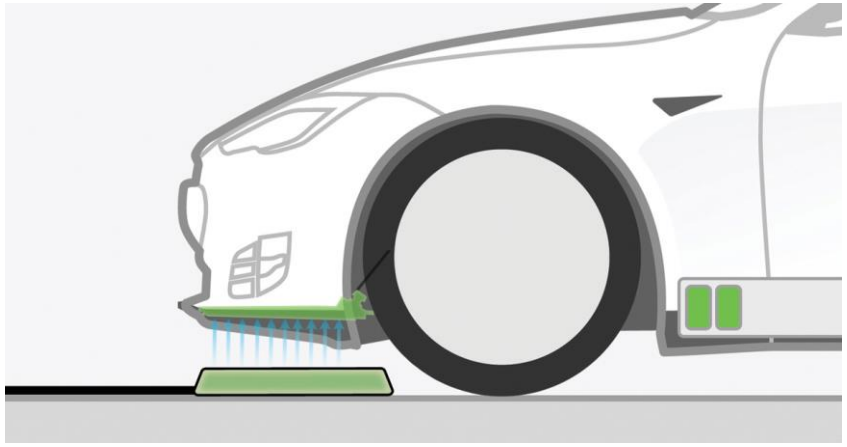
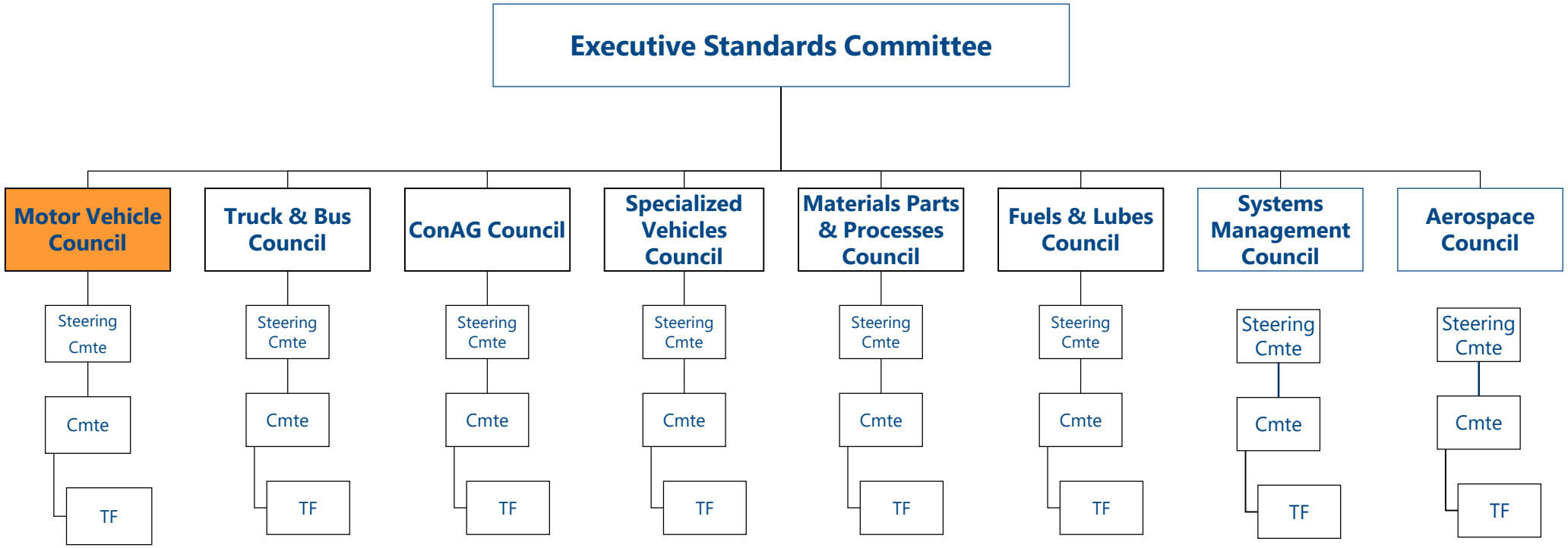


An Overview of SAE International Standards Activities Related to Hybrid / Electric Vehicles

Keith Wilson
Technical Program Manager,
Ground Vehicle Standards

Global Ground Vehicle Standards Structure



- 145,000+ SAE members worldwide
- Representatives from 100 Countries

- 8,375 GV Standards Published
- 1,817 GV Standards Maintained
- 491 GV WIP Standards

- 564 GV Technical Committees
- 8,800 GV Committee Members

- 2,900 Companies
- Representatives from 50 Countries

SAE EV, Hybrid & Fuel Cell Vehicle Standards Development

SAE EV / Hybrid Vehicle Steering Committee

- Started – 2005
- Current Committee Membership
  - > 1100 Individual Participants
  - > 500 Companies
    - OEM's
    - Suppliers
    - Government
    - Academia
- 10 EV / Hybrid Vehicle Subcommittees
- 4 Fuel Cell Standards Subcommittees
- 66 SAE EV, Hybrid, Fuel Cell Vehicle Standards Published to Date

61 SAE EV, Hybrid, Fuel Cell Vehicle Standards:

Fuel Cell Fueling: J2600, J2601, J2601/1. J2601/2, J2601/3,J2601/4, J2719, J2719/1, J2799, J1766, J2578, J2579

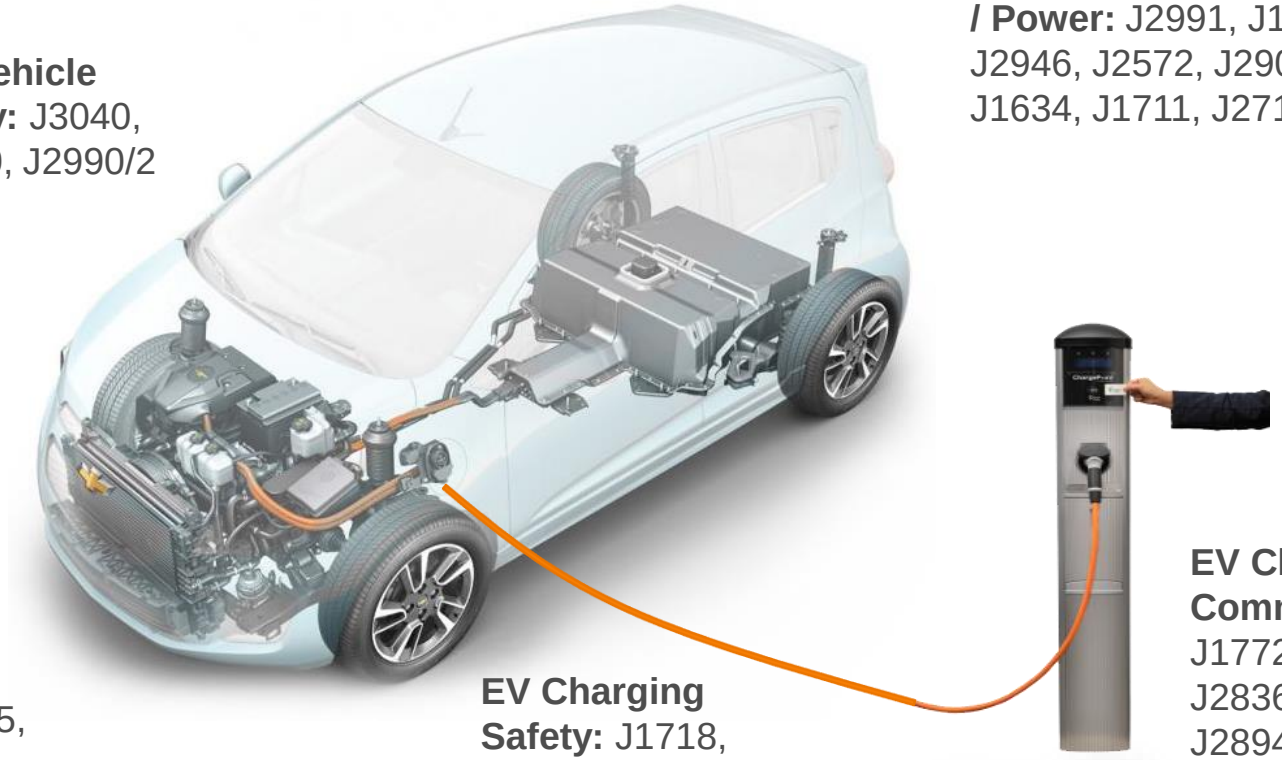
EV / Fuel Cell - Safety: J1766, J2344, J2910, J2990, J2990/1, J3108, J2578, 3108

EV / Fuel Cell Economy, Range / Power: J2991, J1798, J2758, J2946, J2572, J2907, J2908, J1634, J1711, J2711

EV Hybrid Vehicle Crash Safety: J3040, J1766, J2990, J2990/2

Fuel Cell Testing: J2615, J2616, J2617

Fuel Cell Systems: J2579, J2594, J3089



Energy Transfer Systems: J2293, J2293/1, J3072

EV / Fuel Cell Terminology: J1715, J2574, J2760

EV Charging Safety: J1718, J2953/1, J2953/2, J2953/3

EV Charging & Grid Communications: J1772, J1773, J2293, J2836, J2841, J2847, J2894, J2931, J2954, J3068, J3105

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* Blue Font Denotes WIP

SAE EV, Hybrid, Fuel Cell Vehicle Standards Focused on Vehicle Safety

J2990 & J2990/1:

- Emergency Response Guides (Immobilize, Disable, Warnings)
- Vehicle Type Identification (Badging)
- High Voltage Shutdown (Disconnects, Battery & Converter Cables
- Tow & Inspection Guides (Recovery, Isolation, Inspection, Diagnostics)
- Hazard Communication

J2990 - Hybrid and EV First and Second Responder Recommended Practice

J2990/1 - Gaseous Hydrogen and Fuel Cell Vehicle First and Second Responder Recommended Practice

J3108 - xEV Labels to Assist First and Second Responders, and Others (high voltage safety info.)

J2344 - Guidelines for Electric Vehicle Safety (EV, HEV, PHEV and FCV high voltage systems)

J2578 - Recommended Practice for General Fuel Cell Vehicle Safety (fuel cell system, storage & high voltage)

J1766 - Recommended Practice for Electric, Fuel Cell and Hybrid Electric Vehicle Crash Integrity Testing

J2910 - Recommended Practice for Design & Testing Hybrid Electric/Electric Trucks/Buses for Electrical Safety

SAE J1772 Revision 8

Manual AC & DC conductive connection for low and high power levels

Auto OEMs supported moving to higher power levels for charging (8th revision)

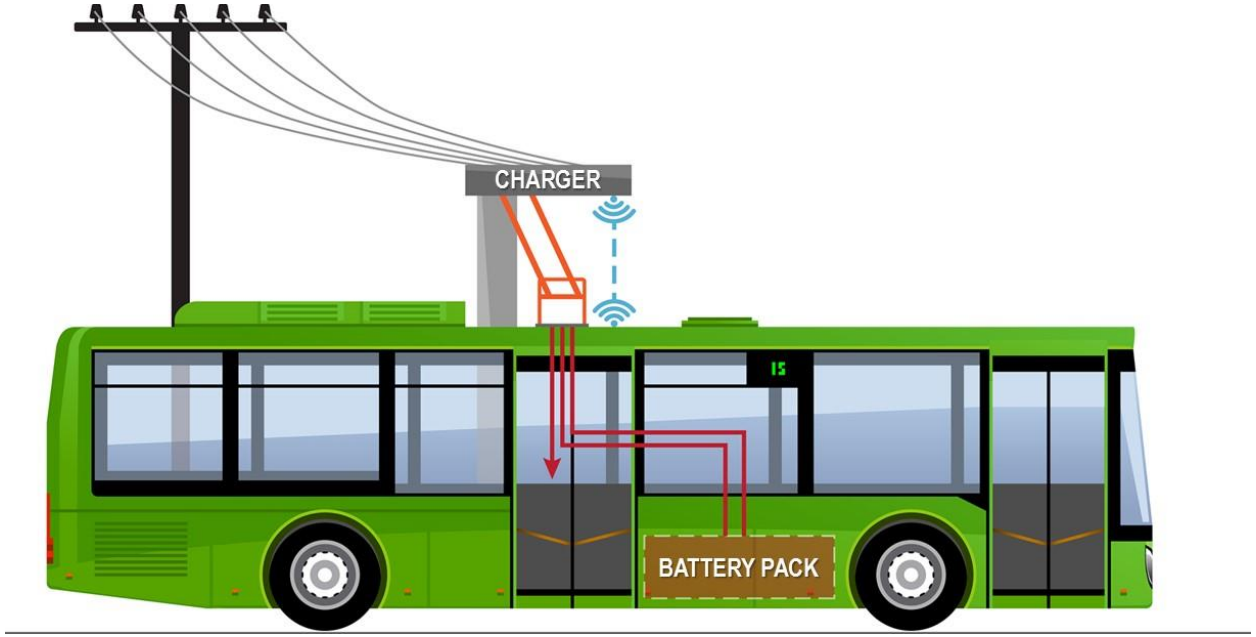
SAE J1772 Task Force has raised the voltage and current limit of the SAE Combo Connector

- Current limit from 200A to 350A
- Voltage limit from 500Vdc to 1000Vdc
- = 350kW Max Power

Publication completed: October 2017

SAE J3105 Overhead & Portal Charging

- Automated charging connection at high power- SAE J-3105
  - Document will standardize the interface between the infrastructure and the bus
  - Targeted towards in-route DC charging, for example to recharge at transit bus during a short stop
  - DC Power Levels (Voltage Range: 250-1,000 DC Volts) up to 1MW



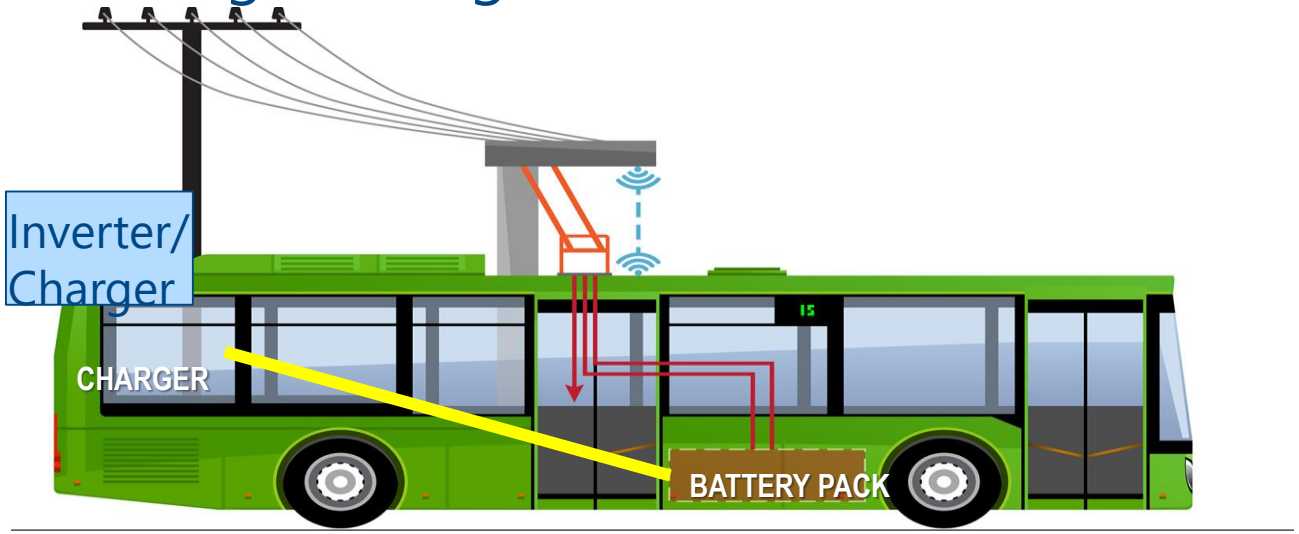
- **DC Power Levels**
- **Power Configurations**
- **Connection Points**
- **Communications**
- **Safety**
- **Alignment Protocol**

SAE J3068 AC Depot Conductive Charging

Depot Charging - 3 Phase AC (J-3068) targeted towards charging at commercial and industrial locations or other places where three-phase AC power is available and preferred such as at commercial and industrial locations (160A 480VAC 3ø = 133kW)

Defines a conductive power transfer method including the digital communication system. It also covers the functional and dimensional requirements for the vehicle inlet, supply equipment outlet, and mating housings and contacts

SAE J-3068 3 phase AC



SAE J2954 Wireless Power Transfer for Light-Duty Plug-In/Electric Vehicles

SAE J2954 establishes minimum performance, interoperability and safety criteria for wireless charging of EVs / PHEVs

SAE J2954 Standard Development

- Inductive Charging Interoperability
- Automated Charging
- Power Transfer Communications
- Smart Grid Interoperability
- Automatic Shutdown Capability
- Autonomous Parking / Charging

Charging Locations:

Residential
Public
On-Road
Static (parking lots, curb side)

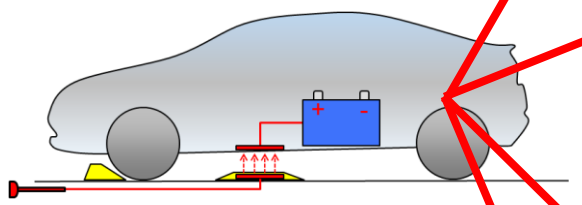
Key aspects:

- Static applications (currently)
- Efficiencies of over 85% (Aligned)
- Air gaps up to 25 cm
- Safety Limits
- Validation Tests

SAE J2954 Task Force Testing Protocols

SAE Standard will Define:

- Performance
- Safety
- Testing Methodologies
- Charge Levels
- Location & Alignment
- Communications



Safety Limits

- **EM Field**
  - EMF Limits with AAMI
  - EMC Limits
- **Performance**
  - Positions / Orientations
  - Efficiency Power Transfer
- **Durability**
  - SAE J1211
  - ISO 16750
  - USCAR 37
- **Safety**
  - Object Detection
  - Temperature Test
  - Automatic Shutdown

SAE J2954 WPT Power Classes			
WPT1	**WPT2**	**WPT3**	**WPT4**
3.7 kW	7.7kW	11 kW	22 kW

SAE EV Charging Communication Standards

SAE Plug-In Electric Vehicle Grid Communication Standards

SAE J2836 ™ Use cases	Scope		Scope	SAE J2847 Detailed Info Messages
/1	Utility Programs *	⟷	Utility Programs *	/1
/2	Off-Board Charger Communications	⟷	Off-Board Charger Communications	/2
/3	Reverse Energy Flow	⟷	Reverse Energy Flow	/3
/4	Diagnostics	⟷	Diagnostics	/4
/5	Customer and HAN	⟷	Customer and HAN	/5
/6	Wireless Charging	⟷	Wireless Charging	/6

- **Series of Standards defining Use Cases, Information Messages and Communication formats**

SAE EV Charging Communication Standards

SAE Grid Communication Standards

SAE J2931	Scope
/1	Power Line Carrier Communications for Plug-in Electric Vehicles
/2	In-Band Signaling Communication for Plug-in Electric Vehicles
/3	PLC Communication for Plug-in Electric Vehicles
/4	Broadband PLC Communication for Plug-in Electric Vehicles
/5	Telematics Smart Grid Communications between Customers, Plug-In Electric Vehicles (PEV), Energy Service Providers (ESP) and Home Area Networks (HAN)
/6	Digital Communication for Wireless Charging Plug-in Electric Vehicles
/7	Security for Plug-in Electric Vehicle Communications

Establishes the requirements for digital communication between Plug-In Vehicles (PEV), the Electric Vehicle Supply Equipment (EVSE) and the utility or service provider

Battery Standards Steering Committee and Technical Committees

- Started – 2009
- Committee Membership
  - >290 Individual Participants
  - >160 Companies
    - OEM's
    - Suppliers
    - Government
    - Academia
- 23 Subcommittees

NEW COMMITTEES

- 24) Electric Vehicle Battery Service
- 20) International Battery Interface

COMPONENTS & MATERIALS

- 23) Battery Systems Adhesives-Sealants-Heat Transfer Materials
- 21) Battery Thermal Management
- 19) Battery Systems Connectors
- 14) Battery Materials Testing

SUPPORT

- 4) Battery Transport
- 12) Battery Testing Equipment
- 13) Battery Terminology
- 3) Battery Labeling

LIFE MANAGEMENT

- 10) Battery Recycling
- 18) Battery Field Discharge & Disconnect
- 15) Secondary Use

PRODUCT SPECIFIC

- 2) Battery Standards Testing
- 1) Battery Safety
- 16) Start-Stop Battery
- 17) Capacitive Energy Storage
- 9) Battery Standards Future Energy Storage Systems
- 5) Battery Size Standardization
- 6) Starter Battery
- 8) Battery Standards Electronic Fuel Gauge

INDUSTRY SPECIFIC

- 11) Small Task Oriented Vehicle Batteries
- 7) Truck Batteries
- 22) Bus Battery

45 SAE Battery Standards Committee Documents

Thermal Management & Adhesives: J3073, J3178

Battery Labeling: J2936

Battery Testing Methodologies: J2758, J2380

Battery Materials Testing: J2983, J3021, J3042, J3159

Battery Secondary Use: J2997

Battery Vibration: J2380, J3060

Battery Transport: J2950

Battery Recycling: J3071, J2974, J2984

Starter & Storage Batteries: J1495, J2185, J240, J2801, J2981, J3060,J537, J930

Battery Life Assessment Testing: J240, J2185, J2288, J2801

Electric Drive Battery Systems Functional Guidelines: J2289

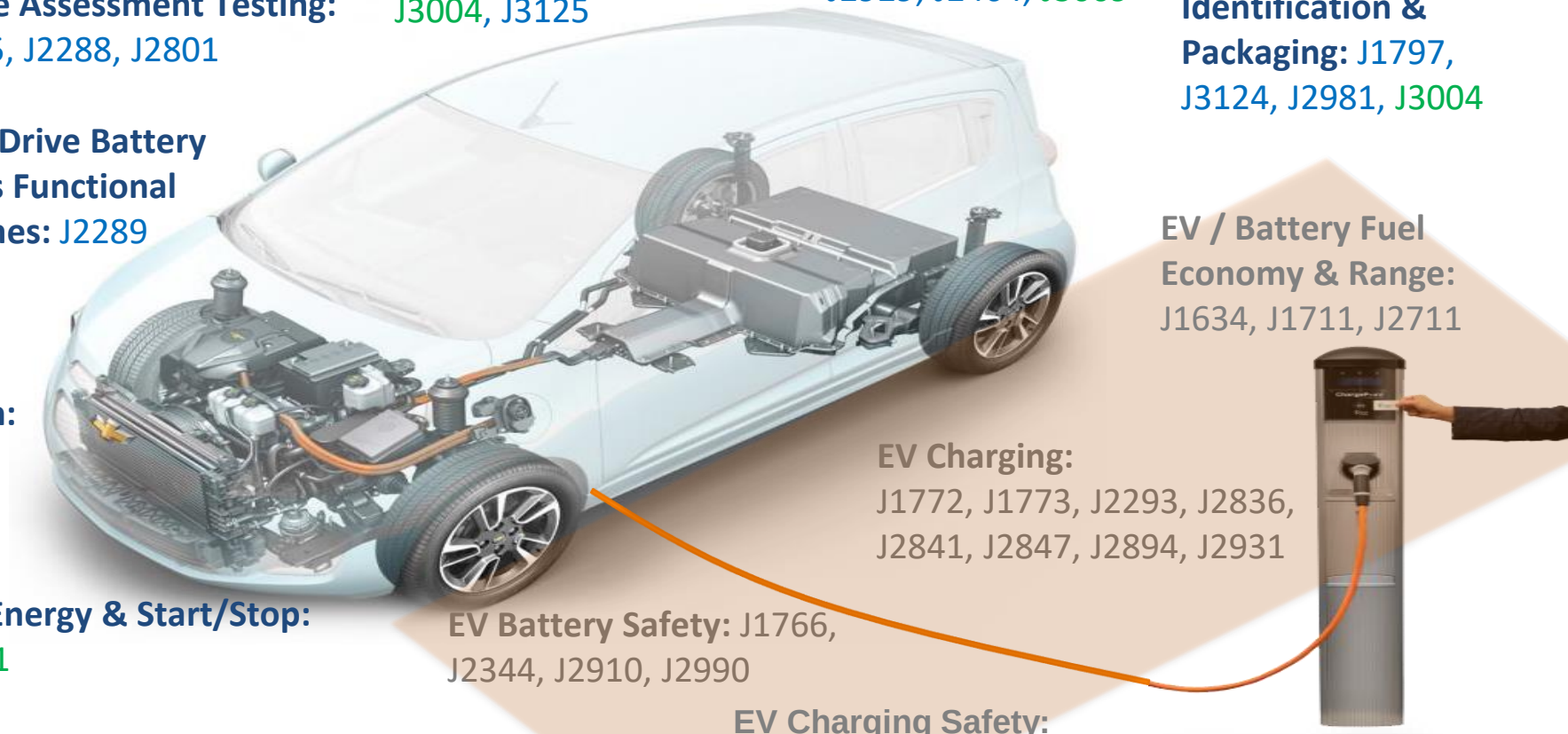
Capacitive Energy & Start/Stop: J3012, J3051

Battery Terminology: J1715/2

Truck & Bus Batterie: J3004, J3125

Battery Safety: J2929, J2464, J3009

Battery Size, Identification & Packaging: J1797, J3124, J2981, J3004



EV / Battery Fuel Economy & Range: J1634, J1711, J2711

EV Charging: J1772, J1773, J2293, J2836, J2841, J2847, J2894, J2931

EV Battery Safety: J1766, J2344, J2910, J2990

EV Charging Safety: J1718, J2953/1, J2953/2, J2953/3

Battery Performance & Power Rating: J1798, J2758

Battery Electronic Fuel Gauging & Range: J2946, J2991

* Green Font Denotes WIP

SAE Low-Speed MicroMobility Devices Committee

New !

Electric Kick Scooter

Electric Skateboard

Segway

Electric Self-Balancing Unicycles

This committee will initially focus on low-speed personal mobility devices and the technology and systems that support them that are not normally subject to the United States Federal Motor Vehicle Safety Standards or similar regulations. These may be device-propelled or have propulsion assistance.

Emerging and innovative mobility vehicles and devices, sometimes referred to as micro-mobility, are proliferating in cities around the world.

These technologies have the potential to expand mobility options for a variety of people. Some of these technologies fall outside traditional definitions, standards, and regulations.

Questions?

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