ETA-HTP06

Revision 2

Effective October 1, 2007

Braking Test

Prepared by

Electric Transportation Applications

Prepared by: _____ **Date:** _____
Roberta Brayer

Approved by: _____ **Date:** _____
Donald Karner

TABLE OF CONTENTS

1.	Objectives	1
2.	Purpose	1
3.	Documentation	1
4.	Initial Conditions and Prerequisites	1
5.	Testing Activity Requirements	3
	5.3 Dry Controlled Test	4
6.	Glossary	5
7.	References	7

Appendices

Appendix A - Handling Pad Test Data Sheet	8
Appendix B - Vehicle Metrology Setup Sheet	11

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1. Objective

This procedure identifies methods for evaluating the braking performance of vehicles participating in HEV America. These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency, which may have or exercise control over the covered activities.

2. Purpose

The purpose of this test is to qualitatively evaluate the controllability of a vehicle during braking. Both the stopping distance and the ability to maintain the vehicle in control (defined as staying in the course lane) are tested. This test is not intended to satisfy the requirements of Section 105 of 49 CFR 571. This activity is meant to test the vehicle as a total system. Tests of specific subsystems or portions of individual subsystems are addressed by other Test Procedures, as appropriate. This testing and data acquisition meets the requirements specified in the HEV America Vehicle Specification.

3. Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with ETA-HAC04, "Review of Test Results." Storage and retention of records during and following testing activities shall be completed as described in Procedure ETA-HAC01, "Control, Close-out and Storage of Documentation."

4. Initial Conditions and Prerequisites

Prior to conduct of any portion of the testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items shall be verified as complete and recorded on the appropriate Test Data Sheet.

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, and when applicable, the appropriate SAE Test Instructions, Administrative Control Procedures, and be certified by the Program Manager, Test Director or Test Manager prior to commencing any testing activities.

4.2 Ambient temperature during road testing shall be ≥32°F (0°C).

4.3 RESS temperatures at the beginning of the test shall be greater than 60˚F (16˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C)

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4.4 The average wind speed at the test site during the test shall not exceed 10 mph (16 km/h). Wind gusts shall not exceed 12.3 mph (20 kph).

4.5 Testing shall be completed on a rolled asphalt "braking course" defined by Electric Transportation Applications at the test facility of Exponent Failure Analysis Associates (or equivalent). This pad shall be dry while the test is being conducted.

4.6 Vehicles shall be tested in their normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.). Certain items (hubcaps, etc.) may be removed where necessary for safety.

4.7 Vehicles shall be tested at delivered curb weight plus 332 pounds.

4.8 Tires provided with the vehicle shall be the standard tires offered by the Supplier.

4.9 Supplier's recommended lubricants shall be employed.

4.10 Accessories shall not be used or operated during testing.

4.11 For vehicles operable in "RESS only mode." verify the RESS is at 100% SOC in accordance with the requirements of ETA-TP08, “RESS Charging Procedure.” For vehicles operable in "normal operation mode," verify the RESS is at an Initial State of Charge (SOC) achieved by operating the vehicle for at least 5 miles (8 kilometers) at a constant speed of 35 mph (56 kph).

4.12 Verify vehicles are in "normal operating mode."

4.13 The overall error of recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.14 Complete or verify completed procedures ETA-HAC06, “Receipt Inspection” and ETA-HTP11, “Vehicle Verification,” for the vehicle being tested.

4.15 The road surface type and condition as defined in SAE J688, "Truck Ability Prediction Procedure," and lengths and grades of test route shall be noted.

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4.16 For instrumentation used in the test, at a minimum, record the following information for each instrument on Appendix B:

4.16.1 Manufacturer

4.16.2 Model Number

4.16.3 Serial Number

4.16.4 Last Calibration date

4.16.5 Next Calibration date

4.17 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with ETA-HAC02, "Control of Test Conduct."

4.18 Speed-time measuring devices and other necessary equipment shall be installed in a manner that does not hinder vehicle operation or alter the operating characteristics of the vehicle.

4.19 All steps shall be completed in the order written. Deviations from any step or requirement must have the prior written approval of the Program Manager, Test Director or Test Manager in accordance with Procedure ETA-HAC02, "Control of Test Conduct."

4.20 All documentation required to complete the testing identified in the contract/proposal/technical guidelines shall be completed, approved and issued prior to the effective date of the procedure. In no case shall the procedure be utilized for official testing or data collection prior to its effective date.

4.21 Testing may take place over the course of several days. Page 1 of Appendix A shall be completed for each day testing is commenced.

5. Testing Activity Requirements

This test qualitatively evaluates the controllability of a vehicle when attempting to stop from 60 mph on a dry surface.

An asphalt vehicle dynamics pad shall be assembled as a straight path with a nominal length of 400 feet. The width of the lane should be 12 feet. Lane width shall be marked by the use of traffic cones or similar devices. Markers shall be a soft resilient material, which can withstand a vehicle impact, without damaging the vehicle.

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NOTE

During this testing, if a vehicle fails electrically or mechanically for any reason, testing of the vehicle shall be halted, and the vehicle removed from the test program until the Supplier has effected repairs. See ETA-HAC02, "Control of Test Conduct" for additional details.

NOTE

If the vehicle is equipped with regenerative braking, the regenerative braking system shall be engaged during this test. If the level of regenerative braking can be adjustable by the driver, the setting with the highest level of regenerative power shall be employed.

5.1 Instrument the vehicle to obtain the following data:

- 5.1.1 Speed versus time
- 5.1.2 Distance versus time
- 5.1.3 RESS temperature

5.2 Record the following environmental conditions on Appendix A:

- 5.2.1 Range of ambient temperature during the test
- 5.2.2 Range of wind velocity during the test
- 5.2.3 Range of wind direction during the test

5.3 Braking Test

- 5.3.1 Verify vehicles are in "normal operating mode."
- 5.3.2 Move the vehicle to the start area, and record the vehicle odometer reading.
- 5.3.3 Record the following information:
  - 5.3.3.1 Initial RESS SOC indicator reading
  - 5.3.3.2 Ambient temperature
  - 5.3.3.3 Wind speed and direction
- 5.3.4 Engage the fifth wheel.
- 5.3.5 Accelerate the vehicle to at least 60 mph (96 km/h) and enter the stopping lane.
- 5.3.6 From a speed of 60 mph +2/-0 mph, decelerate the vehicle in a controlled manner as rapidly as possible to a complete stop.
- 5.3.7 Measure the total distance required to stop the vehicle. Record on Appendix A.
- 5.3.8 Note any test deficiencies, moved or dislodged cones/markers, and any driver comments, on Appendix A.

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5.3.9 Return the vehicle to the start/staging area, and allow at least 15 minutes to pass before proceeding. Note the actual time duration on Appendix A.

5.3.10 Record the RESS SOC indicator reading on Appendix A.

5.3.11 Accelerate the vehicle to at least 60 mph (96 km/h) and enter the stopping lane from the opposite direction.

5.3.12 From a speed of 60 mph +2/-0 mph, decelerate the vehicle in a controlled manner to a complete stop as rapidly as possible.

5.3.13 Measure the total distance required to stop the vehicle. Record on Appendix A.

5.3.14 Note any test deficiencies, moved or dislodged cones/markers, and any driver comments, on Appendix A.

5.3.15 Record the following information on Appendix A:

5.3.15.1 Date and time of test completion

5.3.15.2 Equipment failures, if any;

5.3.15.3 Equipment abnormalities, if any;

5.3.15.4 Final RESS SOC Indicator reading;

5.3.15.5 Driver Notes, if any.

6. Glossary

6.1 Curb Weight - The total weight of the vehicle including batteries, lubricants, and other expendable supplies but excluding the driver, passengers, and other payloads.

6.2 Effective Date - After a procedure has been reviewed and approved, the first date the procedure can be utilized for official data collection and testing.

6.3 Fifth Wheel - A calibrated mechanical instrument used to measure a vehicle's speed and distance independent of the vehicle's on-board systems.

6.4 Gross Vehicle Weight - The maximum design loaded weight of the vehicle specified by the Supplier.

6.5 HEV America – Hybrid Electric Vehicle America Performance Test Program, the DOE sponsored test program for independently assessing the performance of vehicles submitted for testing.

6.6 Initial Conditions - Conditions that must exist prior to an event occurring.

6.7 Initial State of Charge (SOC) - RESS SOC at the beginning of a test.

6.8 Prerequisites - Requirements that must be met or resolved prior to an event occurring.

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6.9 Program Manager - As used in this procedure, the individual within Electric Transportation Applications responsible for oversight of HEV America. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

6.10 Safe Stopping Distance - The distance required to bring a vehicle to a complete stop from a pre-determined speed, without losing control of the vehicle.

6.11 Shall - This word is used to indicate an item which requires adherence without deviation. Shall statements identify binding requirements. A go, no-go criterion.

6.12 Should - This word is used to identify an item which requires adherence if at all possible. Should statements identify preferred conditions.

6.13 State of Charge (SOC) - For vehicles operable in "RESS only mode," the SOC of the RESS is defined as the present capacity, (amperes-hours or watt-hours or miles), expressed as a percentage of the total available. The 100% SOC basis (available ampere-hours, kilowatt hours or miles) is determined by the actual discharge capability of the RESS when discharged to the requirements of the 45 mph Constant Speed Range Test portion of procedure ETA-HTP04.

6.14 Test Director - The individual within Electric Transportation Applications responsible for all testing activities associated with HEV America.

6.15 Test Director's Log - A daily diary kept by the Test Director, Program Manager, Test Manager or Test Engineer to document major activities and decisions that occur during the conduct of a Performance Test Evaluation Program. This log is normally a running commentary, utilizing timed and dated entries to document the day's activities. This log is edited to develop the Daily Test Log published with the final report for each vehicle.

6.16 Test Engineer - The individual(s) assigned responsibility for the conduct of any given test. [Each contractor/subcontractor should have at least one individual filling this position. If so, they shall be responsible for adhering to the requirements of this procedure.]

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6.17 Test Manager - The individual within Electric Transportation Applications responsible for the implementation of the test program for any given vehicle(s) being evaluated to the requirements of HEV America. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

6.18 Yaw – the movement of a vehicle slightly to the side of its intended direction

7. References

7.1 HEV America Vehicle Specification

7.2 ETA-HAC01 - "Control, Close-out and Storage of Documentation"

7.3 ETA-HAC02 - "Control of Test Conduct"

7.4 ETA-HAC04 - "Review of Test Results"

7.5 ETA-HA06 - “Vehicle Verification”

7.6 ETA-HAC08 - "RESS Charging"

7.6 ETA-HTP11 - “Vehicle Verification”

7.7 SAE J688 - "Truck Ability Prediction Procedure," Aug87, SAE Recommended Practice

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APPENDIX-A
Braking Test Data Sheet (Page 1 of 3)

VIN Number: _____

Project No.:	Test Date(s):
Root File No.:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Curb weight plus 332 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	

INSTALLED TIRES (Placard or sidewall whichever is less)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

Track/Weather Conditions

Test Track Location:	Track Grade: %
Ambient Temperature (initial): (≥40°F or 5°C)	Ambient Temperature (final): (≥40°F or 5°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (completion): °

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APPENDIX-A
Braking Test Data Sheet
(Page 2 of 3)

VIN Number:_____ **(Controlled Dry Test)**

Sequence No: 1	File No.:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC,kWh,Ah)	State of Charge (final): (SOC,kWh,Ah)	
RESS Temp (initial): (60-120°F or 16-49°C)	RESS Temp (final): (°F or °C)	
Comments (initials/date): Speed at the Start of Braking: _____ Distance Required to Stop Vehicle: _____		
Sequence No: 2	File No.:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC,kWh,Ah)	State of Charge (final): (SOC,kWh,Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date): Speed at the Start of Braking: _____ Distance Required to Stop Vehicle: _____		

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APPENDIX-A
Braking Test Data Sheet
(Page 3 of 3)

VIN Number:_____

General Comments (initials/date):

Completed By:
(Printed Name) (Signature) (Date)

Reviewed By:
(Printed Name) (Signature) (Date)

Approved By:
(Printed Name) (Signature) (Date)

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APPENDIX-B
Vehicle Metrology Setup Sheets
(Page 1 of 1)

VIN Number: _____

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		
Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By (QA): (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

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