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Chairman Waxman, Sub-Committee Chairman Stupak and the honorable members of the Committee on Energy and Commerce, thank you for holding this important hearing and allowing me the opportunity to testify before you today.

I have been a technical educator involved with automotive diagnostics and trouble shooting for almost 30 years. I have been witness to many evolutionary changes over that time. When I first began teaching in 1981 at Northeastern Oklahoma A&M College, electronic fuel-injected vehicles were relatively new technology. Over the years, automotive technology has continued to progress from fundamental mechanical systems to more sophisticated electrical and electronic systems. Now, as an automotive technical educator at Southern Illinois University Carbondale (SIUC), I have found electrical diagnostic skills to be supremely important diagnosing and repairing modern vehicles. And, I have spent many hours studying and analyzing new electrical circuits and components. Based on my knowledge of real world failures of components, I purposely duplicate multiple types of electrical problems in donated vehicles for my students to study and diagnose. This provides my students an opportunity to analyze wiring schematics and service information, and actively solve diagnostic problems. SIUC Automotive Technology graduates have found employment in virtually every aspect in the automotive industry. Students graduating from SIUC have the technical skills to work closely with automotive design engineers to ensure reliable vehicle service in real-world situations. I believe the exemplary student placement record, is a result of the academic rigor of the program and the emphasis on technical problem solving.

It stands to reason, that my daily teaching responsibilities would include the application and understanding of electronic throttle control diagnostics. I have the unique perspective in my employment, to research and study multiple vehicles and electronic throttle control system designs. In this preliminary report, my initial findings question the integrity and consistency of Toyota Electronic Control Modules to detect potential electronic throttle control system circuit malfunctions. The absence of a stored diagnostic trouble code in the vehicle's computer is no guarantee that a problem does not exist. I instruct all my automotive students with this fundamental statement: You can have a code with no problem - and a problem with no code.

My curiosity in the Toyota electronic throttle control system began simply with a search for the truth concerning sudden unintended acceleration. I recently purchased a 2010 Toyota Tundra, and with the growing attention in the media to what seemed to be increasing events of sudden unintended acceleration, I made the decision to investigate the foundation of these claims on my own. Based on my working knowledge of electronic throttle controls, I did not expect to the system to be easily fooled without detecting a circuit fault and setting a diagnostic trouble code. It was late one evening when I made a startling discovery; electrical circuit faults could be introduced into the electronic throttle control system without setting a diagnostic trouble code. This discovery opened a window of opportunity within the electronic throttle control system for a potential problem with no code.

Without a diagnostic trouble code set, the vehicle computer will not logically enter into a fail-safe mode of operation. All vehicle manufacturers have recognized the importance for electronic throttle control systems to perform exactly as they intended. Since the vehicle computer will only react to defective sensor inputs outside of the range of programmed limitations if the circuit is not defective; it must be good. Knowing that properly operating electronic throttle control system circuits and components are vital to safe vehicle operation, I proceeded to investigate the problem with more urgency. Because of its important role to accurately convey vehicle driver demands for throttle opening, accelerator pedal sensor voltage inputs need to be confirmable by the vehicles computer as absolutely correct. A complete or partial failure of these electrical circuits, sensors, wiring, or actuators in combination with an absence of fail-safe strategies could potentially result in a runaway engine.

The importance of these issues raised in the electronic throttle control system fail-safe strategies should not be underestimated. Sudden unintended acceleration of a vehicle is a very serious safety concern that should be addressed without delay.

Vehicle manufacturers clearly recognized the important requirement for ETC systems to perform exactly as they intended. A failure of the electrical circuits, sensors, wiring, or actuators could potentially result in a runaway engine. Electronic Throttle Control (ETC) systems needed the added redundancy of certain sensors and electrical circuits to ensure safe and reliable operation. In addition, the ECM's were programmed to detect operational abnormalities or defects in ETC components and their related electrical circuits. The intent was to build an ETC system that would always fail-safe in the event of potential problem.

The purpose of my research study was to contribute to a better understanding of electronic throttle control system malfunctions and the fail-safe detection capabilities of selected vehicles equipped with electronic throttle controls. More specifically, this research examined the fail-safe detection capabilities of electrical circuitry designed to prevent sudden or unintended acceleration of electronic throttle controlled vehicles manufactured by Toyota Motor Co. The Accelerator Pedal Position (APP) sensor was identified in the review of manufacturers' service literature as a significantly important ETC input for all vehicles used in the study. Since vehicle driver demands are electrically conveyed through this high priority sensor, basic testing was focused on the APP sensor, voltages, and associated wiring circuits. A secondary purpose was to identify areas of further research of ETC fail-safe detection capabilities of Toyota Motor Co. vehicles and other vehicle brands. This limited analysis attempted to identify and characterize potential safety concerns of Toyota Motor Co. vehicles, as well as other vehicle manufacturers using electronic throttle control systems.

After completing preliminary tests for Accelerator Pedal Position (APP) sensor signal voltages for the Toyota Electronic Throttle System I examined, it was determined that Electronic Control Module (ECM) malfunction detection strategies were not sufficient to identify all types of fundamental APP sensor and/or circuit malfunctions. Some types of Electronic Throttle Control (ECT) circuit malfunctions were detectable by the ECM, and some were not. Most importantly, the Toyota detection strategies were unable to identify malfunctions of the APP sensor signal inputs to the ECM. APP sensor signal circuits must be undeniably correct to electrically convey the appropriate driver commands to the ECM.

With the two APP sensor signals shorted together through a varying range of resistances, all four Toyota vehicles tested thus far reacted similarly and were unable to detect the purposely induced abnormality. The types of signal faults introduced into the APP circuit should have triggered the vehicles' ECM to illuminate a warning lamp within seconds. The ECM should have then set a Diagnostic Trouble Code (DTC), entered the vehicle fail-safe mode, and reduced engine speed and/or power. When the two APP signal circuits are shorted together, the redundancy of the APP circuit design is effectively nullified and lost. In other words, neither of the shorted APP signal circuits can be verified by the ECM as either; correct or incorrect. The condition then exists for a serious concern for driver safety. In the tested Toyota ETC vehicles, incorrect or corrupted APP sensor signal inputs could potentially result in unwanted engine speeds. Additional research should be done to determine if other vehicle manufacturers may have similar inconsistencies in ETC circuit fault detection.

Using shorted APP signal circuit fault conditions purposely installed on the test vehicles, and with known resistance values that would not set a DTC, vehicle operational behaviors were also noted. It was observed that all test vehicles could be operated without the ECM detecting the induced malfunction. Depending on the resistance value of the APP signal circuit fault, a vehicle may or may not experience noticeable changes in accelerator pedal operational behavior. Observed accelerator pedal operational characteristics included: normal response, sluggish response, and travel with inconsistent engine speeds. It is conceivable that a driver of an ETC vehicle may not notice that an APP sensor and/or circuit malfunction currently exists. Without the aid of an illuminated MIL, a driver could be unaware of electrical problems within the ETC system. In addition, the shorted APP signal circuits were connected momentarily to the sensor's five-volt supply circuit with the vehicle in drive. In all test vehicles, the ECM did not set a DTC and the engine speed increased rapidly to full throttle. This result shows that unusual or sudden unintended acceleration of the vehicle was possible in the ETC test vehicles. It should be noted that in all test vehicle cases, the electronic throttle valve instantaneously moved to wide-open position when the fault was introduced. More research should be done to determine the extent of Toyota ETC vehicles that could be affected by this condition.

In review of the Toyota service information, collected vehicle data, and performance observations; some general assumptions can be drawn from the research completed to date. The inability of the Toyota ECM to detect certain types of short circuit malfunctions could fall back to the basic design of the normal APP signal voltage limitations. The parameters for APP signal short circuit fault detection are apparently too lenient. In the Toyota ETC system, the APP sensor signal voltages rise simultaneously in direct response to accelerator pedal depression. With this design, interconnected signal circuits could be more difficult to identify with a circuit fault detection strategy that uses only threshold voltage limitations.

In this preliminary report, the initial findings question the integrity and consistency of Toyota ECMs to detect potential ETC system circuit malfunctions. The importance of these issues raised in the ETC system fail-safe strategies should not be underestimated. While the small sample of Toyota vehicles cannot be representative of all, these primary findings most certainly warrant further investigation and study. Additional Toyota vehicles of different build years and models should be evaluated for their capabilities of ETC system circuit malfunction detection.

A second recommendation should be a thorough technical investigation and evaluation of ETC fail-safe strategies of Toyota, and possibly other vehicle manufacturers, that experience sudden unintended acceleration that do not appear to be caused by floor-mats or sticking pedals. Priority would be studies of identified vehicles with a high incidence of ETC system related incidences, concerns, or failures involving sudden unintended acceleration.