Electric Vehicle Charging Levels and Requirements Overview

Clean Cities December 2010 Webinar

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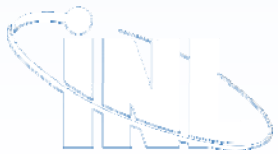

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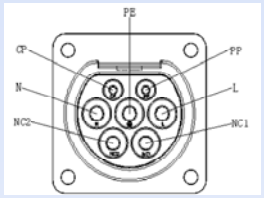
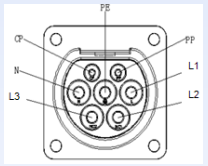
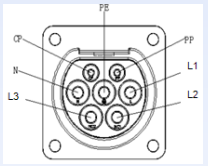
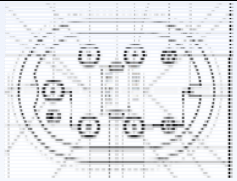
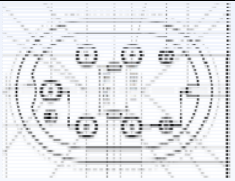
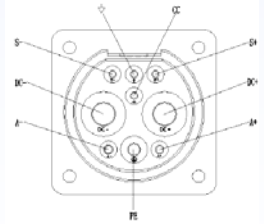
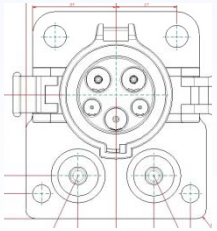
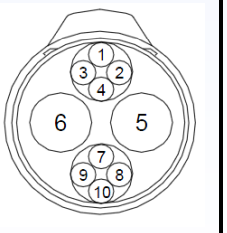
Presentation Outline

- Disclaimer
- Overview of Authorities
- Charging standards
  - Design standards
  - Safety standards and certification
- Charging definitions
- EVSE (electric vehicle supply equipment) examples
- Installation requirements
- Siting considerations

Overview of Authorities

- **Automotive**
  - **SAE (Society of Automotive Engineers)**
  - **JARI (Japan Automotive Research Institute**
    - **CHAdeMO DC Fast Charge Standard (Japan)**
  - **ISO (International Organization for Standardization)**
- **PEV Connector and Equipment Safety**
  - **SAE J1772**
  - **IEC 61851 PEV Conductive Charging System (International Electrotechnical Commission)**
  - **IEC 62196 Industrial plugs and sockets-outlets**
  - **OSHA (Occupational Safety and Health Administration) Nationally Recognized Testing Laboratory (NRTL)**
  - **NEC 625 (National Electrical Code)**
  - **Permitting and inspection authority having jurisdiction (AHJ)**

International Summary

		China	US	Japan	EU (IEC-62196)	
AC	Single Phase	 Type 2	 J1772	 J1772	 J1772-Type1	
	1 Phase or 3 phase				 Type 2 Mode 1	 Type2 All Modes
	1 Phase or 3 phase				 Type 3 Mode 1	 Type3All Modes
DC 200A 350A 400A		 Mode 3	 J1772 "Hybrid"	 CHAdeMo	Type 2 "Hybrid"	

Charging Standards

- **Published SAE Standards**
  - **SAE J1772 Surface Vehicle Recommended Practice**

    Title: SAE Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler

    - **First Published October, 1996**
    - **Revised December, 2009 (AC L1 & L2 Only)**
      - **Specifies a new conductive charge coupler and electrical interfaces**
      - **Increased AC Level 2 power levels (32A to 80A)**
      - **Added Positive detection circuit (sourced and monitored by PEV)**
      - **Added provision for PEV to lock the connector**
    - **Adoption date January 2010**

Charging Standards (cont'd)

- Summary of Advanced Communication SAE standards
  - SAE J2836 (New)
    - General Use Cases for Advanced Features
      - Dash 1 – Utility programs
      - Dash 2 – Off-board charger communications
      - Dash 3 - Reverse Energy Flow
      - Dash 4 - Diagnostics
      - Dash 5 - Customer and HAN
  - SAE J2847 (New)
    - Detailed Messages for Advanced Features
      - (Same Dash designations)

Charging Standards (cont'd)

- SAE J2931 Protocol (Requirements)
  - Dash 1 – General Requirements
  - Dash 2 – InBand Signaling (control pilot)
  - Dash 3 – PLC over Mains
  - Dash 4 – Wireless ??
  - Physical communication standards - defines how to send messages

- SAE J2953 Interoperability
  - Dash 1 – General Requirements
  - Dash 2 – Testing and Certification
  - Defines how to test devices to insure compatibilities between manufacturers

Charging Standards In Process

- J1772 Vehicle Conductive Charge Coupler
  - In Process for 2010
    - Tighten up standard to include interoperability between multiple EVSE and PEV suppliers
    - Add DC (Level 1 – up to 20kW) back into document
  - On-going process (2011)
    - Add DC (level 2 – up to 80kW) connector
    - Potential to add Reserve Energy Flow

Charging Standards In Process (cont'd)

- **Advanced Communication Standards**
  - **Planned for ballot in 2010**
    - **J2836/2™ - DC Use Cases and general info**
    - **J2847/2 – DC Messages and detail info**
    - **J2931/1 - Digital communications for PEVs**
      - **Communication requirements and protocol (AC & DC)**
    - **J2931/2 – Inband signaling communication for PEVs**
    - **J2931/3 – PLC communication for PEVs**

Charging Standards In Process (cont'd)

2011 and Beyond

- **Advanced Communications - 2011 and beyond**
  - **Reverse Energy Flow (J2836/3™ & J2837/3)**
    - **J2836/3™ Use cases for communication between PEVs and the Utility Grid for Reverse Energy Flow**
    - **J2847/3 Messaging between PEV and Utility for Reverse Energy Flow**
  - **Diagnostics (J2836/4™ & J2847/4)**
  - **Customer and HAN (J2836/5™ & J2847/5)**
- **Interoperability (J2953)**
  - **J2953/1 PEV Interoperability with EVSE**

Electrical Safety Codes

- National Fire Protection Association (NFPA 70 – 2008)
  - National Electrical Code (Article NEC 625)

    "Electric Vehicle Charging System"

    - Scope
      - The provisions of this article cover the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means, and the installation of equipment and devices related to electric vehicle charging.

NEC Article 625

- History of NEC 625
  - Introduced into NEC in 1995
  - Revised in:
    - 2002: Allowed longer cable lengths with Cable Management Systems & options for ventilation indoors
    - 2005: Included Neighborhood electric vehicles (Low Speed Vehicles), addressed Loss of Primary Power (backfeed), and Interactive Systems.
    - 2008: Clarified requirements for Disconnecting Means
  - You have to buy a copy from NFPA
  - Each jurisdiction can adapt whatever year code they chose

NEC Article 625 (cont'd)

- **Key Issues Addressed in 625**
  - **EV Coupler**
    - **Grounding Requirements (make first, break last)**
    - **Polarization – only fits one way**
    - **Unique – not interchangeable with other wiring devices**
    - **Constructed to prevent contact with live parts**
  - **EVSE – Fixed Wiring or Cord and Plug Connected**
    - **Permits 125VAC, 15 or 20Amp, single phase EVSE (cord-set) to be cord and plug connected**
    - **For 240VAC - must be permanently connected and fastened in place (hard-wired) unless it meets the following:**
      - **625.18 Interlock Requirements**
      - **625.19 Automatic de-energization of cable**
      - **625.29 Indoor sites**
      - **Listed as suitable for the purpose (UL)**

NEC article 625 (cont'd)

- **Interlock requirements (625.18)**
  - **Requires EVSE to be provided with interlock that de-energizes EV connector & cable when EV connector is disconnected from the vehicle.**

    Exception: Not required for portable cord and plug connected EVSE intended for connection to a 15A or 20A, 125VAC, single phase receptacle.

- **Automatic De-energization of cable (625.19)**
  - **EVSE or cable – connector combination requires automatic means to de-energize cable conductors & EV connector when subjected to strain that could rupture or separate cable from EVSE or result in exposure of live parts.**

    Exception: Not required for portable cord and plug connected EVSE intended for connection to a 15A or 20A, 125VAC, single phase receptacle.

NEC article 625 (cont'd)

- **Personnel Protection against electric shock (625-22)**
  - **EVSE shall be provided with listed system of protection against electric shock of personnel.**
  - **For cord and plug connected EVSE, interrupting means of the listed system shall be integral part of attachment plug or located (in-line) in power supply cable within 12 inches of plug.**

- **Loss of Primary Source – Backfeed (625.25)**
  - **EVSE requires means to prevent electrical energy from feeding back into premise wiring system in the event of a power failure or other loss of voltage from utility.**

    Exception: EVSE used for interactive systems per Article 625.26

NEC article 625 (cont'd)

- **Interactive Systems – Optional standby source (625.26)**
  - **EVSE or other parts of the systems, either on-board or off-board the vehicle, specifically Listed and identified for use as optional standby system, or electrical power source, or intended for bi-direction power feed shall be Listed and suitable for the purpose.**

- **Ventilation (625.29)**
  - **Ventilation not required for non-vented storage batteries (SAE J1718) or EVSE Listed or labeled and marked for indoor charging without ventilation.**
  - **Where venting batteries are used, mechanical ventilation requirements are provided in 625.29.**

Future changes to NEC Article 625

- **Add Plug-in Hybrid Electric Vehicles (PHEV)**
- **Expand to include “Smart” systems for power transfer & information exchange between utility, EVSE and PEV.**
- **Identify generic battery types & other energy storage types or maximum sizes of battery packs (PHEVs) where emission of hydrogen or other flammable gases do not occur, or do not exceed 25 percent of the lower flammable limit.**

EVSE Certification

- **Tested and certified by an NRTL (National Research Testing Laboratory, E.g. Underwriters Laboratory, TUV, ETL)**
  - **U.L. 2594 (new). Test standard for EVSE**
    - **Incorporates (UL 2202, UL 2231, UL 2251)**

UL Subject 2594 covers electric vehicle (EV) supply equipment, rated a maximum of 250 V ac, with a frequency of 60 Hz, and intended to provide power to an electric vehicle with an onboard charging unit. Subject 2594 covers electric vehicle supply equipment intended for use where ventilation is not required.

The products covered by Subject 2594 include EV Power Outlets, EV cord sets and EV charging stations, Level 1 & 2. EV cord sets may be designated as portable cord sets or stationary cord sets and may be designated for indoor or outdoor use. EV charging stations may be designated as either movable or permanent charging stations and may be designated for indoor or outdoor use. The products covered by Subject 2594 are intended for use in accordance with the National Electrical Code (NEC), ANSI/NFPA 70.

Charging Definitions

- Defined in Society of Automotive Engineers (SAE) J1772
  - AC (On-board vehicle charger)
    - Level 1: 120V AC (up to 16 Amps, ~ 1.92kW Max)
    - Level 2: 240V AC (up to 80 Amps, ~ 20kW Max)
    - Level 3: > 20kW (proposed)
  - DC Charging (Off-board vehicle charger)
    - Level 1: Up to 20kW (proposed)
    - Level 2: Up to 80kW (proposed)
    - Level 3: >80kW (proposed)
  - There may be other levels proposed

Selecting the Charger Type & Rate

- AC (On-board DC Charger)
  - Level 1
    - Convenience charge cord typically provided with PEV used for emergency purposes.
    - Charge times range from 6+ hours (PHEV) to 24+ hours (BEV)
    - Could be used to charge PHEV on a daily basis but dissatisfaction can occur if PHEV does not fully charge
  - Level 2
    - 240VAC EVSE connected to dedicated branch circuit
    - Charge times range from 2 hours (PHEV) to 8 hours (BEV)
    - Good for Malls, Movie theatres, Work Place

Selecting the Charger Type & Rate (cont'd)

- DC (Off-board Charger)
  - Level 2 (>20kW and up to 80kW)
    - 50kW is currently the most common power output today
    - Provides 3-5 miles / minute of charge
    - Good for City corridors, convenience stores and fast food restaurants

Examples of Level 1 EVSE

Examples of Level 2 EVSE Hardware

Examples of DC Fast Charging

Installation Requirements

- Local Authority Having Jurisdiction (AHJ) Permitting and Inspection Requirements
- Licensed/Bonded/Insured Electrician
- Circuit Requirements
  - Level 1
    - Dedicated 125VAC / 15A or 20A branch circuit
  - Level 2
    - Dedicated 240VAC / 40A (typical) branch circuit
    - Up to 80A (100A branch circuit) allowed by SAE
  - DC Fast Charger
    - 208VAC/3 Phase or 480VAC/3 Phase
    - Breaker sized appropriately to power level

Commercial Site Considerations

- Geographic Coverage / Planning
- Local attraction(s)
- Proper charger level for location
- ADA Requirements
- Lighting / Security
- Signage
- Access
- Local Permitting Authority

Signage Example

Ignoring The Signage Example

Acknowledgement

This work is supported by the U.S. Department of Energy's Vehicle Technologies Program

Additional AVTA Information, Reports, and Fact Sheets @

http://avt.inl.gov

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