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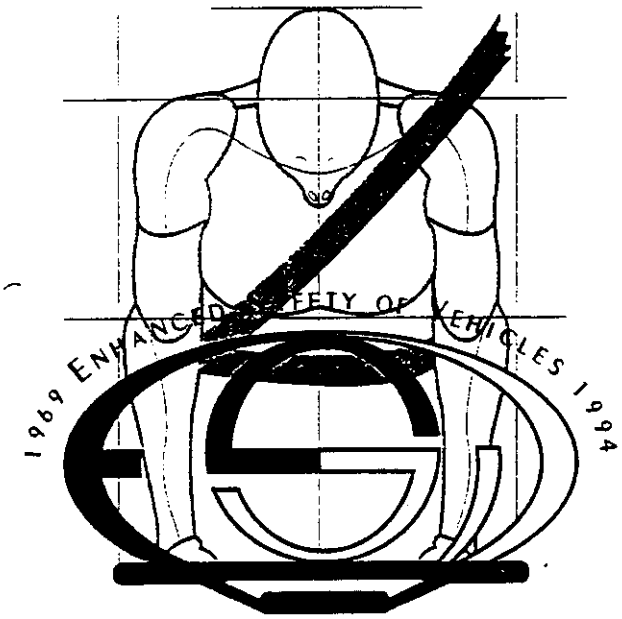

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The Effect of Countermeasures To Reduce the Incidence of Unintended Acceleration Accidents

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ABSTRACT

This paper provides a description of "Unintended Acceleration" (*UA*) in passenger cars, presents data pertaining to the scope of the problem as defined by the number of accidents and injuries reported annually to NHTSA that are alleged to be associated with *UA*, discusses the causes of *UA* and countermeasures to reduce the incidence of *UA*, and provides analysis to assess the reductions in reported *UA*-related accident rates which have resulted from the use of automatic shift locks.

UA reports are defined as incidents of high-powered unwanted vehicle acceleration from a stationary position or very slow speed, accompanied by reportedly ineffective brakes. Previous studies and investigations conducted by the National Highway Traffic Safety Administration (NHTSA), and by Canadian and Japanese government agencies have concluded that the major cause of such incidents has been drivers unknowingly depressing the accelerator instead of the brake pedal on automatic transmission-equipped cars.

Based on data obtained from NHTSA's computerized consumer complaint file system, and information obtained in the course of agency defect investigations, the paper concludes that the best known countermeasure to *UA* has been factory installation of automatic shift lock systems which prevent the driver from shifting the transmission out of Park unless the brake pedal is simultaneously applied . A comparison of reported *UA* accident rates (accidents per vehicles produced) for automatic transmission-equipped cars indicates that vehicles equipped with shift locks have experienced approximately a 60 percent reduction in *UA*-related accidents compared to similar cars without shiftlocks. Also, the effect on *UA* of retrofitting shift locks on one particular make/model is assessed.

INTRODUCTION

What is "Unintended Acceleration" (*UA*)

The National Highway Traffic Safety Administration (NHTSA) frequently receives letters and telephone calls from drivers who report incidents involving vehicles which seemed to suddenly accelerate very rapidly from a stationary position until they crashed. Typically, the driver reports that pushing on the brake pedal had no effect whatsoever and that the vehicle only stopped when it crashed. The driver usually reports that the

vehicle began to accelerate as rapidly as possible immediately after he or she shifted the automatic transmission into Drive or Reverse. Evidence of high engine power output is frequently found, consisting of acceleration skid marks (the wheels spun) which begin where the vehicle had been parked, and crash damage which indicates that the vehicle had accelerated at its maximum rate. The term "Unintended Acceleration" (*UA*) has been applied to describe such types of complaints, which involve all of the following three elements:

1. High-powered unwanted vehicle acceleration;
2. Initiated from a stationary position or very slow speed (parking lot, driveway speed); and,
3. Accompanied by apparently ineffective brakes.

Less severe types of unwanted engine power problems, such as an abnormally fast idle or throttle sticking which can be controlled with the brakes, are not considered to be *UA*, even though such problems can be safety related.

Two Examples of *UA*

Washington Square Park in New York City was crowded with people enjoying the sunshine on one of the first pleasant warm afternoons in April 1992 when, outside the park, the driver of a parked car shifted the transmission into Drive. To her horror, the wheels suddenly spun and the car lurched forward toward the park at the end of the street, almost 120 m straight ahead. "Knowing" her foot was on the brake, she pushed on the pedal as hard as she could, but the car continued to accelerate, crossed two intersections, and hit the curb at the edge of the park at over 80 km/h. The impact with the curb blew out a tire and deflected the car upwards through the air before it obliterated a concrete drinking fountain in the center of a walkway and came back down. People tried to get out of the way, but many were hit, and several people were thrown through the air as the car continued to move along the walkway, hitting occupied benches, first on the right, and then on the left side of the walkway. Finally, after traveling more than 60 m inside the park, it stopped with one person on the hood and several people underneath the car. The driver said she had been pushing on the brake pedal, and there was something wrong with the car.

Five people died and 26 people, between the ages of 1 and 84, were injured. The police collected enough shoes scattered at the scene to fill a large plastic trash bag. A comprehensive vehicle inspection was conducted after the accident, but no vehicle defect which could have caused the car to accelerate so rapidly was found. Witnesses reported that the vehicle's brake lights were not illuminated at any time during the *UA* incident, even though they were found to function normally after the accident.

Another exceptionally serious *UA* accident occurred in a small town in Illinois in June of 1990, at a church-sponsored picnic in a local park. When the driver of a van shifted the transmission from Park to Reverse in an unpaved parking area, it suddenly accelerated much more rapidly than the driver intended. The startled driver reacted by shifting from Reverse to Drive, but the wheels spun in the opposite direction, and the vehicle began to accelerate forward toward a pavilion filled with men, women, and children, most of whom were friends or relatives. The vehicle shot forward and struck several people. An alert woman quickly moved two children out of the way, but she did not have time to move a 17-month old child in a stroller before the vehicle struck her and the child. The vehicle's forward progress was stopped only when it hit a building attached to the pavilion, with the woman and child pinned between the vehicle and the wall, as the engine was still racing. Other people screamed at the driver to turn the engine off, but she was too horrified to respond, and the passenger turned the ignition key off. After the driver moved out of the driver's seat, a half dozen people were able to push the vehicle backwards away from the wall against which the woman and child had been pinned, but both died shortly thereafter. Nine other people were injured.

The vehicle was impounded by the police and thoroughly inspected by several parties, including NHTSA, but no relevant defect was found. The cruise control system was tested, brake fluid was analyzed, and the electronic engine control computer was removed for testing in an identical vehicle. The engine control unit was subjected to a strong magnetic field, and high voltage sparks were applied to its metal housing. No malfunctions of the engine or braking system were found, and none could be induced.

Magnitude of The Problem

NHTSA's Office of Defects Investigation maintains a consumer complaint data system. This system includes all reports regarding safety problems provided by consumers. This system is used to determine if certain real world safety problems exist which warrant a defect investigation. Figure 1 presents the number of *UA* accidents which have been entered into NHTSA's computerized consumer complaint data system for each calendar year (based on the date of accident). This file does not fully indicate the magnitude of the *UA* problem because it only contains reports of incidents which were submitted voluntarily, and does not include information obtained directly from manufacturers during specific investigations or from other sources. However, the file is useful for making comparisons among different groups of vehicles, and for identifying time-related trends.

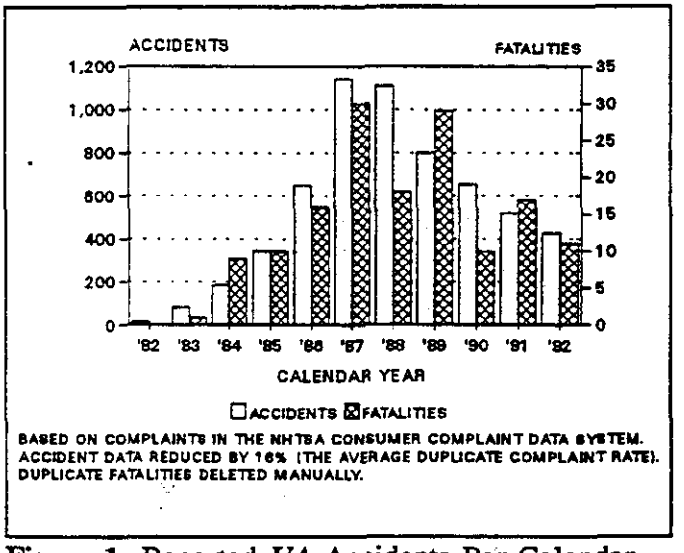

Figure 1. Reported *UA* Accidents Per Calendar Year. All Model Years of Passenger Cars.

Figure 1 shows that a total of 151 fatalities allegedly involving *UA* were reported for calendar years 1982 through 1992. During this 11 year period, a total of 485,000 traffic fatalities occurred in the U.S. Thus fatalities associated with reported *UA* incidents represent 0.03 percent of fatalities. The percentages may be higher since not all *UA* accidents are reported for inclusion into NHTSA's computerized consumer complaint data system. Under-reporting before approximately the middle of 1986 is probably the major reason for the low number of accident reports shown in Figure 1 for 1982 through 1986. In 1986, the NHTSA investigation of *UA* (at that time called "Sudden Acceleration") in Audi 5000 vehicles, as well as *UA* in general, received extensive publicity on television and other media, and this had the effect of greatly increasing the number of *UA* accidents which were reported (fewer unreported accidents).* Therefore, the reported number of fatalities allegedly associated with *UA* could be close to the actual number during the peak reporting year of 1987. At this level, reported *UA* incidents could involve 0.07 percent of total fatalities.

Balancing the above discussion of underreporting of *UA* incidents, the number of *UA* accidents which are not reported is less than for most other types of accidents because the involved drivers usually believe that they were the victim of a serious vehicle defect for which they blame the vehicle's manufacturer. Also, publicity may have influenced some driver's interpretations of what happened during the rapid, unexpected chain of events associated with *UA*, with the results that some accidents were incorrectly attributed to *UA*. For example, after widespread publicity pertaining to *UA* in Audi 5000 vehicles, one driver turned off the ignition key while idling at a traffic light, refused to drive the car, and reported *UA*, when she heard a sound produced when the cooling fan suddenly started. Several other Audi drivers reported *UA* in the forward direction when they shifted from Park to Reverse, even though the transmission linkage was not subsequently found misaligned. In those instances, the engine had probably been started in Neutral and was then shifted one detent position, into Drive. The startled and disoriented drivers subsequently thought *UA* had occurred because they had been led to believe that Audi vehicles were prone to suddenly accelerate uncontrollably. This demonstrates that some inaccurate reports, which probably compensated for under-reporting to some extent, are included in the data. Taking all of these factors into consideration, it is postulated that *UA* is associated with between 0.03 and 0.07 percent of all traffic fatalities.

* Reinhart, W. 1989. Investigative Report, ODI Case No. C86-001 (1978-1986 Audi 5000 Passenger Cars) NHTSA. 32-33.

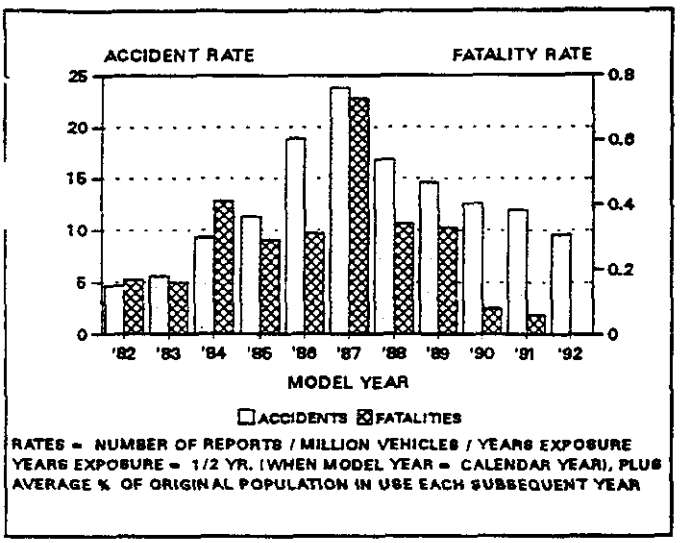

Figure 2. Reported *UA* Accidents And Fatalities Per Million Vehicle Years For Each Model Year.

Figure 2 shows the reported *UA* accident and fatality rates for each model year, in terms of reports per million vehicle years of exposure. Vehicle exposure is based on the assumption that exposure (in vehicle years) during the calendar year which is equal to the model year is 1/2 times the total number of vehicles sold; and that for each subsequent calendar year, exposure equals one times percentage of the original population which remains in use each year, applicable to each specific vehicle model year. All vehicles of the same model year are assumed to have experienced the same rate of attrition.

Figures 1 and 2 indicate that the *UA* accident and fatality rates have been declining, beginning with both calendar and model year 1988. Additional data is presented later in this report, which explains how vehicle design changes have resulted in a substantial reduction in the *UA* accident rate for 1988 and newer vehicles. The relevant design changes made to some 1988 models do not involve a sufficiently large proportion of all of the passenger cars in use during calendar year 1988 to explain the magnitude of the reduction in reported *UA* accident rates. However, the two models of older vehicles which had accounted for a substantially disproportionate number of *UA* accident reports before 1988* had automatic shift locks installed during recall campaigns begun in 1987, and those changes resulted in a great reduction in *UA* reports beginning with 1988. This is discussed further in the "Countermeasures" section presented later in this report.

Although *UA* is involved in only a small portion of traffic accidents and fatalities, such events can have devastating consequences, as demonstrated by the two previously cited examples. These anecdotes show how anyone can become a victim, since each person injured or killed during those two accidents had been relaxing in a park away from traffic, and the involved drivers had not engaged in any illegal, reckless, or unusual activities before they suddenly lost control of their vehicles. Perhaps more significant is that drivers perceive *UA* incidents as occurring regardless of human actions, and unresponsive to human intervention. This perceived lack of human control over the machine has made it necessary to determine the root causes of *UA*, and to convince drivers that they are not likely to become helpless victims of an uncontrollable machine.

Importance of Accident Data

Figures 1 and 2 are based on reports which allege that an accident occurred, and which were entered in the NHTSA consumer complaint file under a fault code for "Engine Runaway/Sudden Acceleration or Surge." Only reports coded as accidents, rather than all incident reports, were considered for this analysis, because some of the reports of "Engine Runaway" or "Surge" contained in the file involve incidents which do not meet the criteria for *UA*. For example, an engine surging incident, in which the driver was able to control the vehicle sufficiently to avoid an accident, probably did not involve the high engine power and allegedly ineffective brakes characteristics reported in *UA* incidents. However, the unexpected high-powered acceleration of *UA*, accompanied by an apparent loss of braking effectiveness, almost always results in a crash.

Another reason for limiting this analysis to accident involvement is that it provides a more objective measure for comparing *UA* rates among different vehicles, by removing the subjectivity involved in deciding which reports, involving a wide range of unwanted engine power incidents ranging from minor fast idle conditions to allegations of powerful unexpected engine surging,

* 1978 through 1986 Audi 5000, and 1979 through early production 1987 Nissan 280/300 ZX passenger cars.

should be classified as *UA*. For example, it is not always possible to determine if an incident involving a low speed collision with a parked vehicle or a wall in a confined area should be classified as *UA* (high powered acceleration accompanied by apparently ineffective brakes), or simply as an engine surging incident, because it is not always clear whether or not the driver had sufficient time to make effective use of the brakes before the collision stopped the vehicle. Such an incident is more likely to involve *UA* if the vehicle accelerated for an amount of time and distance sufficient to reach an impact speed which results in property damage or injury (an accident), than if the available space and time for the vehicle to accelerate was so limited that it was stopped by a benign collision (not an accident).

CAUSES OF UNINTENDED ACCELERATION

Pedal Misapplications

Most drivers who experienced a *UA* accident claim that the vehicle must have malfunctioned in some mysterious way, even though in the vast majority of cases, no vehicle defects which would explain the vehicle's apparent behavior are ever found. A *UA* involved vehicle manufacturer generally explains the events by stating that the driver stepped on the accelerator pedal instead of the brake pedal. However, the driver often does not believe that explanation, since he or she has correctly applied a brake pedal without error on thousands of previous occasions.

A pedal misapplication by the driver just before shifting out of Park provides a logical explanation for those *UA* incidents which began as soon as the driver shifted out of Park, since this would cause a vehicle to accelerate abruptly as soon as the transmission engages in a moving gear.* A driver who believes that his/her right foot is on the brake pedal could be expected to react to sudden unexpected acceleration by pushing more forcefully on that pedal, since increasing brake pedal application force normally reduces vehicle speed. As a result, if the wrong pedal were being depressed, the accelerator pedal would be depressed as far as possible, causing it to then feel firm like a brake pedal. Under these conditions, the throttle would be held in the fully open, maximum engine power position, no braking action would be produced, and no relevant vehicle defects would be found afterwards.

That explanation is consistent with the following facts and observations:

- Most *UA* incidents began when the driver shifted an automatic transmission out of Park, or into or out of Reverse.

  Pedal misapplications are more likely to occur when the driver attempts to make the first brake application after entering the car or when the upper body is rotated to look behind the vehicle.

- Although reports of engine performance problems such as excessive idle speed, surging, throttle linkage sticking, and cruise control system malfunctions are received for almost all car models, reports involving all of the characteristics of *UA* are not received for cars with manual transmissions.

  A car with a manual transmission cannot be put in motion unless a driver places one foot on the clutch and the other on the accelerator pedal.

- Reports of *UA* have been received for all common makes, models, and model years of cars with automatic transmissions sold in substantial quantities during the last 20 years.

  Many different engine and braking system design features have been utilized, and many changes in vehicle design have been made during the last 20 years, while the basic characteristics of humans pertaining to perception, neuro-muscular control and feedback, panic reactions, etc., have not changed.

- A disproportionally large number of *UA* accidents have been reported for elderly drivers, based on the number of licensed drivers and the average miles driven. For certain domestic cars, the mileage based reported *UA* accident rate for drivers over the

* 70% of *UA* accidents for vehicles without shift locks were reportedly triggered by shifting out of Park. See Table 1, Infra.