

SAE J2907 MOTOR POWER RATINGS STANDARDS SUPPORT

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Coordinated by:

SAE Hybrid/EV Technical Standards Committee



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

Overview

Timeline

Started: April 2014

Targeted end: Nov 2016

Percent complete: 70%

Budget

FY14: \$25K, FY15: \$50K, FY16: \$50K

Need for Standard

- Currently there is no widely accepted standard for specifying the performance of a traction motor for xEV's
- Ratings tests are needed to validate MFG claims of Net Power and Maximum 30 Minute Power
- SAE J2907 specifies procedures for tests to be done in a laboratory setting to foster a consistent and repeatable mechanism for the assessment of motor net power and maximum 30 minute power

Barriers

Barriers addressed

- J2907 is open, some Mfg. tests proprietary
- Pre-conditioning the electric traction drive system (ETDS) varies by country
- European and Korean ratings tests have established pre-conditioning requirements
- Validation of MFG claims on power testing per UN/ECE R85 must be witnessed by UN representative
- The U.S. never signed the ECE Treaty
- China has own std: GB/T 18488.1-2015

Partners

- J2907 task force members from OEM's, Tier 1's, industry



Relevance

The need for a uniform measure of ETDS output has been pointed out for several years now, and by OEM's

M. Hoyer, "The Misconceptions of EV Motor Testing," Machine Design, Nov. 18, 2013 noted that: *It's time to rethink performance tests on electric motors destined for use in electric vehicles.*

Motortrend news on 2016 Prius Launch puts it this way:

"Automakers haven't collectively agreed on a single harmonized procedure to rate their hybrid powertrains. They aim to make it as similar to current engine-only ratings as possible, but hybrid configurations are highly diverse. Toyota's change in rating technique influenced the 2016 Prius' lower system horsepower."

SAE 11 Jan 2016 Prius is Re-engineered on Toyota New Global Architecture

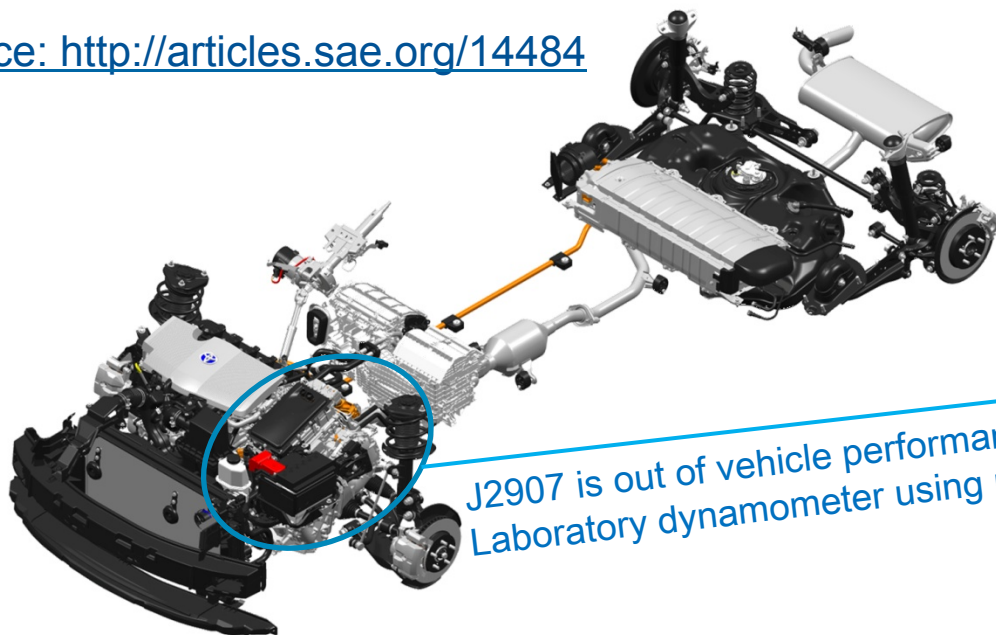
"SAE net power for the gasoline engine is 95 hp (71 kW) and 105 lb·ft (142 N·m), while the electric motor is rated at 71 hp (53 kW) and 120 lb·ft (163 N·m)".

Relevance

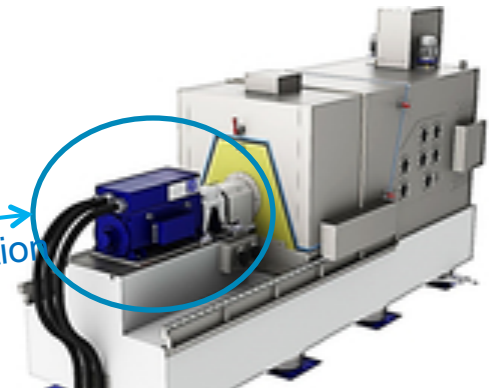
Objectives: (March 2015–March 2016)

Develop consensus of opinion on an acceptable procedure for measuring the key performance parameters of the ETDS to permit component to component comparisons separate from the performance of the motor in a vehicle.

Source: <http://articles.sae.org/14484>



J2907 is out of vehicle performance characterization
Laboratory dynamometer using power supply



<https://www.avl.com/dynamometers1>

Approach/Strategy

SAE J2907 – Performance Characterization of Electrified Powertrain Motor-Drive Subsystem

In J2907 we note that “Test procedures are varied among manufacturers and frequently are not explicitly defined when motor characteristics are quoted, resulting in ambiguous and vague specifications that can confuse both consumers and developers.”

Technical Approach/Strategy:

- Develop a uniform measure of ETDS output that can be validated by 3rd party testing facilities
- Achieve consensus on Pre-conditioning metrics
- Define procedures and conditions to validate MFG claims on Net Power and Maximum 30 Minute Power
- Develop a single J-doc for procedures and results to minimize cost to MFG
- Develop communications page in J-doc appendix for validation of MFG declared Net and Max 30 Minute Power
- Enter balloting process to Technical Information Report (TIR) readiness

Approach/Strategy

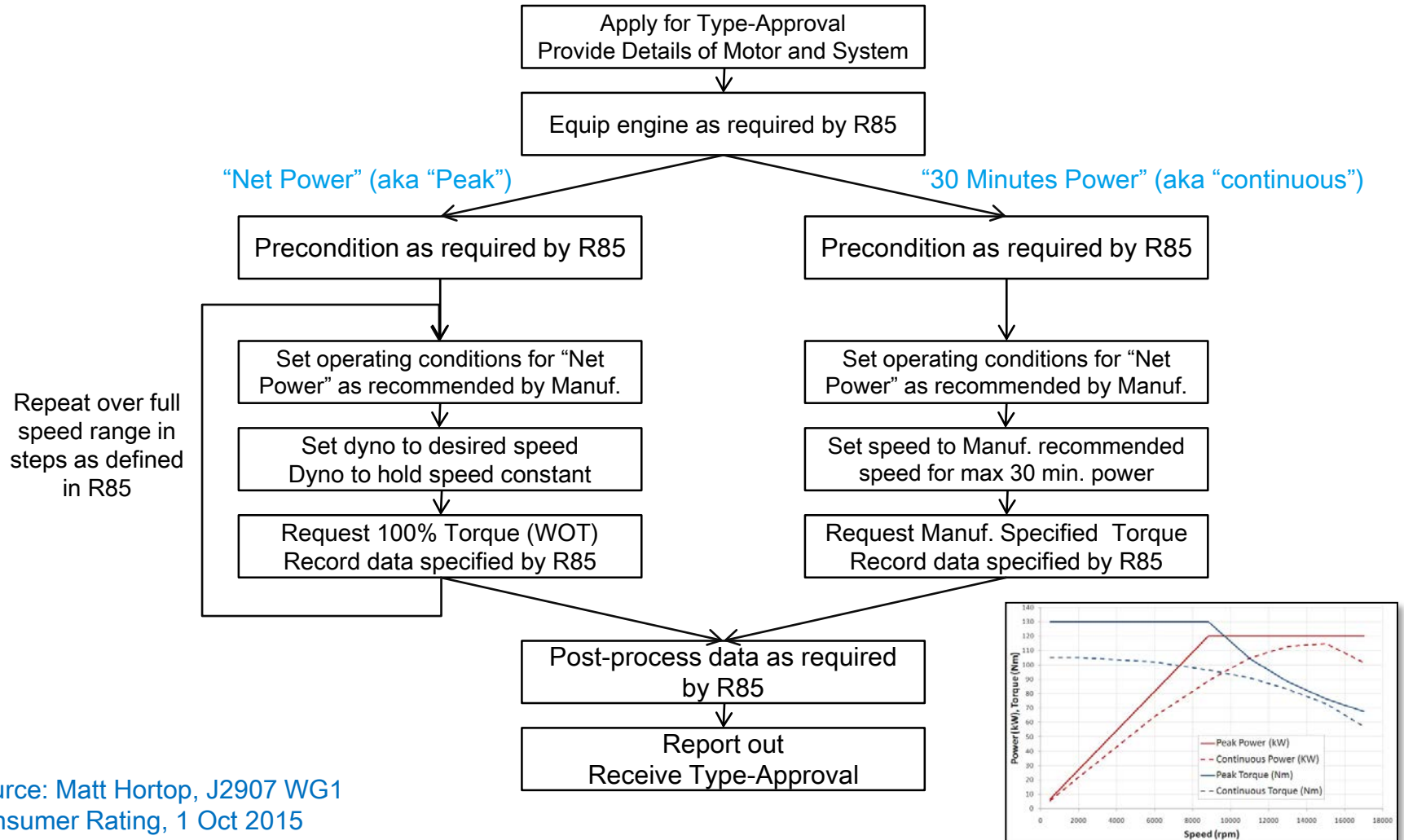
Goal is an internationally accepted standard for electrified powertrain characterization to reach TIR readiness Nov 2016

Month	March	April	May	June	July	Aug	Sept	Oct	Nov
Draft									
Ballot Survey									
Balloting									

- Key concerns of members have been:
 - How is pre-conditioning defined?
 - Will additional characterizations incur additional testing cost?
 - Is development of torque-speed map essential?
 - Should measurement time be specified (1s, 10s, 30s, 1min)?
 - Does J2907 focus only on BEV and FCEV traction motors?

Technical Accomplishments/Progress

J2907 is now structured to be similar to ECE R85 and be U.S. standard

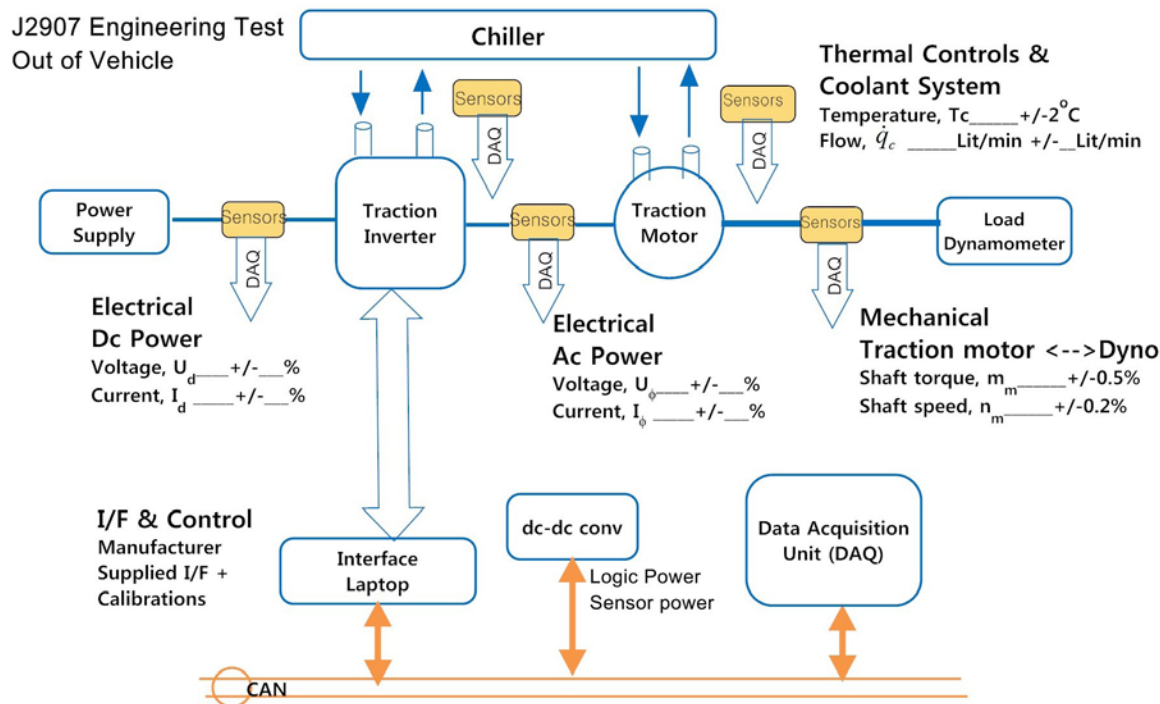


Source: Matt Hortop, J2907 WG1
Consumer Rating, 1 Oct 2015

Technical Accomplishments/Progress

J2907 Committee has reached consensus on key attributes of TIR

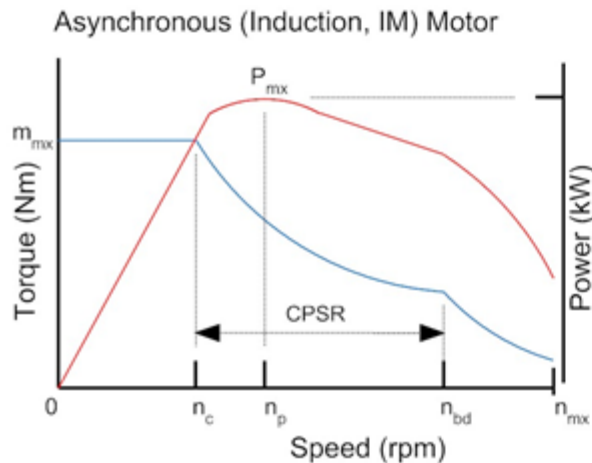
- Out of vehicle characterization via in-laboratory testing
- Applicable to all electrified powertrains (xEV = BEV, FCEV, HEV, PHEV)
- Using laboratory power supply set to MFG specified nominal voltage
- Using calibrated and certified equipment



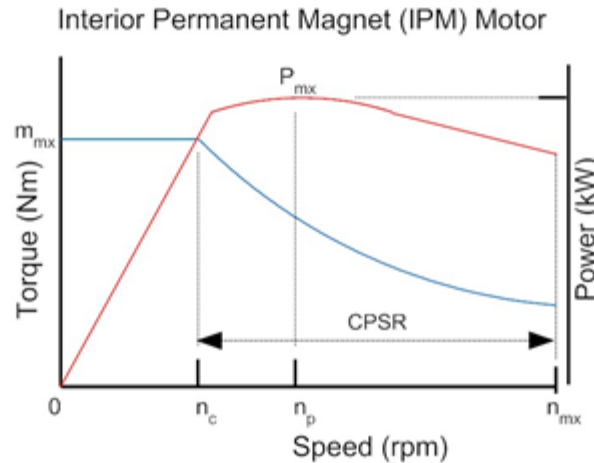
Technical Accomplishments/Progress

J2907 is out-of-vehicle characterization. J2908 is in-vehicle testing

- Procedure focuses on net (peak) power and maximum 30min (continuous) power
- Cooling system may be 2 channel, even 3 channel, to best mock-up MFG application
- Communications interface to the ETDS requires close collaboration with MFG
- Sensors and data acquisition coordinated between J2907 and J2908

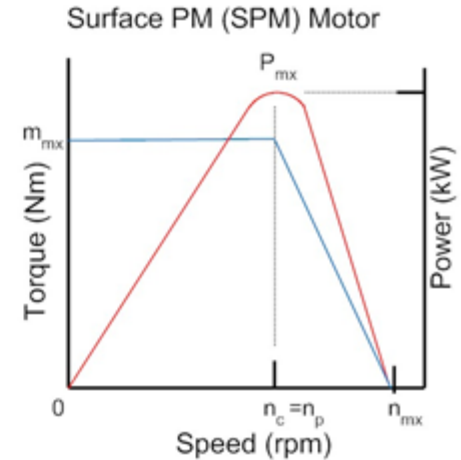


n_c = corner point speed, end of constant torque region
 n_p = maximum power speed
 n_{bd} = IM 2 breakdown speed
 n_{mx} = maximum speed, limit of field weakening
CPSR = constant power speed ratio = n_{mx}/n_c



CPSR (IM) ~ 2.7:1
CPSR (IPM) ~ 5:1

Switched Reluctance Motor (SRM) has CPSR similar to IPM through control of phase advance and pulse dwell



SPM has very limited CPSR (<1.6:1)
Field weakening by phase advance only
Same as Brushless dc Machine (BDCM)

Technical Accomplishments/Progress

Net Power Validation

- Laboratory power supply voltage per MFG specified nominal and droop $< 1.25\% V_{nom}$
- Precondition with coolant $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ at 80% max power for minimum 3 minutes
- Perform test runs at 5s/point at rated power inverter output
- Generate torque-speed, coolant, and motor temperature data. Compute power
- Locate speed (n_p) at maximum power (and torque). Validate declared power.

$$\left| \left(\frac{P_{max}}{P_{declared}} \right) - 1 \right| \times 100 < 2\%$$

Maximum 30 Minute Power Validation

- Same preconditioning process
- Set power inverter output to MFG specified level for continuous operation
- Perform test runs at speed n_p at $< 5\text{s/point}$ for each minute of 30 minute overall run
- Validate declared 30 minutes power.

$$\langle P_{30max} \rangle = \frac{1}{N} \sum_{k=1}^{N=30} P_{30}(k) \quad \left| \left(\frac{\langle P_{30max} \rangle}{P_{30declared}} \right) - 1 \right| \times 100 < 5\%$$

Technical Accomplishments/Progress

J2907 is structured to provide SAE validation of MFG declared power

Granted, Extended, Refused

Declared Max Power __kW @ __rpm
 Declared Max Torque __Nm @ __rpm
 Declared Stall Torque __Nm
 Declared Max 30min Power __kW
 Test dc Voltage __V
 Cooling type Liquid/Air _____

J2907 testing to validate whether the MFG declared power values are true within prescribed tolerance

Table of Contents

Rationale	4
1. Scope	4
1.1 BACKGROUND AND PURPOSE	4
1.2 FIELD OF APPLICATION	5
2. References	6
3. Definitions	8
4. Test Procedures	11
4.1 Initialization	12
4.1.1 Dynamometer Test Initialization	12
4.1.2 Stall Torque Validation	12
4.2 Net Power Validation	13
4.2.1 Determination of net power	13
4.2.2 Net power equipment verification	14
4.2.3 Net power determination	14
4.2.4 Torque Ripple Test	14
4.3 Determination of maximum Continuous Power	14
4.3.1 Maximum 30 minutes power	14
4.4 Efficiency during 30 minutes power test	14
5. Test Instrumentation	15
5.1 Instrumentation Accuracy	15
5.2 Equipment and Safety	16
6. Calculations	16
6.1 Instrumentation Bandwidth	17
6.2 Bandwidth of instrumentation cascade	17
6.3 Calculation of Mechanical Power	18
6.4 Calculation of Net and Maximum Continuous Power	19
6.5 Calculation of Mechanical Power	19
7. Test Data	20
APPENDIX	20

APPENDIX	20
communication	20
8. Approval	20
8.1 Approval Number	20
9. ETDS DESCRIPTION	20
9.1 Trade name or mark of the unit under test	20
9.2 ETDS Type	20
9.9 Approval is granted, extended, refused, withdrawn (line out if not applicable)	21
9.10 CONCLUSION (include only if 9.9 is granted)	21
9.11 Tests performed by: _____; Revised by: _____	21
10. Preconditioning	21
11. Declared values	22
11.1 Maximum Net Power _____ kW @ _____ rpm	22
11.2 Maximum Net Torque _____ Nm @ _____ rpm	22
11.3 Maximum Net Torque at Stall _____ Nm	22
11.4 Maximum 30 minutes power _____ kW	22
12. equipment and test conditions	22
13. Test Procedures	22
13.1 Initialization	22
13.1.1 Dynamometer Test Initialization	23
13.1.2 Stall Torque Validation	23
13.1.3 Preconditioning (J2907 – this section needs thorough review)	23
13.2 Data recording (J2907 – I agree with Task Force that tables shown can be external files)	23
13.2.1 Net power log	24
13.2.2 Maximum 30 minutes power log	24
13.2.3 Efficiency during continuous power testing	25

J2907 working draft V.7
 under review March thru
 Aug 2016

Collaborations and Coordination

J2907 maintains close collaboration with J2908 for consistency in measurements, tolerances, and relevance

If a **new J-doc** is initiated, there J2908 would not cover System Power, it would cover the other parameters.

Same equipment as the New J-Doc. Power measured only in EV Mode.

	Consumer Ratings					Engineering Tests		
	System		Components			System	Component	
	Consumer Powertrain System Rating	PHEV EV Mode Power (wheel kW)	Assist and Regen (battery kW)	Consumer Motor Rating	Consumer Engine Rating	Powertrain System Power Test (Wheel)	Motor Test	Engine Test
ICE	New J-Doc	--	--	--	J1349	defer to New J-Doc	N/A	J1349, J1312
HEV		--	J2908	--	J1349		J2907	J1349, J1312
PHEV		J2908	J2908	--	J1349		J2907	J1349, J1313
BEV		--	J2908	--	N/A		J2907	N/A
FCV		--	J2908	--	N/A		J2907	N/A

J1312	Procedure for Mapping Performance - Spark Ignition and Compression Ignition Engines
J1349	Engine Power Test Code - Spark Ignition and Compression Ignition - Net Power Rating
J2907	(In Progress) Performance Characterization of Electrified Powertrain Motors and Drive Systems (outside of vehicle)
J2908	(In Progress) Hybrid System Power Rating - limited to ratings specific to electrified powertrains
New J-Doc	New rating to prescribe wheel/axle power for any powertrain

Box with No Color = Undecided or Not Applicable

Graphic obtained from
Mike Duoba, Chair
J2908 10 Dec 2015

Proposed Future Work

April to August 2016

- Working draft revisions based on OEM and industry feedback
- Drive for consensus on preconditioning, test time/point, coolant temperature excursion, measurement tolerance, and data analysis

September to October 2016

- Prepare for circulation of ballot (J-doc still in revision stage)
- Achieve full OEM support for draft TIR

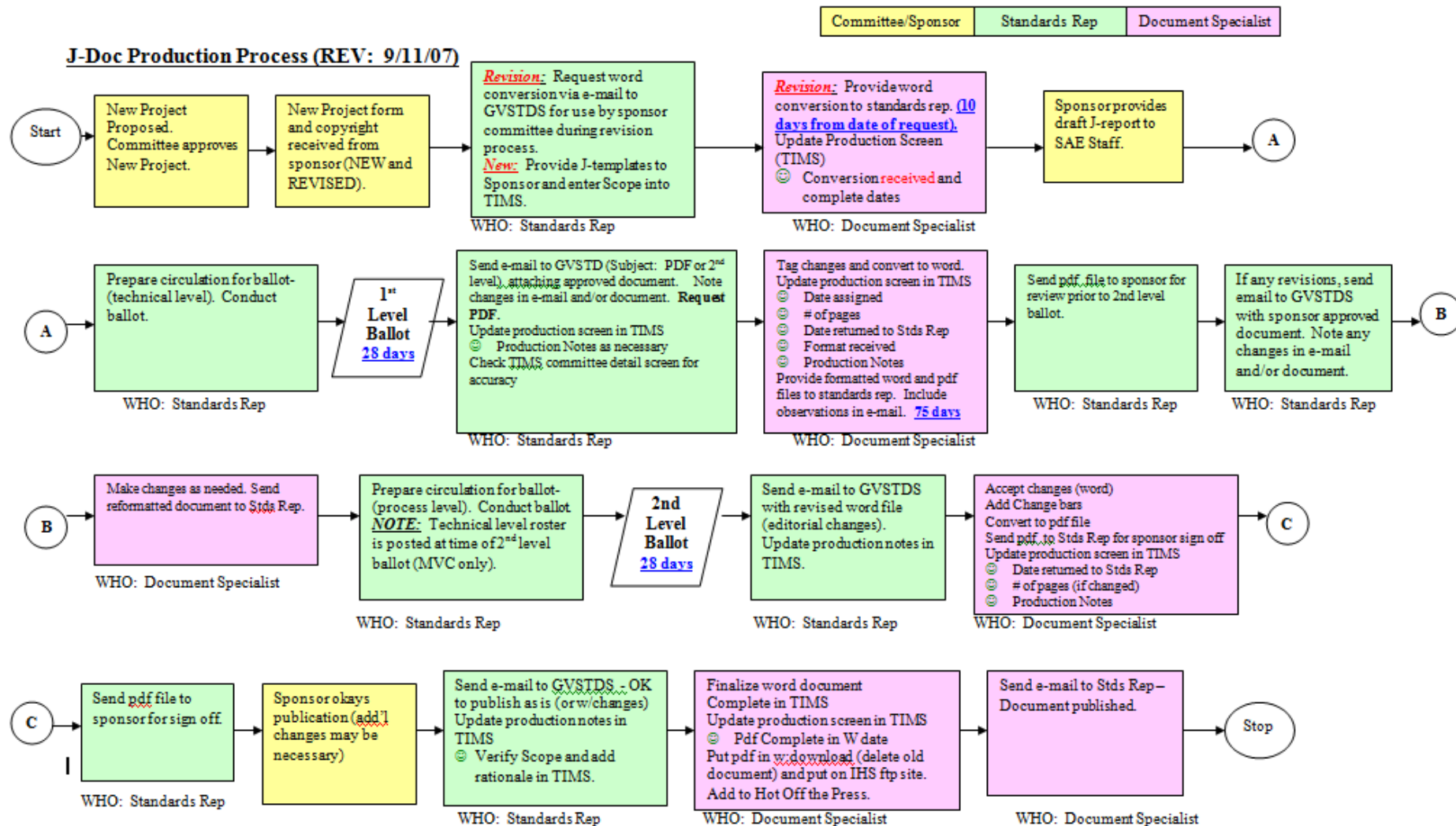
November 2016

- Official balloting process commences

Key milestones.

- J2907 committee consensus for TIR vs Guideline status by end FY16
- Publish J2907 as TIR per J-doc production process during FY17
- Advancement from TIR to Standard if no further revision

Proposed Future Work



Summary

J2907 is designed to be an open document with all procedures capable of being performed by independent 3rd parties

Goal is single J-doc at TIR status in FY17 to minimize traction motor validation costs to the manufacture and to be uniform measure of output – “A standard that provides an independently verifiable level playing field for all.”

Achieved consensus on procedure and results for Net Power and Maximum 30 Minute Power in March 2016

J2907 standard (TIR, Guideline) will mean SAE representative witnesses validation testing instead of UN representative

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

Thank You!

Questions?