APPENDIX K

TECHNICAL SUPPORT DOCUMENT FOR ECONOMIC IMPACTS RELATED TO THE PROPOSED EXHAUST AND EVAPORATIVE TEST PROCEDURE AMENDMENTS

Date of Release: December 5, 2008
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Exhaust Test Procedure Cost Analysis

Vehicle Testing

The current Exhaust Test Procedures are the basis for evaluating the cost impact of the proposed test procedure. In comparing the current procedures with the proposed procedures, an analysis is made for a PHEV[1] that has only all-electric range during charge depleting operation since it can be fully tested by both procedures. A blended type PHEV cannot be fully tested using the current procedures, so it cannot be reasonably compared to the proposed procedure.

For this cost analysis, a hypothetical PHEV with a 40-mile all-electric range is chosen. This vehicle is a near worst case example for a PHEV since it would have a charge depleting range of 40 miles, requiring many test cycles to reach charge-sustaining conditions. Most PHEVs introduced initially are expected to have a charge depleting range of around 10 miles.

The cost estimate is based on the following assumptions:

1. The cost of electrical measurement for battery SOC, alternating current (AC) charging, the cost of fuel and drain, and road load derivation is roughly the same between current and proposed procedures.

2. The vehicle emissions test cell is equipped with a relatively new emission sampling and measurement system capable of SULEV emissions measurement.

3. The energy to fully charge after the urban charge-sustaining test or highway charge-sustaining test is assumed to be the same. Although it is possible that the urban and highway charge energies could differ, manufacturers have indicated that they will be the same, which will minimize testing.

4. Prior to the charge-sustaining emission test, it is assumed that at the vehicle battery is either at the charge-sustaining SOC or can be discharged to the charge-sustaining SOC by means of on-road driving.

5. For cold temperature tests at 20°F and 50°F the current procedures only required the vehicles to be tested in charge-sustaining operation. However, the proposed procedures require vehicles to be tested in the worst case of charge depleting or charge-sustaining operation, based on results from the urban charge depleting and charge-sustaining tests. For charge-sustaining tests, testing cost for the current and proposed procedures would be the same. However, for the

[1] Staff is using the more common term of PHEV for readability. The use of PHEV is not meant to restrict the use of the vehicles to receive charging only from the grid, as with the PHEV definition used in Pavely. To address this restriction, staff refers to these vehicles as off-vehicle charge capable hybrid electric vehicles or OVCC HEVs through out the test procedures and regulatory text.

proposed procedure some vehicles will require a charge depleting test instead of the charge-sustaining test. For the purpose of this cost analysis it is assumed that for charge depleting operation at cold temperatures, vehicles will start the engine within the first UDSS to protect the battery and to warm the vehicle for passenger comfort, rather than using electrical energy from the battery. Based on this assumption, the cost for cold temperature charge depleting and charge-sustaining tests would be the same.

6. For simplicity the urban all-electric range and the highway all-electric range are identical.

Individual Test Costs

Table K-1 shows individual test costs. These are typical costs for a commercial vehicle test laboratory. Staff surveyed three laboratories and averaged the individual test cost information.

Table K-1
Cost per Test Type

Test Type	Cost per Test in $
UDDS	850
HFEDS	600
US06	700
SC03	700
UDDS w/o emissions	450
HFEDS w/o emissions	350
US06 w/o emissions	400
Canister Preconditioning	150

Total Cost of Current Exhaust Test Procedure

Table K-2 shows the cost for the current test procedure for the example vehicle. The table shows the type and quantity of required tests. The total testing cost of the current procedures is $10,400.

Table K-2
Current Procedure Testing Cost - 40-mile AER PHEV

Test Sequence	Test Description	Tests Required	No. of Tests	Cost per Test, $	Total Cost, $
- Day 1	City All-Electric Range Test	UDDS w/o emissions	6	450	2,700
Day 2	Highway All-Electric Range Test	HFEDS w/o emissions	4	350	1,400
Day 3	Vehicle Preparation	UDDS w/o emissions	1	450	450
		Canister Preconditioning	1	150	150
Day 4	Urban Exhaust Emissions Test	UDDS	2	850	1,700
	Highway Emissions Test	HFEDS	2	600	1,200
	US06 Emission Test	US06	2	700	1,400
	SC03 Emission Test	SC03	2	700	1,400

Total Cost - Current Procedure **$10,400**

Total Cost of Proposed Exhaust Test Procedure

Table K-3 shows cost a similar cost analysis for proposed procedures. The proposed procedures increase the number required for some test types. The total testing cost of the current procedures is $15,200.

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Table K-3
Proposed Procedure Testing Cost - 40-mile AER PHEV

Test Sequence	Test Description	Tests Required	No. of Tests	Cost per Test, $	Total Cost, $
Day 1	Vehicle Preparation	UDDS	2	850	1700
		Canister Preconditioning	1	150	150
Day 2	Urban Charge Depleting Range Test	UDDS w/o emissions	5	450	2250
		UDDS	3	850	2550
Day 3	Urban Charge-Sustaining Emission Test	UDDS	2	850	1700
Day 4	Highway Charge Depleting Range Test	HFEDS w/o emissions	3	350	1050
		HFEDS	2	600	1200
Day 5	Highway Charge-Sustaining Emission Test	HFEDS	3	600	1800
	US06 Emission Test	US06	2	700	1400
	SC03 Emission Test	SC03	2	700	1400

Total Cost - Proposed Procedure **$15,200**

Vehicles qualifying for the Type G PHEV option would require five additional US06 non-emission tests yielding an additional cost of $2000.

Cost Differential

As shown below, staff estimates that proposed test procedures would increase testing cost for PHEVs by $4,800

Proposed Procedure Testing Cost: $15,200
Current Procedure Testing Cost: $10,400

Increased Testing Cost of Proposed Procedures: $ 4,800

For the Type G PHEV, the differential cost would increase by $2000 for total of $6,800.

A similar analysis was performed for a PHEV with a 10-mile all electrical range, which also showed an increased testing cost of the proposed procedure to be $4800. Therefore, depending on range, the proposed procedures would increase testing costs by $4,800 to $6,800.

The typical overall costs of testing a blended PHEV are expected be less than that of testing a PHEV with significant all-electric range for the proposed procedure. This is because a blended PHEV is typically expected to use a smaller battery than a PHEV with significant all-electric range. The smaller battery of the blended PHEV will result in less electric range and fewer test cycles to deplete the battery, and therefore result in reduced testing costs. In addition, blended PHEVs will typically not be subject to the associated costs of testing for a Type G advanced componentry allowance, since most if not all will not qualify for it. The following example in Table K-4 represents a PHEV with a 10 mile EAER. This vehicle cannot be adequately tested on the current procedure, so a comparison cannot be made to the current test procedure.

Table K-4
Proposed Procedure Testing Cost - 10 mile Blended PHEV

Test Sequence	Test Description	Tests Required	No. of Tests	Cost per Test, $	Total Cost, $
Day 1	Vehicle Preparation	UDDS	2	850	1700
		Canister Preconditioning	1	150	150
Day 2	Urban Charge Depleting Range Test	UDDS	4	850	3400
Day 3	Urban Charge-Sustaining Emission Test	UDDS	2	850	1700
Day 4	Highway Charge Depleting Range Test	HFEDS	2	600	1200
Day 5	Highway Charge-Sustaining Emission Test	HFEDS	3	600	1800
	US06 Emission Test	US06	2	700	1400
	SC03 Emission Test	SC03	2	700	1400

Total Cost - Proposed Procedure **$12,750**

Test Facility Costs

To accommodate the new test cycles in the proposed procedures such as the continuous urban test, continuous highway test, and continuous US06, test facilities may require hardware and software upgrades. These upgrades are estimated to cost from $20,000-$100,000 depending on upgrades necessary. This would be a one-time additional cost. The proposed procedures are not expected to significantly change facility maintenance costs.

Evaporative-Related Test Procedure Cost Analysis

Vehicle Testing

The current HEV Evap Test Procedures are used as the basis for evaluating the cost impact of the proposed amendments. There are two distinct changes to these test procedures that impact the associated costs. The first one is the requirement that the vehicle-preconditioning step for 2011 and subsequent model-year PHEVs include at least one UDDS conducted in a charge-sustaining mode of operation instead of the current requirement for HEVs to conduct only a single UDDS. In general, manufacturers are expected to be able to satisfy this vehicle-preconditioning requirement using a single UDDS. However, depending on their own particular design, other manufacturers may choose a more conservative approach of conducting two consecutive UDDS cycles. Thus, staff used the conservative approach in estimating the extra cost of conducting a second UDDS, along with performing both UDDS cycles in a charge-sustaining mode of operation. The second cost-impacting change is the requirement that PHEVs equipped with non-integrated refueling canister-only system use the new fuel-tank-refill canister-loading method. This new method increases the canister-preconditioning costs because it requires more steps and amount of test fuel, in aggregate, needed to perform the process.

The cost impacts related to the proposed vehicle-preconditioning changes are applicable to both AER and blended PHEVs. The cost impacts involving the new fuel-tank-refill canister-loading method are applicable to both AER and blended PHEVs that are equipped with non-integrated refueling canister-only systems. Accordingly, the cost analysis is not specific to any particular type of PHEV. Furthermore, the cost analysis uses the following assumptions:

1. Prior to conducting the vehicle-preconditioning step, it is assumed that the vehicle battery is either at the charge-sustaining state of charge or can be discharged to the charge-sustaining state of charge by means of on-road driving.

2. Laboratories that will perform testing of non-integrated refueling canister-only system-equipped PHEVs are already equipped with an ORVR-capable SHED, along with the ancillary refueling equipment.

3. A “representative” fuel tank capacity of 12 gallons is assumed for estimation purposes. This is the approximate fuel tank capacity of a current model-year Toyota Prius hybrid-electric vehicle at an ambient temperature of 70ºF.

Additionally, cost estimates used in the analysis are based on limited information from two commercial test laboratory sources.

Total Cost of Current Evaporative Tests

Estimated costs for the current evaporative-related tests are listed in Table K-5. These estimates include $8,000 for the 3-Day Diurnal plus Hot Soak test sequence (which includes the Running Loss test); $3,000 for the 2-Day Diurnal plus Hot Soak test sequence (which does not include any exhaust emission sampling); and, $6,760 for the ORVR test.

Table K-5
Current Evaporative Test Costs

Test Sequence	Cost per Test ($)
3-Day Diurnal + Hot Soak Test Sequence (w/RL Test)[a]	8,000
♦ 3-Day Diurnal + High-Temp. Hot Soak Test (3D+HS)	4,500
♦ Running Loss Test (RL) (point-source method)	3,500
2-Day Diurnal + Hot Soak Test (no exhaust sampling)	3,000
ORVR Test	6,760

[a] The "3-Day Diurnal + Hot Soak Test Sequence" includes both the 3D+HS test and the RL test.

Proposed Fuel-Tank-Refill Canister-Loading Method Costs

The additional costs associated with the proposed fuel-tank-refill canister-loading method for preconditioning canisters on PHEVs equipped with non-integrated refueling canister-only systems are indicated in Table K-6. These total cost of the extra procedural steps and test fuel amounts are approximately $1,400.

Table K-6
Additional Cost For Proposed Fuel-Tank-Refill Canister-Loading Method

Additional Step	Cost per Test ($)
Vehicle soak (6 – 24 hr at 80ºF)	900
Fill/drain step	200
Fuel required (total)[a]	285
Total Cost:	**~1,400**

[a] Estimated cost of delivered certification test fuel is $25.00/gallon.

Evap Test Total Costs – Proposed Non-Integrated Refueling Canister-Only Equipped PHEVs

Estimated total costs for conducting the proposed evaporative-related tests of PHEVs equipped with non-integrated refueling canister-only systems are provided in Table K-7. These estimates include $10,650 for the 3-Day Diurnal plus Hot Soak test sequence (including the Running Loss test), $5,650 for the 2-Day Diurnal plus Hot Soak test sequence (no exhaust emission sampling), and $9,410 for the ORVR test.

Table K-7
Proposed Evaporative Test Sequence Total Costs

Test Sequence Description	No. of Tests	Cost per Test ($)	Total Cost ($)
3-Day Diurnal + Hot Soak Test Sequence (w/RL Test)	1	8,000	8,000
Delete: UDDS w/o emissions (ref. Table 1)	1	450	-450
Add: UDDS (ref. Table 1)	2	850	1,700
Add: Fuel-Tank-Refill Canister-Loading Method	1	1,400	1,400
Total Cost:			**10,650**
2-Day Diurnal + Hot Soak Test	1	3,000	3,000
Delete: UDDS w/o emissions (ref. Table 1)	1	450	-450
Add: UDDS (ref. Table 1)	2	850	1,700
Add: Fuel-Tank-Refill Canister-Loading Method	1	1,400	1,400
Total Cost:			**5,650**
ORVR Test	1	6,760	6,760
Delete: UDDS w/o emissions (ref. Table 1)	1	450	-450
Add: UDDS (ref. Table 1)	2	850	1,700
Add: Fuel-Tank-Refill Canister-Loading Method	1	1,400	1,400
Total Cost:			**9,410**

Estimated Cost Differential

Comparing the estimated total costs for the current test procedures (Table K-5) and the proposed test procedures (Table K-7) shows a cost difference of $2,650 for PHEVs that are equipped with non-integrated refueling canister-only systems. This estimated cost difference is applicable to all of the evaporative-related test sequences, including the 3-Day Diurnal plus Hot Soak test sequence (with the Running Loss test), 2-Day Diurnal plus Hot Soak test sequence (no exhaust emission sampling), and the ORVR test.