VSS123

SAE J2907 Hybrid Motor Ratings Support

Principal Investigator:

Laura Marlino, Presenter

2014 U.S. DOE Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting

June 17, 2014

Center for Transportation Analysis

This presentation does not contain any proprietary, confidential, or otherwise restricted information

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

OVERVIEW

Timeline	Barriers*
• Project start date: May 2013 • Project end date: Sept. 2016	• Lack of standardized test protocols • Consensus on repeatable, validated test methods are needed for market to gain confidence in HEV/EV technologies • Accepted means of validating modeling and simulation activities to promote R&D activities **from 2011-2015 VTP MYPP*
Budget (DOE share)	**Partners**
• FY14 funding: • DOE VSST - $50k • FY15 (current expected) funding: $75k	• Laboratories-ORNL, Argonne, • OEMs- GM, Ford, Chrysler, Toyota, Honda, Nissan • Suppliers-UQM, Delphi, Protean, XL Hybrid • Universities-University of Michigan • Others-TARDEC, Advanced Energy, JMAG Corp

OBJECTIVE: Support development of traction motor test standards to establish consistency and repeatability in assessing performance

"WHY"

- Manufacturers lack consensus on standard means for performing motor tests to enable comparisons of differing technologies
  - No means for apples to apples comparisons currently exists
- A need exists for accepted standards to establish reliable performance rankings in order to promote market adoption

"HOW"

- Revive SAE J2907 Motor Rating Standard (initiated in 2007) Task Force
  - Provide support, direction and guidance to membership
- Work closely with J2908 and J2711 groups to establish and maintain logical flow between interacting standards and build upon one another
- Interact with OEMs, National Laboratories, Universities and industry to examine and establish a unified consensus on motor testing procedures

Published motor values often don't adequately characterize the machine and typically lack critical test conditions and information.

FY2014 MILESTONE

- **Establish comprehensive knowledge base of existing motor test standards**

IEEE Standards

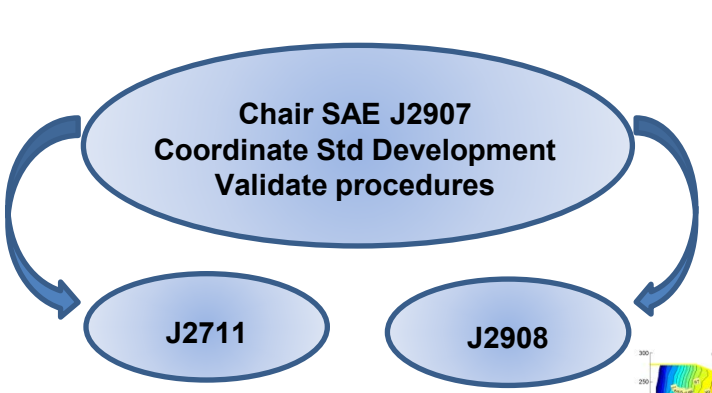
- IEEE P1812™/D1 Draft Trial use Guide for Testing Permanent Magnet Machines
- IEEE Std 112, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators
- IEEE Std 115™, IEEE Guide for Test Procedures for Synchronous Machines, Part I – Acceptance and Performance Testing; Part II – Test Procedures and Parameter Determination for Dynamic Analysis.
- IEEE Std 11 Standard for Rotating Electric Machinery for Rail and Road Vehicles

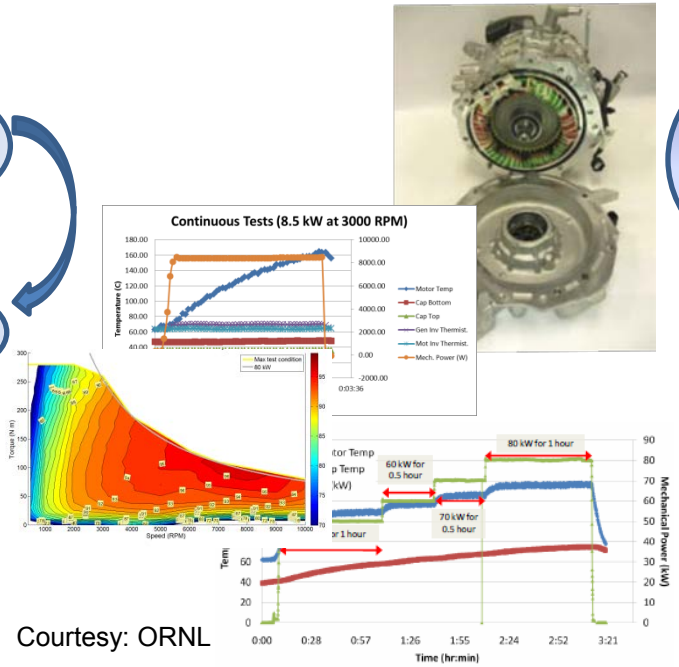
Others

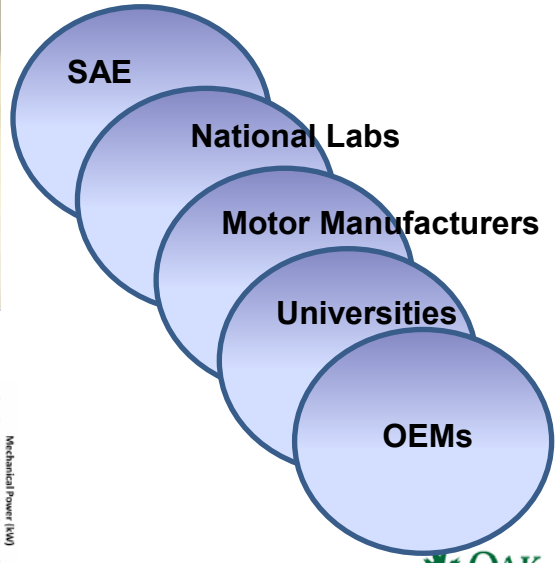
- IEC (International Electrotechnical Commission) EIC/TR 60785 Ed. 1.0b:1984 Technical Report Rotating machines for electric road vehicles
- JIS (Japanese Industrial Standards) D 1302:2004 Electric vehicle –electric motors – Test method of maximum power
- Chinese standards GB/T 18385-2001 “Electric vehicles – power performance –test method

APPROACH: Resurrect SAE J2907 Committee

- Petition SAE Hybrid Committee to reopen J2907
  - Evaluate interrelationship of J2907 to existing SAE Task Forces
- Solicit involvement from OEMs, National Laboratories, Universities and Industry
- Research applicability and coordination with existing global standards
- Define Committee scope
- Coordinate and lobby membership for relevant presentations, opinions and discussions
- Draft document for member review
- Validate test procedures in lab environment to ensure applicability and ease of acceptance







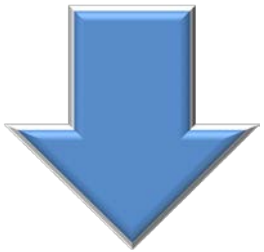
Courtesy: ORNL

ACCOMPLISHMENT: Re-start of J2907 Task Force

- Petitioned SAE to resurrect J2907 and work with SAE Hybrid Committee
- Expanded Task Force membership
  - Reconnected with prior members
  - Solicited new representatives
- Defined relationship to existing SAE standards
- Scope of standard clarified

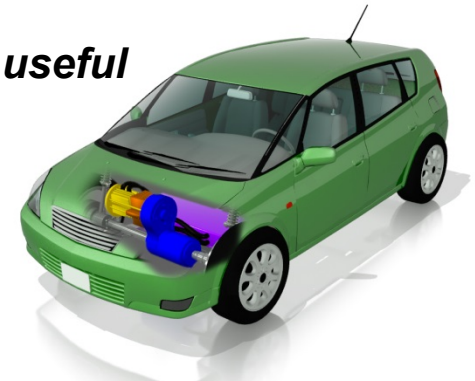
Courtesy: ORNL Benchmarking Activity

Intrinsic electro-magnetic parameter tests



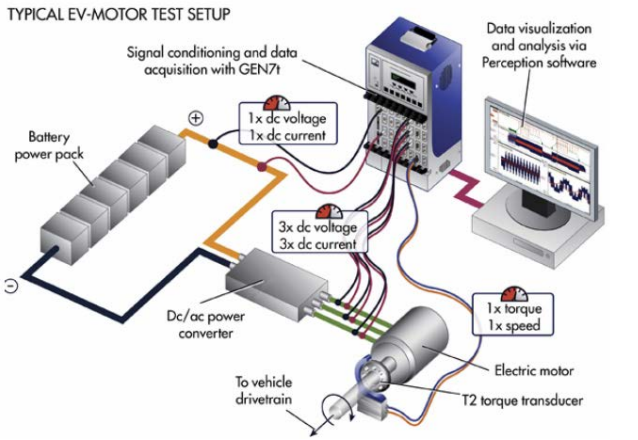
Representative application system tests

Both approaches useful



ACCOMPLISHMENT: Investigation of existing domestic and international standards completed

- Relevant tests, protocols, equipment setup, accuracy of measurements
- Review and acquisition of existing codes and standards being used in industry
  - Synchronous and Asynchronous machines
  - Application specific standards
  - Hybrid vs All Electric
- Supplier test criteria
- IEEE Documents
- Automotive OEM test methods
- Japanese and Chinese standards



Machine Design, Nov 18, 2013, Mike Hoyer, applications Engineer HBM Inc., Marlborough, Mass

Effort is Ongoing--particularly with regards to overseas test standards

ACCOMPLISHMENT: Draft Document Begun

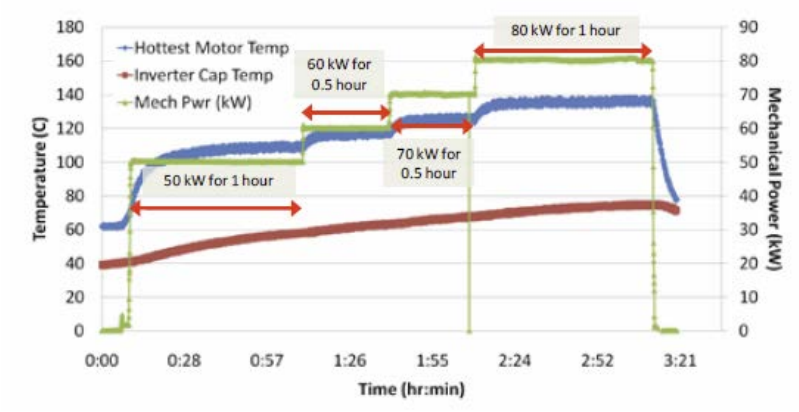
What is the maximum output of the motor/drive system?

Initial Tests to be included in the standard:

- Peak Power
  - Maximum power at speed increments
  - Duration of time system can operate at peak conditions
- Continuous Power
  - What power/torque can the system continuously sustain
- Efficiency Mapping
  - What operational regions are most efficient

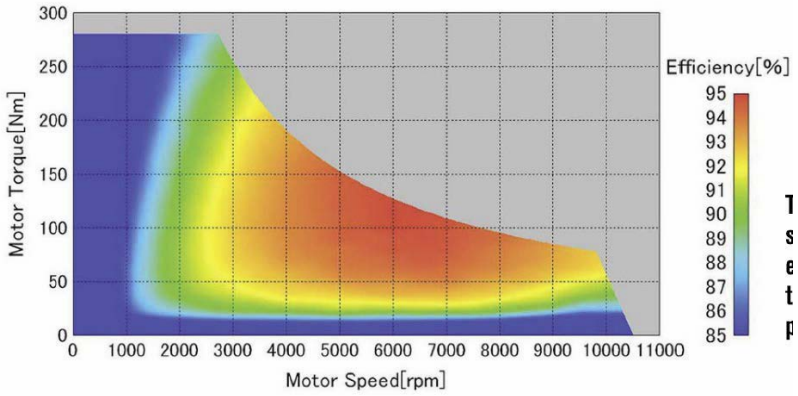
- Test Conditions Detailed
  - Measurement Increments
  - Coolant Temperature and flow rates
  - Motor Temperature
  - Accuracy of Measurement Equipment

2012 Nissan Leaf Continuous Power Tests at 7,000 rpm



Courtesy: ORNL

2012 Nissan motor/efficiency contours



"*Power from Within*", Nissan LEAF Special Edition of SAE Vehicle Electrification, p. 17, Feb. 23, 2011.

Responses to Previous Year Reviewer Comments

- **This project is a new start for FY2014, and was not reviewed last year.**

COLLABORATION AND COORDINATION

- SAE Hybrid Technical Committee
  - SAE J2908 Task Force
  - SAE J2711 Task Force
- National Laboratories
  - Argonne
- OEMs
  - GM, Ford, Chrysler
  - Honda, Toyota, Nissan, Mitsubishi
  - Protean, XL Hybrid, UQM
  - GE
- Universities
  - University of Michigan
- Tier 2 Suppliers
  - Delphi

PROPOSED FUTURE WORK

- **FY2014**
  - **Complete compilation and investigation of existing codes and standards pertaining to applicable motor testing**
  - **Continue J2907 monthly committee meetings to arrive at consensus on test methods**
  - **Participate in SAE Hybrid Committee Meetings to ensure cohesion between standards work**
  - **Finalize first draft of J2907**
- **FY2015**
  - **Validate test methods through laboratory bench, HIL, and dynamometer testing**
  - **Report on test and standardization progress at SAE Committee Meetings**
  - **Submit J2907 to SAE Committee for ballotting**

SUMMARY: SAE committee has been reestablished and is actively pursuing development of test standards and protocols for drive train motors

- SAE J2907 committee brings together experts at multiple levels
  - OEMs and suppliers, motor manufacturers, Universities, National Laboratories
- Monthly meetings providing mechanism to educate membership on issues and reach agreement on scope and tests
- Initial draft has been completed and circulated to committee for review and comments
- It is expected J2907 Committee will continue in FY15
  - Finalizing draft document
  - Broadening range of tests

ACKOWLEDGEMENTS

Lee Slezak
Lead, Vehicle and Systems Simulation and Testing
Office of Vehicle Technologies
US Department of Energy

David Anderson
Vehicle and Systems Simulation and Testing
Office of Vehicle Technologies
US Department of Energy

Contacts

Laura Marlino
Project Principal Investigator

(865) 946-1245
marlinold@ornl.gov

David Smith
Director
Center for Transportation Analysis (CTA)
Program Manager
Advanced Vehicle Systems
(865) 946-1324
smithde@ornl.gov