NEMA Energy Transition Series

Electric Vehicle Conductive Charging standards – Legacy and Future Development

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February 28, 2023

Meet your Presenter

Joe Bablo

- Principal engineering manager, Energy Storage and e-Mobility.
- Principal engineer, Automotive Equipment and Associated Technologies.
- Responsible for technical standards development for electric vehicle (EV) charging, including EV supply equipment, EV chargers and EV couplers.
- Serve as a technical representative for all UL Solutions charging-related standards, as well as all IEC committees for EV charging.
- Serve as Code Making Panel 12 Chairperson for the National Electrical Code®.
- Distinguished Member of Technical Staff, W. H. Merrill Society, with 27 years at UL Solutions.

Agenda

- Legacy Standards
- Future Development areas
- Wrap Up

Legacy Standards

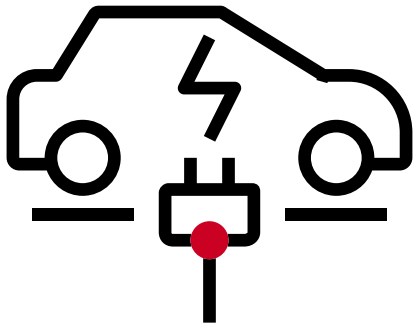
Current State

North American Standards

- AC Output Devices (EVSE):
  - UL 2594/CSA C22.2 No. 280/NMX-J-677-ANCE
- DC Output Devices (Chargers):
  - UL 2202/CSA C22.2 No. 346/NMX-J-817-ANCE
- Charge Couplers:
  - UL 2251/CSA C22.2 No. 282/NMX-J-678-ANCE

IEC Standards

- AC Output Devices (EVSE):
  - IEC 61851-1 or IEC 62752
- DC Output Devices (Chargers):
  - IEC 61851-1 and IEC 61851-23
- Charge Couplers:
  - IEC 62196-1 and IEC 62196-2 (AC rated)
  - IEC 62196-1 and IEC 62196-3 (DC rated)
  - IEC 62196-1, IEC 62196-3, and IEC 62196-3-1 (Cooled)



Future Standards Development Areas

Automatic Connection Devices

- Means to connect to vehicle without manual intervention
  - No need to lift cables
  - No need to leave vehicle
- Originally focused on bus and truck
  - Opportunity charging
  - Smaller battery, longer range
- Now expanding to passenger vehicles
  - Same benefits but different use cases

Automatic Connection Devices

- Standardization is underway

  – Essentially addresses the connection means, and may not impact charger requirements in any significant manner

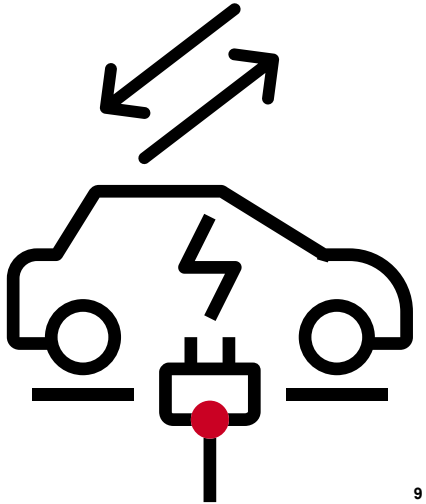
  – Automated or robotic nature of connection means needs to be standardized in a manner that addressed fire, shock, injury to persons, and damage to property.

  – Higher reliance on functional safety due to nature of functionality

  – Depending on location, higher environmental considerations compared to existing connection means.

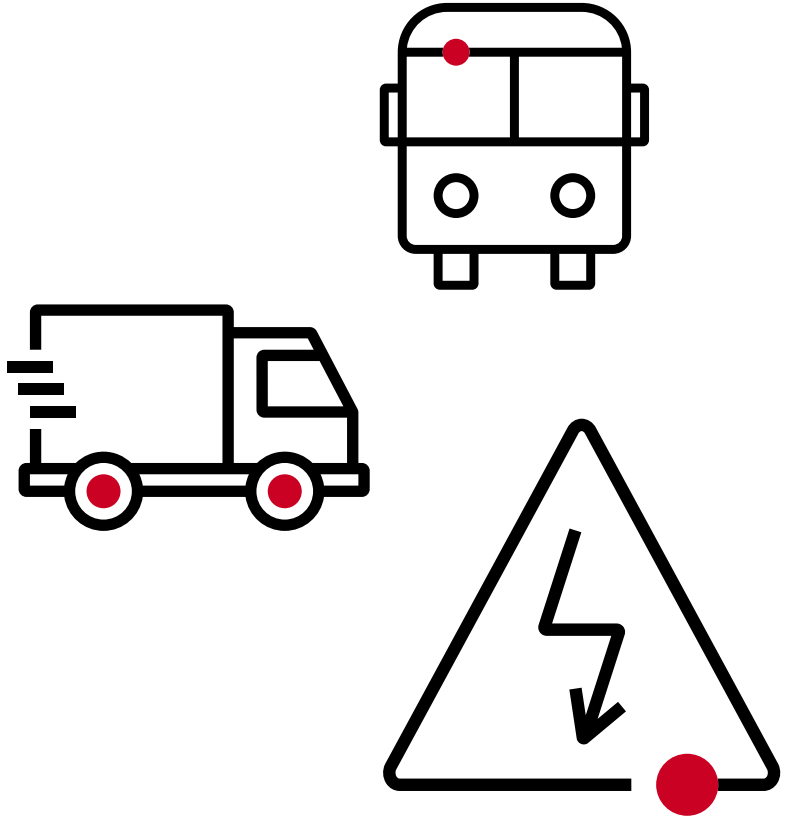
Bi-Directional Chargers

- Allows for charging and for power export from the vehicle
  - V2L – Vehicle to load – power export form vehicle to a specific load
  - V2P, V2H – Vehicle to Premise or home – power export onto building wiring
  - V2G – vehicle to grid – power export that can be accessed by the utility
  - V2V – vehicle to vehicle – emergency charging services
- Utilities and vehicles have specific requirements and history
- Equipment between the two must act to protect the user
- Using the vehicle as a source is not standardized at the vehicle level
- Work has begun, with the first edition of these standards published soon



Megawatt Charging

- The next innovation in conductive charging
- New systems using new couplers and new protocols
- Three levels of charging:
  - Level 1: 1500 V dc, 350 A
  - Level 2: 1500 Vdc, 1000 A
  - Level 3: 1500 Vdc, 3000 A
- Active cooling is required on the infrastructure side for Level 2; active cooling on both infrastructure and vehicle for Level 3.
- Primarily intended for truck and bus, but foreseeable that in the future, passenger vehicles could make use of Level 1.



Megawatt Charging

- Research and testing is ongoing to assist in identifying and addressing new and increased hazards
- Research into how to test infrastructure products without a vehicle for level 3
- Concerns with how to test at fault condition levels for products rated 3000 A.
- Potential for medium voltage considerations increases, legacy standards were low voltage
- Development on a global scale attempting to answer questions without actual products being reviewed.
- Actual product design will be critical in determining how to address compliance

Solar/Energy Storage based Chargers

- Portable type devices or more permanently mounted versions exist.
- Consist of energy storage, PV and inverters, and EV charging
- Can be grid tied (ESS supplements grid) or non-grid tied (ESS is only power source)
- Smaller systems are self contained; larger systems can consist of multiple products interconnected in the field.
- Individual requirements exist, but system level requirements covering interactions of all components are needed.

Battery Swap

- Overall, consists of a facility to swap batteries in electric vehicles
- Concept works well for fleets and standardized vehicles
- One facility that can do all cars with all batteries is not feasible
- Facilities can be larger buildings or smaller facilities.
- Batteries stored and recharged are essentially energy storage systems and the same risks should be considered.

Wrap Up

Wrap Up

- Legacy standards are not finished and will always require update
- New areas of technology are in development but require industry input and actual products to help formalize final requirements.
- Certification of products will be sought by employers, authorities, and others, therefore standardization is needed.
- Standards are reactive to technology, codes, and regulations, and time is needed to react. So the earlier standards are worked on the better.
- Electric vehicles are not going anywhere and the need for infrastructure will always drive technology and innovation – standards should not be an afterthought.

Questions

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Thank you

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