

**CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
AIR RESOURCES BOARD**

**SUPPLEMENTAL STAFF REPORT:
PROPOSED RULEMAKING FOR PLUG-IN HYBRID-ELECTRIC VEHICLES**

**MODIFICATIONS TO THE PROPOSED
AFTERMARKET PARTS CERTIFICATION REQUIREMENTS**

Location:
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This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Executive Summary

In January 2009, staff presented certification test procedures for plug-in hybrid electric vehicles (PHEV) along with certification procedures for aftermarket PHEV conversion systems. The Board adopted the certification test procedures for new PHEVs, but asked that staff return with a proposal for the conversion system requirements that allowed more flexibility and created a phased approach to certification that encouraged development of systems. Staff is returning to the Board with this proposal which creates a tiered approach to certification of PHEV conversion systems starting with application and engineering analysis that shows that there are no emission increases compared to the unconverted vehicle for the first ten units; requiring emission testing for the subsequent 90 units; and full certification for units thereafter. Warranty requirements for systems are also phased in. Staff is proposing to limit use of this tiered certification program to the first 5,000 units industry wide in order to allow the industry to get started with the expectation that technology maturity will develop sufficiently by the time 5,000 units are certified that traditional aftermarket certification requirements can be used thereafter.

Staff has identified some risk to emissions performance associated with this certification approach. It is staff's expectation that the initial engineering analysis included in the first tier of the certification process will identify how the systems will control cold start and evaporative emissions; however, if this analysis is wrong or if the systems fail to deliver durable emissions performance, the conversion system failures could lead to significantly increased emissions compared to the unconverted vehicles. For this reason, staff recommends adoption of the proposed tiered certification procedures with the limited numbers of vehicles per tier and the 5,000 total systems cap for the industry. This would cap the worst case potential emission increase at 19.4 tons per year of excess oxides of nitrogen plus non methane organic gases. The economic impacts of this proposal are largely the same as the original staff proposal; however they are spread out over the manufacturer's first 100 vehicle conversions, providing conversion companies with a revenue stream to support certification costs.

Introduction

The most recent changes to the zero emission vehicle (ZEV) regulation, considered in March 2008, included provisions that strongly encourage commercialization of PHEV or off vehicle charge capable hybrid electric vehicles (HEV). However existing regulations governing emission test procedures applicable to PHEVs needed to be modified and certification procedures for conversions needed to be created to fully implement the incorporation of this vehicle technology. At its January 23, 2009, public hearing, the Air Resources Board (ARB or Board) considered staff's proposed regulations for the certification of PHEV conversion systems and emission test procedures applicable to PHEVs. These certification procedures are required because any emission related vehicle modification requires an exemption from California's anti-tampering statute, Vehicle Code

section 27156. The anti-tampering exemption is needed to assure that vehicle modifications do not cause increase emissions.

During the Board Hearing several conversion system manufacturers expressed that the proposed certification procedures were too costly, would stifle innovation, would severely impact small businesses, and might eliminate the technology. At the conclusion of the hearing, the Board requested that staff continue to meet with PHEV conversion system manufacturers to determine if additional flexibility could be incorporated into the certification procedures. The Vehicle Code limits the amount of flexibility that can be given. Staff met with PHEV system manufacturers and held an additional public workshop on March 25, 2009, to consider whether additional flexibility could be provided without violating the Vehicle Code.

Staff is proposing modifications to the PHEV conversion system certification regulations to provide additional flexibility to conversion system manufacturers, while staying within the guidelines of the Vehicle Code and limiting the potential emissions impacts of converted vehicles should tests show that application statements are not validated. This is accomplished through a tiered certification requirement system, which allows conversion manufacturers to sell a limited number of vehicles as they move through the certification process. This Supplemental Staff Report describes staff's revised proposal for the certification of PHEV conversion systems.

At the January 2009, hearing's conclusion, the Board also approved with modifications, staff's proposals for emission test procedures applicable to PHEVs. This Supplemental Staff Report does not review the emission test procedures because the Board's approved modifications will be available separately when staff releases a notice of availability of modified text. Additional information on the emission test procedures is available on ARB's internet website at:

<http://www.arb.ca.gov/regact/2008/phev09/phev09.htm>.

Overview of Current Certification Processes

Currently, certification or installation procedures designed specifically for PHEV conversion systems do not exist. In the absence of certification procedures, PHEV conversion systems may be certified two ways: an exemption from the anti-tampering requirements or recertifying the entire vehicle. PHEV conversions systems may be granted an exemption from the anti-tampering requirements, using procedures for exemption add-on and modified parts, provided the converted vehicle can meet the emission certification standards and the onboard diagnostic system requirements of the original vehicle. This exemption procedure does not include warranty provisions and is not applicable to conversion of vehicles still operating under the OEM's warranty.

Many PHEV conversion system manufacturers want to convert hybrid electric vehicles that are still operating under the original equipment manufacturer's (OEM) warranty. For HEVs certified as partial zero emission allowance vehicles (PZEV), the OEM warranty is 15 years or 150,000 miles for all emission related components and 10 years or 150,000 miles for the zero emission energy storage device. An example of a zero emission energy storage device is a battery.

Currently, a conversion system manufacturer modifying a vehicle still covered by the OEM warranty must certify the converted vehicle as a new vehicle and be responsible for the entire vehicle as a small volume manufacturer. An application for certification must be submitted to and approved by ARB and the U.S. Environmental Protection Agency, concurrently. Uncertified conversions would violate California's anti-tampering statute.

Proposed Modifications

ARB staff proposes modifications to staff's originally proposed certification procedures to provide additional flexibility to conversion system manufacturers, while limiting the potential emissions impacts of converted vehicles and addressing the requirements of the anti-tampering regulation. The proposed modifications provide for a three-tiered certification process. The proposed tiered certification process grants a manufacturer certification based on conversion system production and sales numbers and allows the gradual increase in certification requirements to address increased emissions impact potentials. In addition, staff desires to keep these procedures aligned with the certification procedures for alternative fuel conversions.

The staff's revised proposed aftermarket certification procedure provides a streamlined process for PHEV conversion system manufacturers to certify their products, while balancing the economic concerns expressed at the January Board Hearing. The proposed certification procedure is less onerous than ARB's small volume manufacturer requirements or staff's original proposal for PHEV conversion system certification. Staff's revised proposal modifies the certification and installation procedures by breaking the certification requirements into three tiers. Each tier contains additional certification requirements. Once the requirements of the next tier are met, conversion companies can increase their sales. Tier 3 is similar to staff's original proposal. The revised certification procedure assures, however, that a conversion system does not increase the original vehicle's emissions. With this assurance, the revised certification procedures fulfill the criteria for exemption from California's anti-tampering statute, while allowing the additional flexibility needed to address the cost to comply.

Tier 1 allows the sale of up to 10 vehicle conversion systems. In the first tier, the conversion system manufacturer's application must address five main criteria: initial durability component data, a durability test plan for the converted vehicle, a consumer manual that shows at least a three-year or 50,000-mile warranty on the conversion system, a discussion on the process to maintain records of sales and installations, and an engineering analysis showing that conversion does not impact the emissions of the original vehicle.

Tier 2 allows the sale of up to 100 vehicle conversions. In the second tier, manufacturers must meet the first tier requirements along with three additional criteria: provide an onboard diagnostic compliance plan, submit a consumer manual which shows at least a warranty of 5 years or 75,000 miles, and submit emission test data which shows that the vehicle meets applicable emission standards, and does not trigger the onboard diagnostics malfunction indicator light (MIL) or diagnostic trouble code (DTC). During the second tier, ARB may perform confirmatory testing to verify the emission test data.

In the third tier, conversion system manufacturers must fully comply with the emission test procedures, among other requirements, to achieve certification. The requirements must be met when a manufacturer has sold 100 vehicle conversions. For this tier, all of the requirements of the previous two tiers must be met along with proof that the following requirements are met:

- The battery durability requirement is completed;
- The durability of the conversion is proven to last through the vehicle's useful life;
- The converted vehicle must fully comply with onboard diagnostics;
- The warranty must go through the remaining OEM warranty or the requirements in the second tier, whichever is longer; and
- The exhaust-, evaporative-, and on-board-vapor-recovery-refueling emission standards testing for hybrid electric vehicles are satisfactorily completed.

The proposed regulatory language is shown in Appendices A and B.

For the third tier, the conversion system certification requirements are similar to what staff proposed at the January Board Hearing with the exception of the warranty. The conversion system warranty originally proposed in the December 5, 2008, Staff Report was equivalent to the OEM warranty: 15 years or 150,000 miles, and 10 years or 150,000 miles for the zero-emission energy-storage device. In the new proposal the third tier requires a five-year or 75,000-mile warranty or the remaining OEM warranty whichever is greater, and thus reduces the warranty requirements.

The compliance flexibility of the tiered certification procedure applies to the manufacturer and not to individual conversion system designs. Therefore a manufacturer may choose to submit multiple applications for different conversion system designs; however, only ten total conversions per manufacturer can be certified under Tier 1. This allows each company to make a decision on how many systems to develop and what will best serve the company's goals. After 5,000 vehicles are converted industry-wide, Tier 1 and Tier 2 options are no longer available. This limits and controls the overall potential emissions and economic impacts for the tiers as will be discussed in the next section.

The proposed tiered certification process provides additional flexibility that is balanced with the potential impacts to air quality and the economy. The flexibility is provided to encourage the conversion system industry to certify vehicles and, therefore, operate legally in California. As product sales increase, staff anticipates conversion system manufacturers will have the resources to meet each tier of certification requirements.

Table 1 on the following page summarizes staff's proposal for tiered certification of PHEV conversions.

Table 1: Proposed Tier Requirements

Tier [†]	Number of systems that can be sold in the tier ¹	Requirements prior to sale in the tier	Action items to proceed to next tier
1	0-10	<ol style="list-style-type: none"> 1. Application (see below for items to be included) 2. Engineering analysis showing no impact on emissions (specifically canister purge and cold starts) 3. Submit durability test plan² and initial durability data (component and in-use)³ 4. System Warranty 3yr/50K mi 5. Installation Warranty 3yr/50K mi 6. ARB approval of engineering analysis & submittal prior to exemption/sale 	<ol style="list-style-type: none"> 1. Conduct emission tests. 2. Develop process for compliance with OBD. 3. Maintain record of sales/installations. 4. Durability test plan begins for their vehicle³
2	11-100	<ol style="list-style-type: none"> 1. Application for Tier 2 2. Emission test data 3. Show that durability testing has begun³ 4. Show of readiness indicators set and no OBD MIL/ DTC during emission tests 5. OBD compliance plan 6. System warranty: 5yr/75K mi 7. ARB may perform confirmatory testing to verify emission test data. If requested, provide test vehicle. 8. ARB approval of submittal prior to exemption/sale 	<ol style="list-style-type: none"> 1. Start OBD compliance process. 2. Maintain record of sales/installations. 3. Continue durability testing
3	101+	<ol style="list-style-type: none"> 1. Application for Tier 3 2. Durability test data to vehicle useful life³ 3. Battery durability/test data 4. OBD approval 5. System warranty: 5yr/75K mi or remaining OEM warranty, whichever is longer 6. ARB approval of submittal prior to exemption/sale 	<ol style="list-style-type: none"> 1. ARB will begin in-use testing. If requested, conversion manufacturers provide converted vehicles³. 2. Maintain record of sales/installations.

[†] The tiered system ends and is no longer available for any manufacturer after a cumulative total from all manufacturers reaches 5000 vehicle conversion kits. For the 5001st vehicle conversion and all conversions thereafter, all manufacturers must meet the full certification requirements in the regulation. OBD compliance flexibility is still available under the OBD regulations.

¹ The experimental permit process allows manufacturers to produce a prototype system and test up to 5 vehicles. Manufacturers must apply for the permits and the vehicles cannot be sold.

² Plan must be for useful life of vehicle.

³ Up to 5 vehicles temporarily needed for in-use testing.

Potential Impacts of the Proposed Modifications

Warranty Impacts

Most hybrid electric vehicles (HEV) that conversion manufacturers are interested in providing systems for are certified to partial zero emission vehicle (PZEV) emission standards. These vehicles come with a 15-year or 150,000-mile warranty on the emissions system and a 10-year or 150,000 mile warranty on the zero-emission energy-storage device. In the case of HEVs, the zero-emission energy-storage device would most likely be a battery. Warranties on the emissions system are a valuable tool to encourage consumers to repair their vehicle and guarantee the emission benefits of those cars operating in California. Staff has determined that consumers typically fix emission related problems with their vehicles only if required through SmogCheck, recalls or if covered by warranty. Converting a vehicle could impact the OEM warranty, if a defect in the conversion is determined to cause the damage to the OEM's system.

Emission Impacts

While staff believes a PHEV conversion can be done without increasing the vehicle's emissions, installations or configurations must be made carefully to prevent significant increases to the original vehicle's emissions. Staff has evaluated the potential emission impact of PHEV conversions. Based on emissions testing performed on several converted PHEVs, a PHEV conversion system can easily increase the original vehicle's exhaust emissions up to five times the amount its original certification value. In addition, the evaporative emissions can increase to up to 16 times the amount of its original certification value. Table 2 shows a comparison of PZEVs (the certification standard for the original vehicle) and the potential emissions of PHEV conversions without careful consideration of cold start and evaporative emissions.

Table 2: Potential Increase in Emissions from 5000 PHEV Conversions in TPY*

	NOx	Hwy NOx	NMOG	CO	PM
PZEV	1.2	1.7	1.3	57	0.6
Potential PHEV conversion	5.8	8.6	13.8	287	2.9
Incremental Increase	4.6	6.9	12.5	230	2.3

* Assumes 11,500 miles per year

A vehicle's emissions come predominantly from internal combustion engine starts. Catalytic converters are designed to reduce these emissions, but catalytic converters must be adequately warmed for the emissions system to work properly. Hybrid systems operate on an electric motor, an internal combustion engine, or a combination of both. Emission increases can occur with multiple engine starts during a single vehicle trip,

and inadequate warming of the catalytic converter. In an HEV, the internal combustion engine starts and stops depending on user demand and the amount of energy stored in the energy storage device. If user demand exceeds the amount of energy stored, the vehicle's computer will trigger the internal combustion engine start. Examples of this would include high acceleration rates, streets with high grades, or even simple driving habits if the battery is depleted. If this consumer demand occurs when the catalytic converter is not adequately warmed the emissions will be higher as well.

Converting hybrids to add plug in capability can increase evaporative emissions, as well. Careful consideration of the canister limitations must be evaluated. If the conversion prevents the internal combustion engine from purging the canister or the control system from recognizing when the internal combustion engine should purge the canister, emission breakthrough will occur.

Verification of Emissions Performance

To ensure that the emissions do not increase, maintenance and periodic checks are necessary to ensure that the emissions do not increase over the life of the vehicle. In addition, three programs determine if emission related issues exist: certification, SmogCheck, and in-use testing.

The certification requirements include provisions which require the conversion system manufacturer to demonstrate that the conversion does not increase the original vehicle's emissions throughout the useful life of the vehicle. Generally, for aftermarket conversions, the demonstration is made through emission and durability testing. Through aftermarket certification, these two demonstrations are used to determine if the vehicle meets the anti-tampering requirements prior to public sale.

For most vehicles, SmogCheck is the main tool that is used after certification to determine if vehicles have emission related problems and need emission systems repair. SmogCheck does not determine if a vehicle meets its ARB certification values. At best, the SmogCheck tailpipe test identifies vehicles meeting in-use exhaust emission levels that were more than two or three times the vehicle exhaust emission standards. All 1993 and newer model year vehicles are held to the same SmogCheck tailpipe in-use levels even though certification standards have dropped by at least an order of magnitude. In addition, conversion installations are usually verified for correct installation and checked for ARB certification at SmogCheck stations. However, HEV testing is not available under the existing SmogCheck process and these vehicles are exempt from Smog Check through January 2010 for purposes of vehicle registration renewal.

HEVs are currently excluded from SmogCheck because the current SmogCheck test has a mandatory tailpipe test and these results must be electronically recorded in order for the vehicle to pass. Since HEVs have two modes of motive power and, therefore, do not always utilize the internal combustion engine, an HEV will not reliably run the internal combustion engine during the tailpipe test. This will cause a SmogCheck failure since the analyzer thinks the technician has not run the test correctly (failed to turn the engine on, is diluting the tailpipe exhaust, etc.). The Bureau of Automotive Repair (BAR) plans to modify the test to allow HEVs to receive all the other elements of the SmogCheck test (On Board Diagnostics (OBD), visual inspection, and gas cap test) without conducting the tailpipe test.

Uncertified and illegal conversions would normally be identified during SmogCheck's visual inspection. Since HEVs are excluded from SmogCheck, uncertified and illegal aftermarket PHEV conversions are going unnoticed, and consumers owning these converted vehicles are able to renew the vehicle's registration without knowing their vehicle may have increased emissions. Once modified, SmogCheck will identify emission related problems in HEVs through the OBD and the visual inspections. Visual inspections will identify conversions and then verify certification of the conversion system. Therefore, a complying OBD system is a necessary component for the PHEV certification requirements.

To determine if vehicles meet the certification standards and requirements, the vehicles are also tested in ARB's in-use testing program. ARB's in-use testing is currently the only enforcement mechanism that can determine if an HEV is not meeting the certification requirements and thus having emission related problems. ARB's in-use testing program allows ARB staff to randomly select vehicles and check them for compliance with certification standards. ARB has the authority to require OEMs and conversion system manufacturers to recall vehicles that fail to meet certification emission standards under ARB's in-use testing program. In addition, ARB may choose to rescind a conversion system manufacturer's certification executive order.

Economic Impacts

Staff evaluated the economic impacts of the proposed modifications and determined that the costs will not be more than what was discussed in Staff's December 5, 2008, Initial Statement of Reasons. Most economic costs to the conversion system manufacturer are reduced or shifted. Since under the modified proposal for Tiers 1 and 2, emissions testing, durability testing, and OBD compliance are based on submitted data rather than testing, the costs associated with these items are reduced. In addition, the modified proposal's reduced warranty periods shift most of the warranty costs and risk from the conversion system manufacturer to the consumer. This is true

of all three tiers, but will most significant impact in the first two tiers. In the third tier, costs, with the exception of the reduced potential economic impact of the warranty, will be the same as staff's original proposal.

Issues

After meetings with conversion system manufacturers and our March 25, 2009 workshop the following issues remain for conversion system manufacturers:

- Conversion system manufacturers have requested higher vehicle thresholds for Tier 1 and Tier 2

Staff does not believe increases in the thresholds are appropriate. Vehicle Code section 27156 allows the anti-tampering exemption only if emissions are not increased. Under the tiered process, aftermarket certification requirements are less onerous for Tiers 1 and 2 and take into account the size of the businesses. By tiering aftermarket certification requirements, the modified proposed procedure would set a new precedent and would be the least stringent of all ARB's conversion system certification procedures.

- Conversion system manufacturers believe the warranty for the battery is too onerous

Conversion system manufacturers want to reduce the warranty on the battery from ten years to three years. The modified proposal requires a minimum of five years or 75,000 miles or the remainder of the OEM warranty. Staff believes the warranty is needed to assure emissions control systems' performance and for consumer protection. Supplemental batteries can cause additional load on the OEM battery and thus an early failure. The overall effects of conversions on the existing emissions control systems are unknown. More studies need to be done before reversing the precedent set for warranties in other ARB aftermarket procedures.

- Conversion manufacturers want to "grandfather" existing converted vehicles into PHEV certification

Vehicle Code section 27156 prevents the ARB from certifying vehicles that do not meet the requirements. These conversions can be certified as long as they meet the proposed requirements. If certified, staff proposes that these vehicles count in the manufacturer's tier requirements. If not certified, the vehicles will be operating illegally.

- Conversion manufacturers want to be able to make running changes to controls and are concerned that these changes may trigger additional emissions testing

As with all certifications, production vehicles and conversions must be identical in all material respects to those of the certification vehicles for which the certification was granted and all emissions-related production running changes and field fixes must be approved prior to sale. Some running changes may have the potential to impact emissions and therefore may require additional emissions testing.

The experimental permit process will remain available to manufacturers still perfecting their aftermarket conversion systems. Due to the research purposes and experimental nature of vehicle conversion systems operating under the experimental permit process, however, vehicles converted under experimental permits are not eligible for sale. Aftermarket companies should seek certification of their conversion systems when their conversion systems are able to meet the applicable certification requirements and are ready for sale to the public.

Conclusion

Staff recommends the Board adopt the modified proposal as described.

APPENDICIES

APPENDIX A: PROPOSED REGULATION ORDER (no additional modifications from December 5, 2009)

APPENDIX B: MODIFIED PROPOSED LANGUAGE FOR AFTERMARKET PARTS CERTIFICATION OF OFF-VEHICLE CHARGE CAPABLE HYBRID-ELECTRIC VEHICLES

Date of Release of the Initial Statement of Reasons: December 5, 2008
Date of Initial Board Hearing: January 22-23, 2009
Date of Release of Supplemental Staff Report: May 12, 2009
Date of Second Board Hearing: May 28-29, 2009

APPENDIX A

PROPOSED REGULATION ORDER: (no modifications to December 5, 2009 version)

Note: The regulation text is shown in underline to indicate additions to and ~~strikeout~~ to indicate deletions from the current regulations. For ease of review, the text of section 2032, which is proposed for adoption as a new regulation, is shown without underline as permitted by section 8, title 2, California Code of Regulations.

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Date of Release of the Initial Statement of Reasons:	December 5, 2008
Date of Initial Board Hearing:	January 22-23, 2009
Date of Release of Supplemental Staff Report:	May 12, 2009
Date of Second Board Hearing:	May 28-29, 2009

Amend the title of article 5, chapter 1, division 3, title 13, California Code of Regulations and adopt section 2032, title 13, California Code of Regulations to read:

Article 5. Approval of Systems Designed to Convert Motor Vehicles to Use Fuels Other Than the Original Certification Fuel or to Convert Motor Vehicles for Emission Reduction Credit or to Convert Hybrid Electric Vehicles to Off-Vehicle Charge Capable Hybrid Electric Vehicles

§ 2032. Off-Vehicle Charge Capable Hybrid Electric Vehicle Conversion Systems

(a) Applicable Standards.

Hybrid electric vehicles for the 2000 and later model years in the passenger car, light-duty truck, and medium-duty vehicle classes, converted to incorporate off-vehicle charging capability shall meet the California emission standards for the model year of original manufacture and certification.

(b) Applicable Test Procedures.

The certification and installation procedures that shall apply for approval of systems that convert 2000 and later model-year hybrid electric vehicles in the passenger car, light-duty truck, and medium-duty vehicle classes to use off-vehicle charging are contained in the “California Certification and Installation Procedures for Off-Vehicle Charge Capable Conversion Systems for 2000 and Subsequent Model Year Hybrid Electric Vehicles,” adopted by the state board on [INSERT DATE OF ADOPTION], which are incorporated herein by reference.

(c) Definitions.

The definitions that apply to section 2032, title 13, CCR, are contained in sections 1900, 1962, and 1962.1, title 13, CCR, and the test procedures incorporated by reference in paragraph (b), section 2032, title 13, CCR.

NOTE: Authority cited: Sections 39515, 39600, 39601, 43000, 43006, and 43013, Health and Safety Code. Reference: Sections 43000, 43004, 43006, 43008.6, and 43013, Health and Safety Code; and Sections 27156 and 38391, Vehicle Code.