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PEV-EVSE INTEROPERABILITY PROJECT

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Presenter: Jeffrey Wishart

Intertek Testing Services, North America

2015 Annual Merit Review

June 9, 2015

VSS169

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OVERVIEW

TIMELINE

Project Start: July 1, 2013
Project End: Apr. 30, 2015
Percent Complete: 100%

BUDGET: Part of VSS029

Total Project: $ 500,000
Total Spent (Feb 2015): $ 471,320

BARRIERS

Vehicle Participant Willingness
EVSE Participant Willingness
SAE J2953 Standard Completion

PARTNERS

Idaho National Laboratory
Argonne National Laboratory
SAE International
SAE J2953 Committee

Relevance

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OBJECTIVES: Phase 1

- To conduct a series of tests on AC Level 2 charging as part of an evaluation of the SAE J2953 standard (and to assist SAE in finalizing the standard). The standard is used by industry to determine the interoperability of plug-in electric vehicles and electric vehicle supply equipment unit pairs.
- To assist the PEV and EVSE original equipment manufacturers in their product development.
- To evaluate software developed by Argonne National Laboratory that partially automates the SAE J2953 testing procedures.
- Phase 2 to focus on DC fast charging

Approach

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CONDUCT OF TESTING

- Procedures defined by the J2953 standard were used for testing the interoperability of the PEV-EVSE pairs.
- The Argonne National Laboratory software was used for test automation wherever possible.
- All EVSE units were installed at an Intertek laboratory for testing.
- Each PEV was sent to the Intertek laboratory for a three-week period of testing with each EVSE unit.

Approach

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PEV Participants

- 14 PEVs from 12 OEMs
  - 10 EVs
  - 4 PHEVs

PEV Make and Model
Mitsubishi i-MiEV
Toyota Prius Plug-in
Toyota RAV4 EV
Nissan Leaf
Kia Soul EV
Ford Fusion Energi
Ford Focus EV
VW e-Golf
BMW i3
Chevrolet Volt
Honda Fit EV
Honda Accord PHEV
Fiat 500e
Smart fortwo ED

Approach

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EVSE Participants

- 14 EVSE units from 12 OEMs

EVSE Units Make and Model
Eaton Marina EVSE L230CNBW
Clipper Creek CS-100
Clipper Creek LCS-25
GE WattStation
Siemens VersiCharge
Schneider-Electric EV230WS
ChargePoint CT 4020-HD-GW
Merit Charge ergI-01
AddEnergie CoRe+
AddEnergie Smart Two
Aerovironment EVSE-RSW30B15CXXW-0001
Bosch AWU70217BEN-B
EVSE LLC Watt Point
Telefonix L1x2

Collaborations

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NATIONAL LABORATORIES

- Idaho National Laboratory
  - Overall AVTE program management
  - Publication of project report

- Argonne National Laboratory
  - Automation software development
  - Test equipment source

Collaborations

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INDUSTRY PARTNERS

- SAE International
  - Solicitation of project Participants
  - Test results dissemination

SAE INTERNATIONAL™

- SAE J2953 Committee
  - Test procedure development
  - Test results discussion

Accomplishments

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PHASE 1 TEST COMPLETION

- Testing took place from May 15, 2014 to December 23, 2014.
- 2500 individual tests on various PEV-EVSE pairs:
  - 664 Tier 1 Tests
  - 1573 Tier 2 Tests
  - 262 Tier 3 Tests
- Some EVSE units and PEVs experienced failures and not all pairs could be fully tested.

Accomplishments

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PHASE 1 TEST RESULTS DISSEMINATION

- Each PEV and EVSE Participant was provided test results from PEV-EVSE pairs involving their product via SAE International partner.
- The test results were then anonymized and included in a report that also includes observations made in four areas:
    1. General testing observations
    2. Equipment observations
    3. SAE J2953 standard observations
    4. ANL software observations
- The report was submitted to INL in April 2015 as the Project Manager of the AVTE program and was published on the AVTA website at http://avt.inl.gov/.

Future Work

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PHASE 2: DC FAST CHARGING

- The SAE J2953 committee is currently developing the DC fast charging section of the SAE J2953 standard.
- In addition to the Combined Charging System (CCS) of SAE J1772, there are two other competing DC fast charging standards with deployed infrastructure in the U.S.
    1. Tesla Supercharger network (vehicles from other OEMs cannot currently access this network, so no interoperability issues; however, Tesla offers adapters for its vehicles to CHAdeMO and CCS DCFCs)
    2. CHAdeMO stations (various networks)
- Phase 2 of the Interoperability Project will be to test the interoperability of the capable PEVs and DCFCs sharing the same standard.

TESLA

CHAdeMO

Future Work

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PHASE 2: CHALLENGES/BARRIERS

- There is no set date for SAE J2953 completion. The testing of Phase 2 may have to begin prior to standard completion.
- There is no interoperability standard for CHAdeMO or the Tesla adapters. The decision will have to be made on how to develop an interoperability test procedure for these use cases.
- The EVSE units of Phase 1 are relatively inexpensive to both purchase and install (the EVSE Participants either loaned or donated their unit). DCFCs are much more expensive to purchase and install. Additionally, installing all the DCFC units in one place is difficult from a logistical, space, and electrical service perspective.
  - Conduct Phase 2 in the same manner as Phase 1 and install all EVSE units in one place, or have all the vehicles at one location and have the DCFCs sent sequentially?

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2014 AMR Reviewers' Comments and Responses

- This project was not reviewed last year.

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2015 AMR SUMMARY

- Sub-project of the AVTE program, VSS029
- 14 PEVs from 12 vehicle OEMs and 14 EVSE units from 12 infrastructure OEMs were tested.
- 2500 total tests on PEV-EVSE pairs from the SAE J2953 standard were conducted.
- Results for each PEV-EVSE pair were shared with the respective OEMs.
- Results were anonymized and presented in a report that is published on the AVTA website at http://avt.inl.gov/. The report also includes observations made in four areas:
    1. General testing observations
    2. Equipment observations
    3. SAE J2953 standard observations
    4. ANL software observations

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TECHNICAL BACKUP SLIDES

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TEST RESULTS LEGEND

- **Pass:** No failed transitions or time/voltage measurement(s) outside of the accepted criteria ranges and the charge event was able to be completed.
- **Soft Pass:** The charge event was able to be completed, but one or more failed transitions occurred or one or more time/voltage measurement(s) was/were outside of the accepted criteria ranges.
- **Fail:** The charge event was not able to be completed.
- **Feature:** Applies to the Charge Functionality Test and Safety Feature Functionality Test of Tier 1 only. This designation indicates that the test could not be completed due to a feature of the PEV that would not allow for switch S3 to be opened by the EVSE connector latch button.
- **Incomplete:** Applies to the Safety Feature Functionality Test of Tier 1 only. This designation indicates that the charge event did not resume when the EVSE button is released, and the second portion of this test could not be completed.
- **Pass+, Soft Pass+:** Applies to the Safety Feature Functionality Test of Tier 1 only. This designation indicates that the charge event did not resume when the EVSE button is released, and the second portion of this test could not be completed at first. However, opening the driver-side door did cause the charge event to restart, allowing the rest of the test to be completed. Since the action of opening the door was outside of the SAE J2953 procedure, the "+" was added to the designation of "Pass" or "Soft Pass".

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NON-MECHANICAL TEST RESULTS LEGEND

- **Timer:** Applies to Tier 2 testing only. This designation applies if (1) the charge event is disrupted by the grid event and (2) the EVSE sets a timer instead of resuming the charge event immediately. The charge event does not resume within the 20-minute window specified by the J2953 standard; however, it is possible that the charge event would have resumed at the beginning of the timer window.
- **Exception:** Applies to Tier 2 testing only. This designation indicates a test exception has been made in which the full 20-minute window specified by the J2953 standard to allow the charge to resume after the grid event was not permitted in order to expedite the test process. The wait duration (in seconds) before the test was terminated is included.
- **Comm:** Applies to Tier 2 testing only. This designation is included to accommodate commercial charging EVSE units that require authentication such as reading of an RFID card to begin a charge event. This designation applies if (1) the charge event is disrupted by the grid event, and (2) the EVSE requires the authentication to re-start the charge event.
- **Pass*, Soft Pass*:** Applies to the Charge Interrupt and Resume Test of Tier 3 only. This designation indicates that the 30-minute wait period specified in the SAE J2953 standard was not adhered to during testing due to time limitations, but that the charge event did resume.

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Tier 1 Testing Results Summary

Tier 1 Test	Pass	Soft Pass	Pass+, Soft Pass+	Soft Fail	Fail	Incomplete	Feature
Mechanical							
• Connect	113	8	N/A	3	47	N/A	N/A
• Disconnect	127	5	N/A	6	20	N/A	N/A
Charge Functionality	31	124	3	N/A	0	N/A	13
Safety Feature Functionality	22	120	N/A	N/A	0	12	13

N/A=Not Applicable

Mechanical Test Results Legend

PASS = All 10 values < 75 N
FAIL = All 10 values > 75 N
SOFT PASS = Average < 75 N, but some values can be greater than 75 N
SOFT FAIL = Average >75 N, but some values can be less than 75 N

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Tier 2 Testing Results Summary

Tier 2 Test	Pass	Soft Pass	Fail	Timer	Comm	Exception
Indefinite Grid Event						
• Voltage Swell	53	82	28	0	0	0
• Voltage Sag	59	104	0	0	0	0
• Frequency Swell	58	96	0	0	0	0
• Frequency Sag	51	112	0	0	0	0
Dynamic Grid Event						
• Voltage Swell	25	81	1	0	0	43
• Voltage Range Variation	42	120	0	0	0	4
• Voltage Sag	28	109	0	0	0	0
• Momentary Outage	34	79	3	5	3	35
• Long-Term Outage	14	75	2	14	6	47
• Frequency Range Variation	54	103	0	0	0	0

N/A=Not Applicable

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Tier 3 Testing Results Summary

Tier 3 Test	Pass	Soft Pass	Fail	Exception	Pass*, Soft Pass*
Scheduled Charge					
• PEV Scheduled Charge	56	29	4	N/A	N/A
• EVSE Scheduled Charge	11	11	4	N/A	N/A
Staggered Schedule Charge					
• PEV Scheduled First	6	6	3	N/A	N/A
• EVSE Schedule First	6	6	3	N/A	N/A
Charge Interrupt & Resume					
• PEV Interrupt	0	0	0	4	46
• EVSE Interrupt	0	0	0	3	52
Ampacity Control	0	0	0	N/A	N/A

N/A=Not Applicable