Electric Vehicle Supply Equipment

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Electric Vehicles are in the news
American Recovery and Reinvestment Act

- $1.5 billion in grants to US Manufacturers to produce highly efficient batteries and other components
- Up to $500 million in grants to U.S. based manufacturers to produce other components needed for electric vehicles, such as electric motors and other components
- Up to $400 million to demonstrate and evaluate Plug-In Hybrids and other electric infrastructure concepts—like truck stop charging stations, electric rail, and training for technicians to build and repair electric vehicles
Government Incentives

- US Department of Energy spending $25B over 3 years to promote EV technology
- US Department of Energy is lending $8.5 billion to help car companies re-tool plants and develop technologies to manufacture more efficient cars
- President Obama's plan for 1 million electric cars by 2015
Government regulations (CAFE Standards)
- Energy Independence and Security Act (EISA) of 2007 mandates a 40% increase in fuel economy standards for automobiles and light trucks by 2020.

Volatile gas prices

Consumers’ desire to reduce carbon footprint
Market Drivers

All leading auto manufacturers investing significantly

- BMW Mini-E: 2009
- Mitsubishi: 2009
- Fisker: 2011
- SMART: 2010
- Ford: 2010
- Nissan Leaf: 2010
- BYD: 2010
- Chevy Volt: 2010
- Toyota: 2011
Industry Organizations Driving Product Requirements and Specifications
Industry Jargen

Glossary of Terms

- **EVSE**
  - Electric Vehicle Supply Equipment

- **PEV**
  - Plug-in Electric Vehicle
    - PHEV = Plug-in Hybrid Electric Vehicle
    - BEV = Battery Electric Vehicle

- **Charge Coupler**
  - The connector and mating vehicle inlet that connects the electric charging source to the electric vehicle
Industry Jargon

■ CCID
  ■ Charge Circuit Interrupting Device
    ■ A safety device that will disable utility power to your electric vehicle charger in the event that a loss of isolation is detected

■ SAE International
  ■ Society of Automotive Engineers
    ■ A non-profit educational and scientific organization dedicated to advancing mobility technology

■ SAE J1772™
  ■ North American (and Japanese) standard for electric vehicle charge connectors for electric vehicles established by the Society of Automotive Engineers (SAE)
Today, the SAE J1772™ standard defines charging levels as follows:

- **AC Level 1**: 120V up to 16A, single-phase
- **AC Level 2**: 240V up to 80A (~19.2kW Max), single-phase
- **AC Level 3**: not yet defined; proposed >20kW

- **DC Level 1**: not yet defined; proposed 200-450V, up to 20 kW (80A)
- **DC Level 2**: not yet defined; proposed 200-450V, up to 80 kW (200A)
- **DC Level 3**: not yet defined; proposed 200-600V, up to 200 kW (400A)

Note: Currently, there are a number of DC Level 3 “Fast Chargers” being installed around the country. They are typically utilizing a 480V, 3-phase power source and delivering a charge via a TEPCO connector conforming to the CHAdeMO standard.
AC EV Couplers Standardized

Three BASIC AC couplers are available Globally.

Type 1
SAE J1772 (IEC 62196-2)
Used in USA & Japan
Rating: 208-240 VAC, 80A max. 1 phase

Japan
250 V, 32 A, 1 phase
AC EV Couplers

Type 2
IEC 62196-2
Europe
Rating:
250 V, 13 A, 20 A, 32 A, 63 A, or 70 A, 1 phase;
380-480 V, 13 A, 20 A, 32 A, or 63 A, 3 phase
AC EV Couplers

Type 3
IEC 62196-2
Shuttered design
Rating:
250 V, 16 A or 32 A, single phase and 380-480 V, 32 A, or 63 A three-phase
Universal AC/DC Coupler

US (SAE) Connector
Inlet
Rating: 600 V, 200 A DC

IEC 62196-3
Codes & Standards

- **IEEE P2030.1** - Guide for Electric-Sourced Transportation Infrastructure
- **NEMA (5EV)** - Electric Vehicle Supply Equipment/Systems
- **UL 991** - Standard for Tests for Safety-Related Controls Employing Solid-State Devices
- **UL 2231** - Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits
- **UL 1998** - Standard for Software in Programmable Components
- **UL 2594** - Outline of Investigation for Electric Vehicle Supply Equipment
- **SAE J1772™** - Electric Vehicle Conductive Charge Coupler Standard
- **NEC Article 625** - Electric Vehicle Charging System Equipment
- **UL 2251** - Standard for Plugs, Receptacles and Couplers for Electric Vehicles
IEEE STANDARDS ASSOCIATION AND SAE INTERNATIONAL AGREE TO COLLABORATE ON SMART GRID AND VEHICLE-ELECTRIFICATION STANDARDS

New memorandum of understanding calls for each organization to share draft standards related to the Smart Grid and vehicle electrification.

PISCATAWAY, N.J., and WARRENDALE, Pa., USA, 27 APRIL 2011 – The IEEE Standards Association (IEEE-SA) and SAE International today announced that the two organizations have signed a memorandum of understanding (MOU) to establish a strategic partnership in vehicular technology related to the Smart Grid. In doing so, IEEE-SA and SAE International are striving to create a more efficient and collaborative standards-development environment for the industry participants that they serve.
About SAE International
SAE International is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial-vehicle industries. SAE International's core competencies are life-long learning and voluntary consensus standards development. SAE International's charitable arm is the SAE Foundation, which supports many programs, including *A World In Motion®* and the Collegiate Design Series.
Sample Vehicle Charge Times for the Chevrolet Volt

Vehicle charge times vary significantly depending on battery size, battery management system and EVSE

- Environmental factors can also affect charge times

<table>
<thead>
<tr>
<th>Level</th>
<th>Standard</th>
<th>AMP</th>
<th>Voltage</th>
<th>Charging Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SAE J1772</td>
<td>Up to 16A</td>
<td>120V AC, Single Phase</td>
<td>6 to 8 hours</td>
</tr>
<tr>
<td>2</td>
<td>SAE J1772</td>
<td>Up to 80A</td>
<td>120/240V AC, Single Phase</td>
<td>1 to 4 hours</td>
</tr>
<tr>
<td>3</td>
<td>ChAdeMO</td>
<td>Up to 330A</td>
<td>480V DC, 3-Phase</td>
<td>15 to 30 min. Up to 80%</td>
</tr>
</tbody>
</table>
EV Universe

**Residential**
- Individual homes: Garages, Carports

**Commercial**
- Townhouses, Condominiums, Apartments
- Workplaces, Schools, Hospitals, Hotels, Parking lots, Garages, Retail Facilities

**Public Use**
- Train Stations
- Government Buildings
EVSE Examples

- Residential, commercial and public PEV charging, comprised of:
  - Products (hardware) required for recharging PEVs
  - Software/Network Services for hardware management
Installation Requirements:

- Appropriate circuit breaker rating (20A or 40A)
- Individual branch circuit
- Appropriate conductors for breaker and receptacle rating
- NEMA configured receptacle (when cord and plug connected); for example 6-50R (for 40A) and 6-20R (for 20A)
- Cord and plug connected - indoor sites only
- Hard wired - Indoor and outdoor installation sites
“The means for interlocking (625.18), automatic de-energization (625.19), and the indoor site requirements (625.29) would need to be included in the design of the equipment or at the very least, provisions for operation when connected to the proper systems shall be required. As long as we address these three code references, the product can be listed at 240 V. “

The EVSE is part of a system identified and listed as suitable for the purpose, achieving the requirements of 625.18, 625.19, 625.29.
NEC 2008 50A to the Garage

- Article 210
- Il Branch Circuit Ratings
- 210.21 Outlet Devices
  - 210.21 (B) Receptacles
  - 210.21 (B) (1) Single Receptacle on an Individual Branch Circuit.
- A single receptacle installed on an individual branch circuit shall have an ampere rating not less than that of the branch circuit.