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TOYOTA

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Toyota Motor Engineering & Manufacturing North America, Inc.

Vehicle Safety & Compliance
Liaison Office
Mail Code: S-104
19001 South Western Avenue
Torrance, CA 90501

February 12, 2014

Ms. Nancy Lummen Lewis
Associate Administrator for Enforcement
National Highway Traffic Safety Administration
Attn: Recall Management Division (NVS-215)
1200 New Jersey Ave, SE
Washington, D.C. 20590

Re: Certain Toyota Prius Vehicles
Part 573, Defect Information Report

Dear Ms. Lewis:

In accordance with the requirements of the National Traffic and Motor Vehicle Safety Act of 1966 and 49 CFR Part 573, on behalf of Toyota Motor Corporation ["TMC"], we hereby submit the attached Defect Information Report concerning a voluntary safety recall of certain Toyota Prius vehicles to address an issue with the inverter assembly.

Should you have any questions about this report, please contact me directly.

Sincerely,

Abbas Saadat
Vice President
Toyota Motor Engineering & Manufacturing
North America, Inc.

Enclosures
Part 573, Defect Information Report

DEFECT INFORMATION REPORT

1. Vehicle Manufacturer Name:

Toyota Motor Corporation ["TMC"]
1, Toyota-cho, Toyota-city, Aichi-pref., 471-8571, Japan

Affiliated U.S. Sales Company

Toyota Motor Sales, USA, Inc. ["TMS"]
19001 South Western Avenue, Torrance, CA 90501

2. Identification of Involved Vehicles:

Based on production records, we have determined the involved vehicle population as in the table below.

Make/ Car Line	Model Year	Manufac-turer	VIN		Production Period
			VDS	VIS	
Toyota/ Prius	2010 – 2014	TMC	KN3DU	TBD	TBD

Note: Although the involved vehicles are within the above VIN range, not all vehicles in this range were sold in the U.S.

No other Toyota or Lexus vehicles use the same inverter assembly and software used to control the boost converter in the motor/generator control electronic control unit (ECU) as the involved vehicles.

3. Total Number of Involved Vehicles:

Approximately 700,000

4. Percentage of Vehicles Estimated to Actually Contain the Defect:

Unknown

5. Description of Problem:

The inverter assembly is part of the hybrid system of the subject vehicle. Inside the inverter assembly is an Intelligent Power Module (IPM) which contains a control board equipped with transistors known as Insulated-Gate Bipolar Transistors (IGBT's). Due to certain characteristics of the software used to control the boost converter in the IPM, higher thermal stress could occur in specific IGBT's used for the operation of the boost converter, which is required during high-load driving such as accelerating during highway driving. If this occurs, the IGBT could deform and eventually result in damage to the IGBT(s), illuminating various warning lights on the instrument panel. In most cases, the vehicle will enter a fail-safe mode, resulting in reduced motive power in which the vehicle can still be driven for certain distances. In limited instances, the motor/generator ECU could reset, causing the hybrid system to shut down and resulting in the vehicle stopping while being driven, increasing the risk of a crash.

6. Chronology of Principal Events:

May 2011 - June 2012

Toyota received field reports from the U.S. and Japan markets indicating the vehicle losing power or entering a fail-safe mode along with illumination of warning lights. Toyota examined the returned inverter assemblies and found damaged IGBT(s) on the side of the control board used for operation of the boost converter. The solder beneath other IGBT's surrounding the damaged IGBT was inspected; however there was no evidence of voids or cracking in the solder. Toyota reviewed the production process and confirmed that there were no changes which could possibly lead to damage of the IGBT.

July 2012 - June 2013

Toyota sporadically received returned inverters along with additional field technical reports. Investigation of these returned parts revealed that, in some IGBT's, a hairline crack had developed in the solder which could have originated from a microscopic crack on the nickel plating underneath the solder. Toyota began focusing its investigation on the microscopic crack on the nickel plating and the crack in the solder. A review of the production process found no changes which could lead to development of the solder crack from the microscopic crack on the nickel plating. Several replication tests were conducted; however damage to the IGBT could not be duplicated. Toyota continued to conduct further replication testing and began recovery of inverters from in-use vehicles.

Based on field information alleging sudden vehicle stoppage while driving, Toyota revalidated the fail-safe logic design on the subject vehicles and could not identify any scenario in which the vehicle would not enter a fail-safe mode when IGBT(s) used for operation of the boost

converter became damaged. The fail-safe mode allows the vehicle to be safely operated at reduced speeds. In addition, Toyota was unable to duplicate damage to the IGBT during vehicle simulation tests; however a convex deformation of the IGBT located above the solder crack was noticed during bench testing simulating high-mileage and high-load operating conditions. Toyota continued its investigation and analysis and focused its testing on identifying the mechanism of IGBT damage.

July 2013 - early February 2014

During the investigation, it was confirmed that Prius V vehicles, which use the same inverter assembly, did not experience the same problems in the field on the boost converter and, from inspection of recovered in-use inverters, did not have cracks in the solder used in the IGBT's. Toyota theorized that differences in characteristics of the hybrid control software used to control the boost converter in the Prius and Prius V (e.g. differences in the amount of boost provided when the temperature of the battery becomes high) could be related to the amount of thermal stress on the IGBT. Therefore, replication tests were conducted focusing on these software characteristics and their contribution to thermal stress on the IGBT. It was found that excessive thermal stress could be exerted on IGBT's during high-load driving due to certain characteristics of the software used to control the boost converter, causing the IGBT to slightly deform and eventually become damaged. This damage resulted in illumination of various warning lights and the vehicle entering a fail-safe mode. However, as a result of further testing and an exploration of all possible outcomes, Toyota found that, in limited instances, when the IGBT becomes damaged, the motor/generator control ECU, which sits on top of the IPM, could be exposed to electrical transients generated by large current flowing through the boost converter. These transients could cause a specific microchip in the ECU to reset itself, resulting in the hybrid system shutting down rather than going into fail-safe mode.

February 6, 2014

Based on the above investigation, Toyota decided to conduct a voluntary safety recall campaign on the subject vehicles to update the software for both the motor/generator control ECU and the hybrid control ECU which will prevent damage to the IGBT and also prevent a hybrid system shutdown in the event of a motor/generator control module reset.

7. Description of Corrective Repair Action:

All known owners of the subject vehicles will be notified by first class mail to return their vehicles to a Toyota dealer to have the software updated for both the motor/generator control ECU and the hybrid control ECU. If an owner experiences a failure of the boost converter IGBT before the vehicle receives updated software, the dealer will replace the inverter assembly with a new one at no charge.

Reimbursement Plan for pre-notification remedies

The owner letter will instruct vehicle owners who have paid to have this condition remedied prior to this campaign to seek reimbursement pursuant to Toyota's General Reimbursement Plan.

8. Recall Schedule:

Notifications to owners will be sent in late February, 2014. A copy of the draft owner notification will be submitted as soon as it is available.

9. Distributor/Dealer Notification Schedule:

Notifications to distributors/dealers will be sent in mid-February, 2014. Copies of dealer communications will be submitted as they are issued.