U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

Administrator

1200 New Jersey Avenue SE
Washington, DC 20590

July 26, 2012

Senator Charles E. Grassley
Ranking Member
Senate Committee on the Judiciary

Dear Senator Grassley:

Thank you for your letter of July 12, 2012 regarding unintended acceleration (UA) in vehicles manufactured by Toyota. The National Highway Traffic Safety Administration (NHTSA) has conducted and sponsored two exhaustive studies of the issue, the findings of which are set forth in NHTSA's February 2011 *Technical Assessment of Toyota Electronic Throttle Control (ETC) Systems* ("NHTSA Report") and the National Aeronautics and Space Administration's (NASA) January 18, 2011 *Technical Support to the National Highway Traffic Safety Administration on the Reported Toyota Motor Corporation Unintended Acceleration Investigation* ("NASA Report").

As detailed in the February 2011 NHTSA report, based on the combined work of NHTSA and NASA, NHTSA identified no electronic cause of UA incidents in Toyota vehicles involving large throttle openings and has no reason to believe that any failure of the ETC system would affect a vehicle's braking system. We continue to have confidence in the findings of both the NHTSA and NASA studies.

1) **Why did NHTSA rely on NASA engineers to investigate UA in vehicles?**

   **Answer:** Over the last several decades, NHTSA has investigated the causes of UA in many vehicle makes, including those of Toyota. Nevertheless, because of NASA's established expertise in safety critical systems, electronics, systems analysis, electromagnetic interference and compatibility, and software evaluation, NHTSA retained NASA to conduct a more in-depth investigation into its Toyota UA analysis to determine whether NHTSA had overlooked any electronic cause for the alleged UA in Toyota vehicles. Based on NASA's findings, NHTSA had not.[1]

[1] See NASA Report, page 17

2) **How often does NHTSA utilize other agencies to perform tests and investigations and why?**

**Answer:** NHTSA retains other agencies to assist in its technical studies related to defect investigations very infrequently and when we want a fresh perspective on a particular issue. However, it is not unusual for NHTSA to collaborate with other agencies, both within and outside of DOT, on mission-related projects involving tests and technical inquiries. For example, NHTSA currently is working with the Department of Energy in conducting battery testing. The National Academy of Sciences (NAS) frequently performs studies for NHTSA. NHTSA also relies on other DOT modes, particularly the Research and Innovative Technology Administration (RITA), to perform studies and research projects in furtherance of NHTSA activities.

3) **Do NHTSA personnel lack the sufficient expertise to conduct such investigations and why?**

**Answer:** No. NHTSA has ample expertise to conduct its own investigations, which have led to the recall of 36 million defective or noncompliant vehicles in just the last 5 years. As stated in response to question no. 1, NHTSA chose NASA to take a second look at UA to ensure that NHTSA investigators had not overlooked a possible electronic cause for UA. After its own analysis, NASA found that it also could not identify an electronic cause.

4) **Did NHTSA provide direction to the NASA investigation team? Please describe and provide documentation for any direction given, including but not limited to: initial theories for investigation, required completion timelines, any testing methodologies, identified units for test, and any hardware provided for analysis.**

**Answer:** As stated in Section 5 of the NASA report, NHTSA provided NASA with a charge that was broad in scope and did not place any limitations on the theories for investigation. NASA was asked "to determine if there are design and implementation vulnerabilities in the TMC ETCS-i system that could possibly cause UA that can realistically be expected to occur in consumers' use of these vehicles, and if so, whether these failure modes can be specifically identified and demonstrated through analysis and testing of vehicles or vehicle components."[2] As stated in the NASA Report,[3] NHTSA requested that NASA address the following questions:

1. What specific conditions, both internal and external, are necessary for these failure conditions to occur?

2. Are those conditions evident in the reported cases found in consumer complaints, warranty data, field investigations, and physical/forensic examination of parts collected from the field? If not, is there other evidence that the conditions can realistically be expected to occur in the vehicle's operating environment?

[2] NASA Report, page 18
[3] NASA Report, page 18

3. What physical or electronic evidence does the failure produce? If none, why?

4. What are the expected ranges in severity (throttle opening) and duration that could be caused by the failure?

5. Could the failure have any effect on other interfaces, such as braking system?

**5) What factors contributed to the April 12, 2012 NPRM?**

**Answer:** NHTSA's April 12, 2012 Notice of Proposed Rulemaking (NPRM) relating to Federal Motor Vehicle Safety Standard (FMVSS) No. 124, "Accelerator Control Systems," is designed to update the standard to minimize the risk of loss of vehicle control due to accelerator control system disconnection or accelerator pedal sticking or entrapment. This proposal to update the standard stemmed primarily from the need to change the standard's test procedure to define "disconnection" in the electric throttle context, NHTSA's receipt of reported incidents of high speed pedal entrapment due to mechanical (not electronic) causes, crash investigations conducted by agency personnel, and analyses of existing NHTSA crash databases and consumer information submitted to the agency. Additionally, NHTSA conducted test track work to demonstrate safety effectiveness of the proposed brake override technologies.

**6) What is the NHTSA position on "tin whiskers" as a potential cause of UA? What is the basis of this position? Please provide all information related to "tin whiskers" arising from testing.**

**Answer:** Tin whiskers are one example of a group of resistive fault failure mechanisms that can introduce partial resistances and/or partial shorts into electrical circuits. NHTSA and NASA explored in detail the effects of tin whiskers in the ETCS-i system and were satisfied that the multiple simultaneous shorts required to cause large throttle opening UAs were not occurring in consumers' use of the vehicles. Indeed, NHTSA and NASA found whiskers had occurred, but also found that the ETCS-i design can tolerate shorts from whiskers without resulting in large throttle opening UA. A detailed description of tin whiskers and their effects in vehicles can be found in Sections 6.6.2 and 6.6.3 of the NASA report. The presentation on tin whiskers by a NASA expert last fall, referred to in your letter, was based on the work done for the NASA Report by that same expert and provides no new information that would change these conclusions.

NHTSA has identified a small number of incidents in which accelerator pedal shorting failures of the type that tin whiskers might cause have resulted in a "jumpy" throttle response, which our report notes, "in the broadest sense of the term, could be considered a type of small throttle opening UA."[4] None of the vehicles exhibited a response that would lead to sustained acceleration. Unlike the pedal entrapment incidents that can cause prolonged and very dangerous UA events at, or near, full throttle, this "jumpy" throttle condition ceases immediately as soon as the driver releases the accelerator pedal. In each case, system diagnostics detected the fault, triggered a warning lamp and

[4] NHTSA Report, page 36

diagnostic trouble code, and the vehicle went into failsafe operating mode. Consumer reports of this response sent to NHTSA were consistent with vehicle behavior observed during NHTSA and NASA evaluation and testing. As stated in our February 2011 report, NHTSA's position is that the likelihood of a more severe UA incident arising from tin whisker shorting is very low.[5]

Our analysis demonstrated susceptibility to tin whisker growth in only one type of accelerator pedal assembly used by Toyota in its Camry model from 2002-2006. NHTSA and NASA gathered evidence indicating that whisker shorts in Toyota vehicles equipped with those pedals were rare, a finding substantiated by NHTSA's analysis of complaint, warranty and part sales data. The "jumpy" throttle behavior persists until specific mechanical repairs are performed, meaning that these incidents leave a repair history, unlike the conditions alleged in most reported UA incidents. NASA determined that the other types of pedal assemblies used in the 2007 and later Camry vehicles were either not susceptible to or considerably more robust against whisker-related shorts.[6]

NHTSA is not aware of any UA crashes in which tin whisker shorting has been identified as a cause or contributor. We did not find evidence of patterns or circumstances that would be consistent with whisker growth in our analysis of UA incidents and crashes. Rather, NHTSA identified pedal misapplication as the likely cause of most low speed, high throttle parking lot incidents, which was the most common scenario identified during the UA study. NHTSA conducted dozens of detailed field investigations of such incidents. NHTSA found in each case with relevant event recorder data (with the exception of one pedal entrapment case) that, in the seconds before the crash, the accelerator had been applied but the brakes had not been applied or were applied too late to prevent the crash.[7] We do not believe that tin whiskers are a plausible explanation for these incidents. NASA found no mechanism for tin whiskers to interfere with the braking system.

7) **Of the 9,698 suspected UA complaints, how many vehicles were inspected for the presence of "tin whiskers?" What, if any, other components of the ETCS were inspected for the presence of "tin whiskers"?**

**Answer:** NHTSA carefully reviewed the substance of each complaint to determine whether to conduct a detailed inspection of a vehicle. The vast majority of the UA complaints describe incidents that are consistent with pedal misapplication, pedal entrapment and "sticky pedals." Nevertheless, the agency monitored (and continues to monitor) UA complaints for allegations of component replacement, warning lamp illumination, and diagnostic fault codes consistent with tin whisker and other types of resistive shorts to identify vehicle populations that may warrant further investigation for possible electrical component faults, including electrical shorting due to tin whiskers.

Between January 1, 2000 and March 5, 2010, NHTSA received more than 425,000 inputs in the Vehicle Owner Questionnaire (VOQ) system. Of these, NHTSA and NASA identified 11,454 VOQs describing possible UA events. Of these VOQs, 3,054 involved

[5] NASA Report, page 36
[6] NASA Report, pages 125-127
[7] NHTSA Report, page 45

Toyota vehicles, 831 of which involved Camrys in the population being studied. From the 831 complaints, the team identified only four complaints with allegations consistent with the "jumpy throttle" behavior described in our response to question no. 6 above. In all four cases, the ETC system detected the fault, illuminated the check engine lamp, stored a diagnostic trouble code and put the vehicle in a failsafe operation mode. The effect on vehicle operation, which would have been apparent to the driver, was an abnormal vehicle response (a jerk) when the accelerator was applied in a certain way; however, the engine returned to idle when the accelerator was released, and the brake system remained fully operational.[8]

NHTSA obtained and inspected the accelerator pedal assemblies of two of these four vehicles, both of which had resistive shorts. NHTSA provided one of the pedals to NASA for a comprehensive analysis, which revealed evidence of a tin whisker. NHTSA did not inspect other vehicles for evidence of electrical shorting or tin whiskers because the complaint data did not warrant such a review, (i.e., the vehicle behavior lacked the characteristics, such as "jumpy" throttle, of a resistive short caused by tin whiskers).

8) **Last year, NHTSA asked the National Academy of Sciences (NAS) to study broader questions related to UA. Did the NAS evaluate the impact of "tin whiskers" on UA? Please provide the entire report, findings and suggestions.**

**Answer:** On March 3, 2011, NASA briefed the NAS committee on NASA's full study and report. The briefings included NASA's work related to tin whiskers, which the NAS briefly mentioned in its report, *TRB Special Report 308: The Safety Challenge and Promise of Automotive Electronics: Insights from Unintended Acceleration.*[9] The NAS report found NHTSA's decision to close its investigation of Toyota's ETC system to be fully justified.[10]

If your staff has questions on this or any other matter, they may contact Chan D. Lieu with NHTSA's Office of Governmental Affairs at (202) 366-1836.

Sincerely,

David L. Strickland

[8] NHTSA Report, page 30
[9] NAS Report (http://www.nap.edu/catalog.php?record_id=13342), page 161
[10] NAS Report, page 5