# APPENDIX J

# ON BOARD DIAGNOSTICS (OBD) CONSIDERATIONS FOR AFTERMARKET PHEV CONVERSION SYSTEMS

An on board diagnostic (OBD) system is designed to assist in air pollution reduction and prevention. It is a diagnostic system incorporated into the vehicle's powertrain computer that detects emission control system malfunctions as they occur. OBD systems consist mainly of software designed into the vehicle's on-board computer that monitors virtually every component and system that can cause an increase in emissions. When an emission-related malfunction is detected, the OBD system alerts the vehicle operator by illuminating the malfunction indicator light on the instrument panel. By alerting the driver to malfunctions as they occur, repairs can be made promptly, which result in fewer emissions from the vehicle.

As with other ARB requirements, vehicle manufacturers must design their systems to comply with emission standards, certify the systems with ARB, and have in-use liability for recall or other correction if the system fails to meet the requirements in-use. Unlike most other ARB requirements which govern emission levels for a finite portion of the vehicle life (e.g., for the useful life, which is typically 120,000 miles on today's vehicles), the OBD system is required to work for the entire time the vehicle is operated on-road.

Manufacturers of aftermarket devices that modify certified vehicle configurations are required to demonstrate compliance with the OBD requirements in the modified configuration. As an example, Conversion System Manufacturers of alternate fuel conversion kits (e.g., converting a gasoline vehicle to run on propane or compressed natural gas) are required to certify their systems to the OBD requirements and must integrate their system, add diagnostics where appropriate, test and recalibrate malfunction thresholds for various diagnostics, perform demonstration testing, and submit a complete application for ARB review and approval. Those manufacturers currently offering such products in California have gone through such a process (and do so annually as new model-year products become available for conversion). Conversion System Manufacturers of devices to add off-vehicle charge capability to HEVs will similarly be required to comply with the OBD requirements for their modified configuration and will be required to submit an application for review and certification that includes the data and information to demonstrate compliance.

Systems or conversions that add hybrid functionality will affect the original vehicle's OBD system. Conversion System Manufacturers will have to plan for OBD compliance in their system design and likely will need to integrate substantially with the OEM system to be successful. The Conversion System Manufacturers must assume they have adversely impacted the OEM OBD system and will likely need to add OBD content and recalibrate some existing portions of the system to bring the modified vehicle into compliance. Complying with the OBD regulation takes more than showing that the modified vehicle does not set false faults (e.g., cause diagnostics to erroneously conclude there are faults when none actually exist). A compliant OBD system is one that detects all the required faults when they occur, detects those faults as frequently as

required, and detects those faults at the required tailpipe emission levels. A compliant system will detect all faults that can cause an emission increase, including faults of added hardware as part of the conversion system.

**Potential Impacts to OBD by Aftermarket Conversion Systems**

Today's vehicles are incredibly complex; therefore, it is difficult to accurately predict the full impact of aftermarket conversion systems to the OBD system until specifics are known about the base vehicle and about the hybrid modification itself. However, based on staff's experience, there are several areas where added hybrid functionality will likely have an impact and are worth mentioning as examples.

Vehicle manufacturers must design their monitors to accurately detect faults and accordingly, define specific operating conditions that must be met to allow the monitor to run. These conditions can involve IC engine conditions (e.g., idle, cruise, specific speed and load regions, warmed-up operation, etc.), ambient conditions (e.g., specific altitudes or temperature regions), or many other conditions. Aftermarket systems that alter vehicle characteristics could end up virtually eliminating the conditions necessary for running monitors and result in emission-related components that are no longer monitored. As an example, systems that add an idle off feature can essentially eliminate monitors that only are enabled at idle IC engine speeds. Similarly, systems that expand electric vehicle operation (e.g., to higher vehicle speeds or IC engine loads) may effectively eliminate necessary conditions. Conversion System Manufacturers will need to understand the OEM OBD system thoroughly to be able to assess the impacts their system will have and develop solutions (e.g., prohibit idle off operation until all monitors that require idle have completed running, recalibrate monitors that require idle operation to run off-idle, etc.).

While vehicle manufacturers have to constrain the monitors to only run in conditions where they can accurately detect faults, they must also meet specific frequency requirements on how often such monitors must run on in-use vehicles. Accordingly, they cannot restrict monitoring to a degree that it prevents monitors from running on most driving cycles, regardless of driver habits or operation. If monitors do not run with sufficient frequency, the vehicles can be subject to recall or other remedial action. Furthermore, infrequent monitoring leads to higher emissions in-use as the time between occurrence of a fault and its detection by the system is lengthened. Aftermarket conversion systems can adversely impact monitoring frequency by lengthening the amount of IC engine operation between occurrence and detection of a fault. As an example, monitors that require extended amounts of continuous IC engine on operation could complete much less frequently if the modified system causes the IC engine to run for shorter periods. So, despite the need for the emission controls to work properly on each and every restart and period of IC engine operation, the shortened operating

windows may provide infrequent opportunities to monitor those components and effectively lengthen the amount of IC engine operation with an emission related malfunction prior to its detection. Aftermarket manufacturers will again need to have a thorough understanding of the OEM system and the OBD requirements to integrate their system in a compliant manner.

A third obvious area where aftermarket conversion systems will likely affect OBD compliance is with all added system hardware, such as controllers, input and output devices such as switches, sensors, and actuators, and the battery pack itself. Under the OBD regulation, these devices will likely fall under the comprehensive components requirements.[1] All electronic input and output components that can affect emissions are required to be monitored for specific failures and the OBD system is required to illuminate the malfunction indicator light and store specific information about the fault in accordance with SAE standards. In this context, it is important to note that "affects emissions" is defined as causes a measurable increase in emissions during any reasonable driving condition and is not defined as "causes emissions" to exceed the applicable standards. As an example, battery temperature sensors that falsely indicate the battery is too hot and derate or disable hybrid operation would cause the IC engine to operate sooner/more frequently/at a higher load and typically cause an increase in tailpipe emissions. Accordingly, the battery temperature sensor would need to be monitored by the OBD system. Conversion System Manufacturers that add hardware to the system will likely need to add OBD compliant diagnostics for each and every electronic component and carefully integrate fault handling of these diagnostics with the OEM OBD system. Aftermarket conversion systems that simply "disable themselves" or attempt to "revert back to the OEM system" upon malfunction are generally not sufficient solutions to comply and often result in emission faults going undetected in-use.

Staff understands that most Conversion System Manufacturers will need some time to comprehend the OBD requirements, identify the likely impacts, and develop solutions to bring a compliant product to the marketplace. Accordingly, staff is proposing to use the existing deficiency provisions in the OBD regulation that allow certification of systems that fall short of fully meeting all of the OBD system requirements. Deficiencies can be awarded in cases where the manufacturer has made a good faith effort to comply and has a plan to come into full compliance as expeditiously as possible. Using this mechanism, staff could certify systems that fall short in one or more areas as long as the manufacturer had attempted to comply and had a valid plan to address the shortcomings in a reasonable timeframe. There are some restrictions on items that can be treated as deficiencies, but those are consistent with the type of shortcomings where it would not be appropriate to certify the system.[2] Conversion System

[1] CCR title 13 Section 1968.2

[2] ARB will not approve systems with such reduced monitoring frequency that any monitors are effectively disabled or the vehicle is otherwise incompatible with the Smog Check inspection process.

Manufacturers will still need to meet the vast majority of the OBD requirements and relief is expected to primarily be needed in the area of minimum monitoring frequency. Further, such relief could only be granted for short term relief and only in cases where the Conversion System Manufacturer has determined what is needed to come into full compliance and has a plan to do so in an expeditious manner. Staff's proposal regarding interim relief in the area of monitoring frequency would allow Conversion System Manufacturers to gain necessary in-use experience as to how the vehicle is operated and how often monitors are running and to use that information to refine the system.