Known Vehicle Causes of Unintended Acceleration

Richard Boyd
Acting Director
Office of Defects Investigation

"Sudden Acceleration Incidents"

- Definition: "Unintended, unexpected, high-power accelerations from a stationary position or a very low initial speed accompanied by an apparent loss of braking effectiveness." *NHTSA, "An Examination of Sudden Acceleration," 1989 (Silver Book).*

- Characteristics:
  - Engine power: sudden, large increase in engine power, at or near wide-open throttle (WOT)
  - Brakes: allegedly ineffective (brake application often cited as initiator)
  - Initial speed: over 90% start from stationary position or low-speed
  - Location: most occur in parking lots, garages, driveways, car washes
  - Operating mode: initial shift from PARK to REVERSE or DRIVE
  - Crashes: most incidents result in crashes
  - Drivers: older drivers over-represented
  - Evidence: generally no problems with throttle control or brake systems identified in post-incident vehicle inspection or subsequent vehicle service

- Technical summary:
  - Evidence suggested that most SAI probably involve the driver unintentionally pressing the accelerator when braking was intended
  - No mechanism for temporary, self-correcting brake failure was found to exist

"Unintended Acceleration": A Broader Concept

- The Silver Book's definition of "Sudden Acceleration" did not include all types of incidents involving unwanted engine power
- More recently, "unintended acceleration" (UA) has been used as a catch-all term that is not limited to high engine power, low initiation speeds or allegations of brake ineffectiveness
- Included in UA are the rare incidents involving prolonged open throttle events
- However, data indicate that by far the most common incidents are still those involving sudden, high-power accelerations from a stationary position or very low initiation speed, as in parking lots and driveways, that also include allegations of brake ineffectiveness

Known Vehicle Factors for UA

- Throttle control history:
  - Over 30 years of investigations & recalls (since 1970's)
  - Wide variety of vehicle causes for unwanted engine power
  - In the last 25 years:
    - 109 defect investigations, influencing 34 recalls
    - 174 recalls involving 15.6 million products
- Vehicle Causes Identified in Investigations & Recalls:
  - Stuck Throttle
    - Conditions that prevent or inhibit throttle return to idle when the driver releases the accelerator
    - Most of these conditions do NOT involve full engine power
    - Examples: pedal entrapment, cable binding, throttle icing, cruise control servo
  - Self-Actuation
    - Conditions that cause the throttle to open or result in elevated idle speed
    - Most of these conditions do NOT involve sudden, full engine power
    - Examples: cruise control computer, engine control module, accelerator pedal sensor, high idle & engine surge conditions in heavy vehicles
  - No defect conditions have been identified that:
    - Resulted in sudden WOT; and
    - Simultaneous loss of brake effectiveness

Investigations for UA

Subject		INV.	INFLUENCED RECALLS NO.	INFLUENCED RECALLS UNITS RECALLED
Vehicle based cause	Stuck throttle	57	29	9,428,000
	Self-actuation	11	1	5,000
Vehicle features related to pedal misapplication		41	4	1,815,000
Total		109	34	11,247,000

Observations:

- Stuck throttle:
  - Most likely to result in an influenced recall (approx 50%)
  - 85% of influenced recalls
  - 84% of products recalled
- Vehicle features related to pedal misapplication:
  - Three recalls to install brake transmission shift interlocks (BTSI)
  - One recall to ensure adequate spacing of accelerator and brake pedals

Recalls for UA

	RECALLS			PRODUCTS RECALLED		
Category	MFR	ODI	Total	MFR	ODI	Total
Stuck throttle	118	29	147	4,043,000	9,428,000	13,471,000
Self-actuation	21	1	22	313,000	5,000	318,000
Vehicle features related to pedal misapplication	1	4	5	1,000	1,815,000	1,815,000
Total	140	34	174	4,356,000	11,247,000	15,604,000

Observations:

- Most recalls address defects in "stuck throttle" category
  - 84% of recalls
  - 86% of products recalled
- NHTSA influenced 20% of recalls and 72% of products recalled
- Three Toyota recalls in 2009 & 2010:
  - All involved stuck throttle conditions - pedal entrapment & sticking pedals (internal friction)
  - 7,584,000 vehicles; almost half (48%) of total since 1985

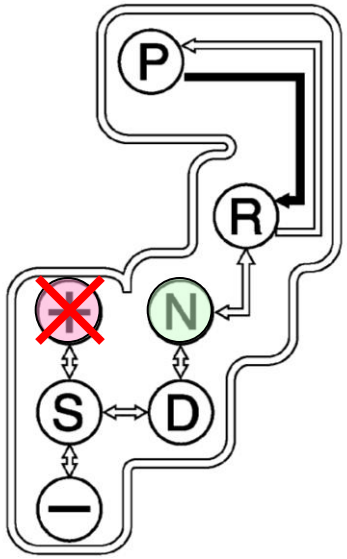
Long-Duration, High-Speed Incidents

- Rare events – require multiple conditions
  - Defect condition must result in sustained high-power at or near WOT (e.g., floor mat entrapment, which occurs after pedal-to-floor acceleration)
  - Braking capacity (braking torque vs. drive axle torque):
    - High-power engine, high initiation speed, and depleted vacuum reduce brake effectiveness
    - Drivers initially able to manage speed for 1-2 miles, but may not be able to stop
    - Brakes lose effectiveness due to over-heating $\Rightarrow$ speed $\Uparrow$ (some >100mph)
  - Complex PRNDL gate design – difficulty shifting to "N"
  - Push-button ignition – difficulty turning engine "OFF"
  - See San Diego County Sheriff's Department Incident Report concerning August 2009 crash in Santee, California (Case No. 09056454)

Pedal Entrapment

PRNDL Gate Design

- Drivers may attempt to shift to “Neutral”
  - PRNDL gate design for Toyota Sequential Shift vehicles may not be intuitive for location of “Neutral”
  - Drivers who successfully shift to “Neutral” may misinterpret ⇑ in engine rpm and shift back to drive



Engine Start/Stop Switch

- Switch operation:
  - Vehicle stationary: momentary press to start and stop
  - Vehicle in-motion: must press and hold for at least 3 seconds (to avoid inadvertent shut-off)
  - Different strategies used by other manufacturers
    - Different time intervals
    - Many included shut-off with multiple press (2x or 3x)
    - Some prevent engine shutoff when moving (and not in PARK)

Countermeasures

- Brake Transmission Shift Interlock (BTSI)
  - Requires brake application for shift from PARK to ensure safe shift
  - Introduced in U.S. in 1987 Audi passenger cars
  - Implemented in 80% of new cars sold by 1992
  - In vehicles without BTSI, approximately 70% of UA incidents occurred upon shift from PARK to REVERSE or DRIVE
  - Effect on UA experience:
    - When first implemented, vehicles with BTSI experienced about a 60% drop in UA
    - Operating mode changed from P-D or P-R shifts to end-of-trip parking maneuvers in D or R
- Brake Throttle Override (BTO)
  - Reduces throttle opening if the accelerator and brake pedals are depressed simultaneously under certain conditions
  - Ensures that braking torque is greater than drive axle torque
  - Software implementation, only possible in ETC vehicles
  - Each company has different implementation strategy
    - Some depend on sequence of pedal application, vehicle speed, amount of brake application or fixed accelerator position to trigger override
    - Not a solution for all UA

Defects Investigation Recommendations

- Are there practical ways to improve NHTSA's ability to find defects that may be based in electronic systems, particularly rare events where physical evidence is not apparent?