

U.S. Department of Transportation  
National Highway Traffic Safety Administration  
Office of Defects Investigation (NVS-210)  
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Washington, DC 20590

Tuesday, March 21, 2023

**Motor Vehicle Defect Petition to recall all Tesla cars produced from 2013 to the present, due to a missing critical interlock feature and specific Autopilot features that contribute to increased likelihood of driver errors in the form of Pedal Misapplication**

Even when driven manually (not in Full Self-Driving mode), all Tesla cars using the Autopilot software implement various strategies of automatic braking, not only as a safety feature (i.e. to avoid an accident) but also as a feature that takes over some of the workload of the driver e.g. in stop-and-go traffic or when about to park. One such “special feature” is the ability of the car to stop and shift into reverse gear when the driver is ready to park, without the requirement of an actual brake pedal activation. There is no practical benefit for this potentially dangerous “party trick”, other than silently testing, developing and implementing parts of the fully autonomous driving package.

In a technical paper attached to this petition, there is a lengthy and detailed description of the cognitive neuroscience concepts and the importance of linearity in the feedback that a driver gets from a car and the break of the sequence of closed loop feedback that creates increased likelihood of pedal misapplication accidents. Instead of a technical summary, we will present here a timeline that explains the mechanism behind the PM/SUA accidents under investigation:

-After many years of driving a “normal” car, the new owner of a Tesla car starts to subconsciously modify his past training through neuroplasticity. After a few weeks of driving a Tesla, the driver starts to acquire the habit of not using the brakes while driving slowly in traffic and when stopping to park the car, gradually trusting the car to brake for him instead.

-The driver grows to enjoy this new and advanced feature of his car, making a point of using it more and more.

-Automatic braking, being non-linear in response, continues to interfere with the training of the driver and the already acquired conditioned responses to various stimuli.

-Moments before the accident, as the driver is getting ready to stop and park the car, he lifts his foot from the accelerator and keeps it hovering just above the pedal. In any other car, at this instance the driver would be moving his foot towards the brake pedal in order to stop and select reverse gear. Not in a Tesla, though, as a Tesla driver “does not need” to brake.

-After a few seconds of coasting and as the driver is experiencing a momentary lapse of concentration, the car decides that it is time to brake by itself.

-The driver senses deceleration through his vestibular system.

-At the same moment, the driver has a tactile input as his foot is lightly touching a pedal.

-His “hard wired” subconscious conditioned response connects the stimuli: “deceleration+tactile feeling underfoot=brake pedal”

- Thinking that maybe the car is not going to stop in time, he steps harder on the “brake pedal”, but this is not actually the brake pedal but the accelerator!
- The extreme torque and the silent operation of the electric motors give no cue and no time to realize one's mistake.
- After the accident, the driver is adamant that he was pressing the brake pedal and of course he is telling the truth. His brain was “short-circuited” in the most effective fashion.

### **Immediate actions:**

It has been proven beyond any doubt that the BTSI, the Brake Transmission Shift Interlock feature of automatic gearboxes of the 80's has successfully mitigated the risk of SUA during start up and successfully trained millions of drivers to always press the brake pedal before moving off. After a 1989 NHTSA report that recommended all cars to be fitted with a BTSI, the industry started to gradually implement it and in 2010 the BTSI became compulsory equipment for all new cars sold in the USA.

It is clear that the industry and the legislators decided to put safety before marketing, even if an interlock or any other safety feature might introduce minor user inconvenience. Today, it is very important to address SUA accidents that are happening again, but in different circumstances than the old 1980's accidents of automatic cars. Modern extremely powerful -but silent- electric cars pose new risks, as they lack the engine sound and the slight delay of throttle response of ICE cars. The industry is aware of the problem and there are two different ways to face it: either proactively (installing interlocks and safeguards in order to prevent the error), or reactively (allowing the error to happen and working to develop a robust automatic system that will -hopefully- always recognize it and react in time).

After proactively solving the problem of SUA accidents in the 1980's, today it seems that we are moving in the opposite direction, allowing a driver to select reverse gear while still driving forward without asking for a brake pedal application(!), actively encouraging drivers to enjoy “feet-off automatic braking and parking”. The clear pattern of serious SUA accidents under similar circumstances tells us that it is imperative for modern cars with self-driving features and non-linear response to driver inputs, to at least include a software interlock, i.e. **the requirement of an actual brake pedal activation before allowing full stop and reverse gear to be selected.**

There is absolutely no need and no reason behind the decision to allow the driver to select reverse gear and wait for the car to stop by itself and then reverse without ever pressing the brake pedal. This is not an oversight but a feature, a choice that puts marketing before safety. A software “interlock” requiring a brake pedal press before selecting reverse gear, would immediately enhance road safety in the same way that the BTSI of the 1980's dramatically reduced pedal misapplication accidents under different circumstances.

Also, it is advisable that automatic braking should only be used as a safety feature and not as a courtesy. Automatic braking of Tesla cars under low speed manoeuvres, encourages drivers to remove their feet from the pedals and enjoy a technologically advanced self-braking car, but this is a dangerous habit that increases the likelihood of pedal misapplication, as proven by the pattern of similar circumstances of recent SUA accidents attributed to driver error. If we accept the theory of the broken sequence of closed loop feedback control or even if we stick to the traditional theory of open-loop proprioception to explain foot and pedal errors, it is true in both cases that

foot removal from both pedals is a major factor contributing to increased likelihood of pedal misapplication errors (a *typical example of such “feet-off” driving that leads to pedal misapplication, can be found in the vehicle data logs referring to VOQ 11206155 as included in the NHTSA report on Investigation DP 20-001, where the car is coasting with a constant speed of 6mph for 3.5sec without any inputs from either pedal, while at the same time the driver is busy turning the wheel towards the garage door.*)

As an additional safety feature, a red Emergency Stop “mushroom” button could be added directly in front of the driver, in the manner of industrial vehicles and machinery so as to give a universally understood “bailout” option for a panicked and confused driver (there is, actually, an “emergency stop” in Tesla cars, but the switch is hidden at the tip of the gearlever where most cars have the controls for the windshield washers, not intuitive at all for a confused driver...)

A detailed analysis of all relevant research on the causes behind all recent SUA accidents, can be found in the attached paper.

As an immediate measure to enhance road safety, I hereby ask you to grant the petition to recall all Tesla cars in order to add a software interlock to their control system, requiring the driver to press the brake pedal before allowing the car to fully stop and reverse gear to engage. Further measures concerning the stochastic nature of automatic braking should also be considered, as it may encourage the occasional complete removal of the driver's feet from the pedals, which has been found to be a necessary condition of all types of pedal misapplication errors.

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*Note: for the sake of simplicity, all technical descriptions are written using “he/him”. This does not in any way express any form of gender discrimination.*