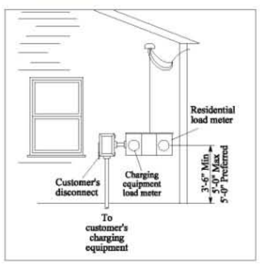
Michigan PEV Readiness

- EVITP Electric Vehicle Infrastructure training program (electrician training certification)
- Outreach to Electrical contractors and inspectors
- Legislative Event
  "House and Senate Energy and Technology Committees"
- Code Change
  MI Res Building Code E3501.6.4

Plug-In Michigan

8

2nd Meter Recommended Configuration



A separate service disconnect for electrical vehicle charging systems shall be permitted. The disconnect shall be located immediately adjacent to the outdoor meter cabinet. A permanent plaque or directory shall be installed at each service disconnect location denoting the other services, feeders, and branch circuits supplying a building or structure and area served by each service, feeder, and branch circuit. The disconnect shall not be required to be grouped with the service disconnects for the structure.

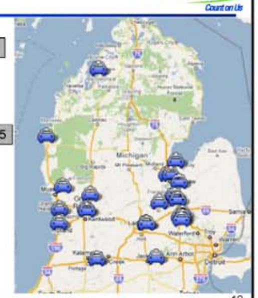
9

PEV Installations

Customers on the new rates: 26*

Customers with meters ordered: 15

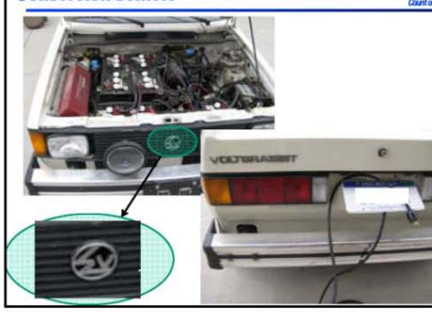
Other known buyers: ~25



*includes company employees

10

Conversion Vehicle

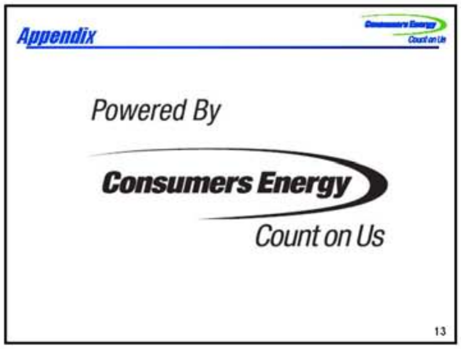


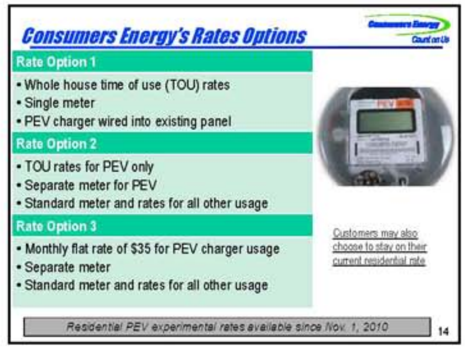
11

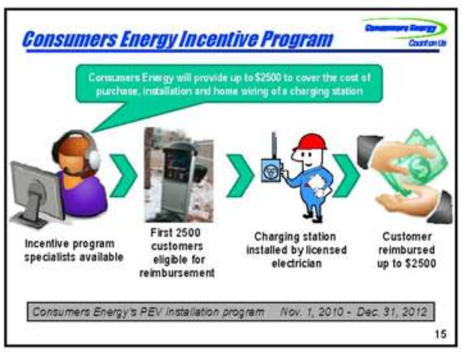
Thank You!

Seth Gerber
Electric Vehicle Program Manager
sdgerber@cmsenergy.com

12


Appendix
Powered By
Consumers Energy
Count on Us
13


Consumers Energy's Rates Options
Rate Option 1
• Whole house time of use (TOU) rates
• Single meter
• PEV charger wired into existing panel
Rate Option 2
• TOU rates for PEV only
• Separate meter for PEV
• Standard meter and rates for all other usage
Rate Option 3
• Monthly flat rate of $35 for PEV charger usage
• Separate meter
• Standard meter and rates for all other usage
Customers may also choose to stay on their current residential rate
Residential PEV experimental rates available since Nov. 1, 2010
14


Consumers Energy Incentive Program
Consumers Energy will provide up to $2500 to cover the cost of purchase, installation and home wiring of a charging station
Incentive program specialists available
First 2500 customers eligible for reimbursement
Charging station installed by licensed electrician
Customer reimbursed up to $2500
Consumers Energy's PEV installation program Nov. 1, 2010 - Dec. 31, 2012
15


Fleet Electric Vehicles
PEVs added to Consumers Energy fleet
Hybrid electric service truck
10 Chevrolet Volts in 2011 (first delivery in March)
2 Ford Transit Connects in 2011
5 service trucks part of 2011 EPRI study
Consumers Energy Volt
Consumers Energy hybrid service truck
16

Electric Vehicle Supply Equipment (EVSE) Standardization

Ken Boyce
2nd Annual Electric Vehicle Safety Standards Summit
September 27, 2011

© 2011 Underwriters Laboratories Inc.

Electric Vehicle Supply Equipment

NEC Section 625.2:

Electric Vehicle Supply Equipment. The conductors, including the ungrounded, grounded, and equipment grounding conductors and the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

2

UL actively engaged with SAE on systems approach to EV safety standards

3

UL Standards

UL has developed and published numerous product safety standards for EV infrastructure equipment, with adjustments as needed for technology

Focus on publication of American National Standards

UL develops standards using a consensus process, with input from balanced stakeholders on our Standards Technical Panels

4

EVSE

Subject 2594/UL 2594 covers EVSE rated 250 V ac maximum. Intended to provide power to an electric vehicle with an on-board charging unit

UL 2202 covers EV chargers with DC output intended to provide power to the on-board battery

5

Plugs, Receptacles, and Couplers

ANSI/UL 2251 covers EV plugs, receptacles, vehicle inlets, vehicle connectors, and breakaway couplings

Rated ≤800 A and <600 Vac or dc

Indoor/outdoor nonhazardous locations

Complements SAE J1772 form factor & charge protocols

6

1

Personnel Protection Systems & cables

ANSI/UL 2231-1 and -2 cover Personnel Protection Systems that to reduce the risk of electric shock to the user from accessible parts, in grounded or isolated circuits for charging electric vehicles

ANSI/UL 62 covers Type EV cables

EVSE/infrastructure certification

EVSE subject to compliance with NFPA 70/NEC compliance, including Article 625

UL Listing assures compatibility with NEC

UL has well-established and recognized certification programs for EVSE equipment and subassemblies

Ongoing EVSE Standards Initiatives

North American harmonization

Wireless charging systems

North American Harmonization

UL, CSA and industry working to co-publish bi-national standards for EVSE, couplers, and personnel protection systems that will be applicable in both the US and Canada

Target publication is January 2012

Mexico harmonization activities are also in process for tri-national

Wireless Charging

Wireless charging is an area of great interest for new product development

Must address safety concerns about fire & shock hazards, human exposure, and functionality issues

UL developing safety requirements in UL Subject 2750; SAE developing interoperability, design & communication requirements in SAE J2954

Summary

EVSE safety standards are well established

Extending requirements to Canada and Mexico

Future focus is on defining wireless charging safety and protocols, correlating with SAE standards

Thank you.

kenneth.p.boyce@ul.com
847.664.2318

Electric Vehicle Safety Standards Summit 2011 SEP 27

Electric Vehicle Towing, Road Service and Recovery

Tow Times Magazine Surveyed 9000 Towers across U.S.A.

- 85 % of respondents have towed a hybrid.
- 48% consider towing a hybrid more difficult.
- 65 % have had some hybrid training.
- 84 % are concerned with the potential of injury from the HV system and liability for damage to the electical system.
- 16% refuse hybrid tows because of risks.

Tow Operator's Major Concerns

- Towability, Recovery and Emergency Road Service as an afterthought in design, engineering and manufacturing. Towers are the sole responders in 95 % of road side incidents.
- Hybrid design considerations hinder quick clearance Traffic Incident Management goals.
- Low payments for warranty tows and service with a higher risk of damage discourages tower interest .

Tow Operator's Major Concerns

- Towing and Recovery Damage Liability
- Post Incident/Crash Recovery and Transport
- Electrocution Hazards, Thermal Runaway
- Electric/Sensor Damage from Towing
- Lack of Clear Concise Towing and Road Service Information Availability

Towing and Recovery Damage Liability

- Lack of adequate Recovery Attachment Points:
  - Accessible front and rear recovery points are needed.
  - Suspension components are not adequate for recovery.
  - Dual purpose Transport Loading and Recovery.
- Low Ground Clearance:
  - Loading time and labor to load and secure the vehicle.
  - Loading vehicles with flat tires.
- Damage to Sensors or Electric Drive Motors
  - Who pays for fault indicator resets?

Post Incident/Crash Towing and Recovery

- Is there a true NEUTRAL for recovery or winching?
- Is there an override if the vehicle is electrically dead?
- Recovery of undamaged vehicles off the road.
  - Recovery damage to ground effects and suspension.
  - Electric components and sensor damage or resets.
- Loading and Safe Transport.
  - Self energizing and moving while loading or unloading.
  - Sensor faults from transport loading.
  - Auto starting during transport.

Post Incident/Crash Towing and Recovery

- Can the High Voltage be disconnected or disabled to minimize the risk during transport and storage?
- Severe crash damage and post crash stability.
  - Electrocution risk from shorted or cut HV components.
  - Chemical stability of HV battery systems. Neutralization and secondary site contamination. Thermal runaway.
- Immersion or submersion recovery.
  - Risks from shallow water exposure.
  - Risk to rescue/recovery diver from submerged HV vehicle?

Post Incident/Crash Towing and Recovery

- Is the vehicle electrically stable post extrication?
- Can the vehicle be completely shut down or drained.
- Post accident fire risk.
  - Electrical shorts from cuts or chafing, thermal runaway?
- Fire risk and secondary contamination.
  - Chemical contamination from burned batteries.
  - Post extinguished inhalation hazards or rekindling?

Electrocution Risks

- The High Voltage system is not clearly understood. Basic PPE requirements?
- Severe weather, rain, humidity, water exposure and electrical shorting.
- Challenges in training and education for the industry. Tower education level and dissemination of information.

Electrical System Damage

- Damage to electrical motors from non powered movement.
- System faults from towing or recovery.
- Synchronization faults from towing without keys. Impounding or recovery winching.
- Unattended engagement while loading.

Training and Vehicle Handling Information

- Road Service and towing information is not readily available to towers.
- Training to date has very limited penetration in towing community with the current information.

Next Steps for Towing and Recovery

- Manufacturer clarification of road service and safe towing/transport/storage procedures.
- Manufacturing, engineering and design upgrades and improvement.
- Industry wide dissemination of the most current and reliable information.


Contact Information
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Local: 703-684-7713
Fax: 703-684-6720
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@towtimes.com
407-327-4817

3

ZURICH

Lithium ion batteries
Property insurance perspective

September 28, 2011
Richard Gallagher
Zurich Services Corporation

Risk Engineering

Photo source: Kristina A. Kreutzer

Zurich HelpPoint

Objectives

ZURICH

- Share the property insurer perspective on Li-ion batteries
- Share information regarding a Li-ion battery project
  - Sponsored by the Property Insurance Research Group
  - Under the direction of the Fire Protection Research Foundation

Photo source: NTSB

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Property Insurance Research Group

ZURICH

- PIRG members include 8 major property insurers
  - CNA
  - FM Global
  - Liberty Mutual
  - Travelers
  - Tokio Marine
  - Torus
  - XL GAPS
  - Zurich

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Property insurer focus

ZURICH

- Li-ion batteries in bulk storage

Photo source: FEMA

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Bulk storage

ZURICH

- Includes palletized storage on the floor
  - Just-in-time delivery of packs to a vehicle assembly plant

Photo source: FEMA

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Bulk storage

ZURICH

- Includes rack storage 15' or 20' tall
  - Cell manufacture finished goods storage
  - Battery pack assembler raw materials and finished goods

Photo source: FEMA

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Bulk storage

- Includes rack storage over 20' tall
  - Raw materials storage for consumer goods assembly
  - Large format pack held in an aging process

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Why the concern with bulk storage

- Reports of Li-ion battery fires
  - Laptop battery pack failures that lead to fire
  - Li-ion batteries suspected causing cargo aircraft fires
- These lead to the compelling question
  - Can Li-ion batteries be a source of fire in bulk storage?

Photo source: FAA

Photo source: NTSB

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Resolving the compelling question

Identify	Research	Influence codes and standards
Can Li-ion batteries start fires in bulk storage?	Pursue a testing program	Share research findings with NFPA and others
What protection is needed?	Develop protection scheme	Influence code making

Photo source: NTSB

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Lithium ion battery project
High level research goal

- Understand Li-ion battery ignition sources and fire control solutions
  - Ignition sources under consideration
    - Internal ignition
      - Cell level thermal runaway with fire propagation
    - External ignition
      - Fires spreading to battery storage

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Internal ignition source

- Develop a test method to classify batteries considering factors such as:
  - Ability to initiate a fire
    - State of charge
  - Ability to propagate a fire
    - Packaging
- Consider:
  - Cells, small packs, large packs

> There is no intent to understand proprietary knowledge such as cell chemistries or pack designs.
> Proposal is a relative classification that will guide fire protection needs.

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External ignition source

- Develop commodity classifications
  - Cells, packs, consumer goods containing batteries
- Understand packaging needs
  - Identify if packaging plays an important role
- Be aware of reignition potential
  - Special considerations may be needed
- Identify potential rocketing behavior
  - Do cells behave similar to aerosol containers
- Develop protection approaches
  - Determine effective agents, validate approaches with large-scale testing
- Identify environmental concerns (fire protection water runoff)
- Identify fire service challenges (battery voltage, overhaul methods)

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Summary
ZURICH
General focus - property protection
Lithium ion battery project focus - bulk storage protecti
Project goals
Classify batteries for internal fire ignition
Classify batteries as a fire protection commodity
Understand role of packaging for bulk storage fire contro
Understand battery behaviors – reignition, rocketing
Develop protection methods (automatic and manual)
Understand environmental concerns
Photo source: NTSB
Risk Engineering
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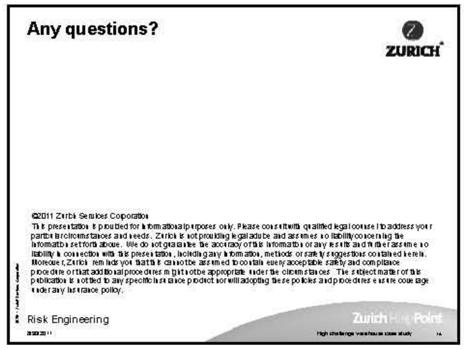
Any questions?
ZURICH
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NREL

Clean Cities and Electric Vehicles

2nd Annual Electric Vehicle Safety Summit

Detroit, MI

Carl Rivkin, P.E.

September 27, 2011

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

DOE's Clean Cities Program

Clean Cities is the U.S. Department of Energy's (DOE) flagship transportation deployment program. Formed in 1993 under the Energy Policy Act (EPAct) of 1992,

Replace petroleum with alternative and renewable fuels
Reduce petroleum use through smarter driving practices, idle reduction, and fuel-efficient vehicles
Eliminate petroleum consumption through the use of mass transit, trip-elimination measures, and congestion mitigation.

100 coalitions across the US that encompass more than 228 million people

Extensive information on alternative fuel technologies including electricity which is classified as an alternative fuel

Support EV Deployment

Basic information on electrical hazards
(Link) http://www.afdc.energy.gov/afdc/fuels/electricity.html

Basic Information on EVs

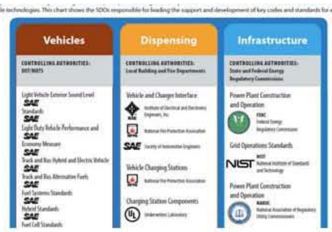
(link) http://www.afdc.energy.gov/afdc/vehicles/electric.html

Basic Information on Stations
(link)
http://www.afdc.energy.gov/afdc/fuels/electricity_locations.html

Training and Education

E-Tools
Using the Alternative Fuels and Advanced Vehicles Data Center
Using the GREET Fleet Footprint Calculator
Using the Alternative Fueling Station Locator (AFDC)
Using the Petroleum Reduction Planning Tool (AFDC)
Using the TransAtlas Tool (AFDC)
Using the Data, Analysis, and Trends Section (AFDC)
Coordinator Basics
Collecting Data for the Alternative Fuel Price Report
Completing the Clean Cities Annual Report
Conducting Media Outreach
Giving an Interview
How to Use the Clean Cities Technical Response Service
Running Effective Meetings
Laws and Regulations
Understanding EPAct-Regulated Fleets
Understanding the Federal Rulemaking Process
Understanding the Renewable Fuels Standard
Understanding the State Rulemaking Process
Vehicle and Fuel Technologies
Compressed Natural Gas in Municipal Fleets
Electric Drive Vehicles: Overview and Impacts
Heavy-Duty Vehicle Idle Reduction
Improving Gas Mileage
Understanding Emissions

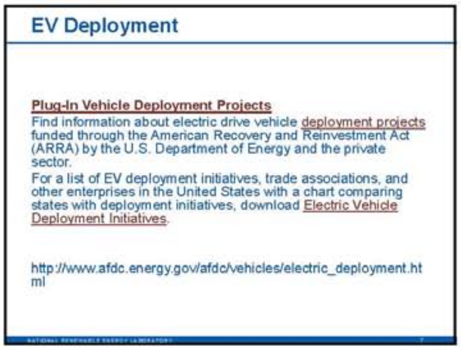
AFDC Codes and Standards Resources



AFDC Codes and Standards Resources

	Organization Name		Standards Development Areas
	AGA	American Gas Association	Materials testing standards
	API	American Petroleum Institute	Equipment standards for petroleum production, storage and handling
	ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers	Promoting sustainability through research, standards writing, publishing, and education
	ASME	American Society of Mechanical Engineers	Mechanical and multidisciplinary engineering design codes and standards
	ASTM	American Society for Testing and Materials	Technical test standards for materials, products, systems
	CGA	Compressed Gas Association	Equipment design and performance standards for compressed gas systems and components
	CSA	CSA Standards	US and Canadian equipment standards
	DOT	Department of Transportation	Federal transportation regulatory agency
	FERC	Federal Energy Regulatory Commission	Regulates interstate transmission of electricity, gas, and oil
	GTI	Gas Technology Institute	Supplies technical support and training for the energy industry
	ICC	International Code Council	Family of model building codes, including the International Fire Code
	IEEE	Institute of Electrical and Electronics Engineers	Electrical standards
	NERC	North American Electric Reliability Corporation	Produces standards for electric grid operation
	NFPA	National Fire Protection Association	Model codes and standards, including the National Electric Code
	NIST	National Institute of Standards and Technology	Measurement standards
	SAE	Society of Automotive Engineers	Vehicle standards
		National Association of Regulatory Utility	

1


EV Deployment
Plug-In Vehicle Deployment Projects
Find information about electric drive vehicle deployment projects funded through the American Recovery and Reinvestment Act (ARRA) by the U.S. Department of Energy and the private sector.
For a list of EV deployment initiatives, trade associations, and other enterprises in the United States with a chart comparing states with deployment initiatives, download Electric Vehicle Deployment Initiatives.
http://www.afdc.energy.gov/afdc/vehicles/electric_deployment.html


Clean Cities PEV Deployment Tools
Customer hires a certified or licensed electrical contractor.
STANDARD PERMIT PROCESS
LIMITED SERVICE AND REPAIR PERMIT PROCESS
Contact building permit department and local utility.
Installation plan.
Installation plan.
Install Electric Vehicle Supply Equipment (EVSE) and prepare site.
Users charge vehicles.
INSTALLATION CHECKLIST
❑ Place order
❑ Select charger
❑ Hire contractor