

# **Interactive Breakout Session – Hybrid Electric Vehicles**

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# Group Discussion

- ❑ Discuss various solutions to meet proposed OBD-II requirements; pros and cons

Discussion points are in red font

- ❑ Industry-wide consensus rating (red, yellow, green) for OBD technology development.

Ratings not done

# OBD Requirements for HEVs

## ❑ Definition of Hybrid Vehicle

Mild or Advanced Technology - Ford Escape and Toyota Prius are advanced technology hybrids. GM pickup is mild hybrid with start/stop.

## ❑ Unique operating modes

engine-off modes - CARB general denominator does not give special preference to hybrids - idle timer for general denominator must count up whether the engine is on or off.

effect of engine-off modes on in-use rates - Ford had to start engine (intrusively) to run evap leak check at idle when engine would normally be off. Not legal to use in-use rates to alter entry conditions for monitors.

definition of engine start for misfire, etc – must start monitoring 2 revs after engine spins up and fuelling is started. Ford had to develop unique algorithm to detect when all cylinders were misfiring.

# OBD Requirements for HEVs

## □ Applying definition of “affects emissions”

15% increase in emissions (25% for PZEV) – affects emissions is a 15% of the standard increase in emissions over a baseline run. FTP increase is applied to SFTP results (is about 3% increase in SFTP – does not make engineering sense, but that’s how reg is written. Even if component is not electrical input/output to PCM, it may have to be monitored if failure affects emissions. Answer emission question, then talk to CARB.

## □ HEV Failure Modes

vehicle shutdown – bad failure mode for customer, but vehicle does not make emissions so no MIL is required. Not legal to shut down vehicle just to avoid lighting MIL.

mitigating emission effect – Failure mode actions can be designed to mitigate emission increases during failure, e.g. limit power enrichment during failure mode.

# OBD Requirements for HEVs

## ❑ Fuel Operated Heater Emissions

accounting for tailpipe and evap emissions – FOH for gasoline PZEV vehicle probably impossible. Will not meet evap standards if heater fuel injector leaks or heater fails to ignite. OK for diesel.

## ❑ Active / Passive devices

Passive device does not ensure that monitoring is not required. Depends on the emission impact, feasibility. Talk to CARB. Examples were air intake HC trap and fuel cooler. HC was not monitored because it was not a primary emission control (added safety margin), was inaccessible to customer so unlikely to be tampered with, no monitoring technology available. Fuel cooler example requires data to see if emissions are affected by failure, then talk to CARB.

# Unique Hybrid Components

- ❑ Traction Battery Systems: provides power to the electric motor during vehicle acceleration.

Emission impact when battery fails? – Ford tested with battery at various states of charge (lowest state of charge was just enough to start engine.) Result was < 25% increase in PZEV emissions on FTP and SFTP so no MIL. Catalyst system had been sized so that the vehicle could meet emissions with the engine on all the time. Battery State of Charge (SOC) must be 1% from start to end of FTP to have valid test. (Starting SOC is not regulated.)

Standalone OBD controller? – no, battery controller reports codes through PCM for Escape.

# Unique Hybrid Components

- ❑ Motor / Generator Systems: generates wheel torque / generates electric power.

Emission impact when motor / generator fails? – Some failure modes will shut down the vehicle. No MIL required (no emissions impact), but fault still stores code and lights “wrench” light.

Standalone OBD controller? – yes, Escape TCM (controls motor/generator/CVT trans) is standalone controller. Lights MIL, stores codes and Freeze Frame.

# Unique Hybrid Components

- ❑ Hybrid Brake systems: recovers energy through regenerative braking.

Emission or fuel economy impact? – No emissions effect on Escape, loss of fuel economy, however, MIL not required for FE loss.

- ❑ High to low voltage DC/DC converters:

Similar to alternator failure modes?

Emission or fuel economy impact? – probably not, no discussion.

# Unique Hybrid Components

- ❑ Electric AC compressor: replaces the FEAD belt driven AC compressor on many hybrids. – little discussion, probably no emission impact.
- ❑ Battery cooling system: cools the battery to optimize battery energy on many hybrids. – A/C often used to cool hybrid battery pack. Don't check battery when environmental condition are very cold or very hot since accurate battery status is not available.

# Unique Hybrid Components

- ❑ Ignition Switch Run/Start input: used to start the shutdown sequence in hybrids. – no discussion, unique HEV component.
- ❑ Transmission Range Sensor: used for determining magnitude and direction of wheel torque application. - no discussion, unique HEV component if “drive by wire” (no mechanical lever position).