

PETITION DP92-017
INADVERTENT RELEASE OF SAFETY BELT BUCKLES

Office of Defects Investigation
The National Highway Traffic Safety Administration

November 18, 1992



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BASIS:

Mr. Benjamin Kelley, President of the Institute for Injury Reduction (IIR), petitioned the National Highway Traffic Safety Administration (NHTSA) by letter dated September 11, 1992, requesting that the agency initiate a defect investigation leading to a recall and a rulemaking proceeding to preclude from sale in the future certain designs of safety belt buckles. The petition alleges that certain designs of buckles are susceptible to "inertial actuation" that causes them to open during a motor vehicle accident. The petition states, "The defect appears to involve seat buckle designs with release buttons on the front face of the buckle ('front release'). It has been found in seat belt configurations spanning about three decades, including new car designs."

The petition specifically requests the agency to "take the following actions concerning the 'inertial actuation' design of some seatbelt buckle-latch connections. . .

1. Initiation of a defect investigation of the design, leading to appropriate recall and corrective action by manufacturers whose belt systems have utilized it;
2. Initiation of a rulemaking leading to amendment of Federal Motor Vehicle Safety Standard 209 to preclude such designs in the future;
3. Issuance of warning and other information necessary to alert the public to the existence, nature and magnitude of such designs, and the hazards they represent
(; and]
4. Issuance of guidelines to safety researchers, police investigators and others reporting crash-related and crash injury-related information that the presence of an unlatched belt following a car crash does not mean per se that the belt was not being worn prior to the crash."

BACKGROUND:

Coincident with the filing of this petition, on September 10, 1992, CBS aired a program on "Street Stories" concerning alleged unlatching of safety belt buckles. The content of the show was essentially based on the alleged defect of inertial unlatching as presented in the petition.

There are many different designs of safety belt buckles in motor vehicles. All have a release button that must be manually depressed for release. The petitioner states that the alleged defect appears to involve buckle designs with release buttons on the "front face" of the buckle. In the particular style that is the subject of this petition, the buckle is generally a

rectangularly shaped assembly, about 1-3/4" by 2-1/2" in size and 3/4" thick. A latchplate, attached to the belt material, is inserted into the buckle. The release button is on the 1-3/4" by 2-1/2" side of the buckle and will be referred to hereafter as a side release buckle. The petitioner refers to this type as a "front release" button.

The other principal style of buckle uses a different location for the release button. The buckle is also rectangular in shape, however, it may be slightly thicker, about 1-1/4 inches. The release button is on the top end of the buckle, and next to the slot for inserting the latchplate. This type is hereafter referred to as an end release buckle. Both buckle styles are widely used by the automotive industry.

The internal designs of these two styles of latches are different by necessity. The direction for pressing the release button of the side release buckle is perpendicular to the direction for insertion of the latchplate. In contrast, the direction for depressing the button on an end release buckle is in the same direction as the insertion of the latchplate.

All new motor vehicles sold in the United States must comply with Federal Motor Vehicle Safety Standards (FMVSS). In particular, safety belts and buckles must meet the requirements specified in FMVSS No. 209, "Seat Belt Assemblies." Under this standard, the "[B]uckle release mechanism shall be designed to minimized the possibility of accidental release."

APPROACH:

To evaluate this petition, the agency conducted an extensive review of crash test data, analyzed real-world accident data, performed full-scale crash and other testing of buckles, requested information from motor vehicle manufacturers, manufacturers of safety belt buckles, and safety belt buckle patent holders, and reviewed complaints filed with the Auto Safety Hotline. The following specific actions have been taken during this evaluation:

- o Wrote letters to eight motor vehicle manufacturers.
- o Wrote letters to five safety belt manufacturers.
- o Wrote letters to seven safety belt buckle patent holders.
- o Analyzed real-world accident data.
- o Reviewed agency laboratory crash data.
- o Evaluated and interviewed ODI accident complaints alleging buckle release.
- o Conducted vehicle and laboratory testing at the Vehicle Research and Test Center (VRTC). Reviewed previous VRTC testing on safety belt buckles.
- o Conducted telephone interviews with callers to Hotline.

The findings from this evaluation is provided in the following sections.

VEHICLE MANUFACTURERS' RESPONSES:

The agency formally requested information from certain vehicle manufacturers regarding the alleged defect of inertial unlatching of safety buckles. Information requests were sent to General Motors (GM), Ford, Chrysler, Toyota, Honda, Nissan, Volkswagen (VW), and Volvo. Each manufacturer was asked to provide complaints, accidents reports, and lawsuits pertaining to the alleged defect. They were asked to describe all tests, studies, and surveys pertaining to the alleged defect and describe any design modifications pertaining to the alleged defect.

These responses are summarized below:

GM: GM's response stated, "GM has had very few reports alleging inertial unlatching of seat belt buckles. In most cases where the occupant reports that the seat belt buckle unlatched in an accident, it is not clear from the allegation whether the belt may have been released from 'inadvertent contact with the release button by external objects', whether it is alleged that the buckle release was caused by inertial forces, or whether some other condition is being alleged." GM has made no design changes in response to the alleged defect.

In response to the question of testing done with respect to the alleged defect, GM reports that it is aware of only two reports of buckle unlatching during its vehicle crash and sled testing that may relate to the alleged defect. Both incidents occurred in tests conducted during 1991. It reports that it conducted more than 749 crash and sled tests with belted occupants in 1991. Since 1970, GM has performed about 30,000 crash and sled tests, most with belted test dummies. Thus, GM data indicate that the alleged defect could be present in, at most, less than 0.007 percent (2/30,000) of its crash testing.

Ford: Ford reports that it has "... located a number of allegations that a seat belt had inadvertently opened or released during an accident. While some of those files contain occasional references to 'inertial unlatching,' few, if any, contain sufficient details to determine with certainty that they allege "... inadvertent release or opening of a safety belt latch due to inertial loading of the release button or latching mechanism caused by external forces acting on the back side of the latch housing." Ford did not report any safety belt buckle unlatching incidents associated with inertial forces during its crash and sled test programs. Ford has made no significant design changes related to the alleged defect.

Chrysler: Chrysler reports that it has only one complaint report that may relate to the alleged defect condition of inertial unlatching. In this case, Chrysler found the "seat belt was intact and functional--nothing to indicate that seat belt was in use at the time of the accident." Furthermore, the case went to trial and the jury found that the complainant was not wearing the seat belt at the time of the accident. Chrysler provided several other complaints alleging buckle unlatching, but finds no evidence that the seat belt was

in use or evidence of a defect in the buckle. Chrysler did not report any safety belt buckle unlatching incidents associated with inertial forces during its crash and sled test programs. Chrysler has made no design changes related to the alleged defect.

Toyota: Toyota reports that it has received "only 7 lawsuits that pertain to the alleged defect, and no other owner complaints, field reports, etc." Toyota also reports it has made no modifications that could relate to the alleged defect and has issued no service or technical bulletins or other communications pertaining to the alleged defect. Toyota did not report any safety belt buckle unlatching incidents associated with inertial forces during its crash and sled test programs.

Honda: Honda reports no complaints or field reports, and only two lawsuits alleging that a seat belt buckle unlatched. Honda is aware of no investigations or surveys on this subject.

In response to the question concerning design changes, Honda's letter states that there has been one modification that "could be related to the alleged defect." Honda provided further clarification of its response by saying that its design change was not in response to allegations of inertial unlatching, but rather to reduce the latch spring force making the buckle easier to release while the belt is under tension. This was done to increase its margin of compliance with the buckle release force requirements in FMVSS No. 209, "Seat Belt Assemblies." Honda had taken a broad interpretation of the question to include any changes to components that are significant to the performance of a buckle when subjected to inertial forces.

Finally, with regard to the safety performance of end release buckles compared to side release buckles Honda reports, "We do not recognize any difference in safety between the end release type and the side release type." Honda did not report any safety belt unlatching incidents associated with inertial forces during its crash and sled test programs.

Nissan: Nissan reports it "is unaware of any accidents, subrogation claims, or lawsuits which specifically pertain to the alleged defect in the subject vehicles." However, they submitted four complaints alleging unlatching of a buckle. One complaint alleged unlatching of an empty child seat but it indicates that the claimant "admitted that she was not positive that the seat belt was hooked properly to secure the infant seat." Nissan reports that the alleged defect has not occurred in any of the variety of tests conducted to assure compliance with FMVSS's and other standards in other countries. Nissan has made no design changes related to the alleged defect.

Volvo: Volvo reports, "Volvo has never seen the alleged defect occur in its many years of conducting laboratory crash testing. Volvo is aware of no real-world accidents, allegations, or lawsuits pertaining to the alleged defect." Volvo did not report any safety

belt buckle unlatching incidents associated with inertial forces during its crash and sled test programs. Volvo has made no design changes related to the alleged defect.

VW: Volkswagen has found no complaints, field reports, studies, surveys, investigations, or technical bulletins that relate to the alleged defect. It also reports, in all of its testing for compliance with United States standards, European Certification, and its own test requirements, that "there has not been one incident related to the alleged defect." VW has not made any design changes related to the design defect.

Table 1 shows a summary of complaints provided to NHTSA in the manufacturer responses. The reported vehicle population is given for vehicles from 1970 to the present. The computed rate of complaints per 100,000 vehicles with side release buckles is shown for each manufacturer.

Table 1
Summary of Complaints of
Inadvertent Release Received from Manufacturers
1970 to Present

MFR	SIDE RELEASE BUCKLE		
	REPORTS	VEHICLE POPULATION (MILLION)	RATE PER 100K
GM	63	119	0.05
FORD	48	67	0.07
CHRYSLER	13	38	0.03
TOYOTA	7	15	0.05
HONDA	2	8	0.03
NISSAN	2	12	0.02
VOLVO	0	1 (1977-92 data)	0
VW	0	3	0
TOTAL	135	263	0.05

The analysis of manufacturer complaints and lawsuits alleging unwanted buckle unlatching shows no evidence to demonstrate that inertial unlatching is a safety concern in crash tests or real world accidents. Contributing factors unrelated to inertial loading may be responsible for an unlatching complaint. The crash and forensic analysis of vehicles, buckles, and

injuries show that, in many cases, the buckle was in good condition with no identifiable defects and that there is no evidence to indicate that the occupant used the safety belt.

Chrysler provided an analysis of inertial loads on safety belts and compared the results to what occurs in a crash test. It demonstrates that the impact required to unlatch a buckle greatly exceeds the acceleration loading on a buckle during a crash test. In the crash testing, the buckle acceleration peaked at 100 g at 1500 lbs of belt tension at the retractor. In Chrysler testing, the buckle system required 145 g to release with no belt tension. Chrysler's testing demonstrated, however, that increasing belt tension greatly increases the engagement force of the latch and greatly increases resistance to inertial movement of the release button, hence the acceleration necessary to unlatch the buckle. Its analysis shows more than a 600 percent increase in the acceleration required to release the buckle associated with an increase of belt tension from zero to 25 pounds. Its data shows, with the belt under tension such as occurs during a vehicle crash, that crash forces do not generate the necessary impact acceleration loading on the buckle to overcome the engagement forces resulting from the belt tension. This finding is consistent with the results of the agency testing discussed later in this report.

The automotive manufacturers uniformly report that their test programs conducted as part of research, development, and certification of vehicles has not shown any problem associated with inertial releasing of buckles in the vehicle crash environment that would indicate a safety risk in the real world.

In summary, the information received from the motor vehicle manufacturers on the performance of safety belt buckles does not indicate that a safety problem with unlatching of safety belt buckles during crashes, due to inertial actuation, exists. The scope represented by these responses includes millions of vehicles over many years of vehicle usage and thousands of crash tests.

SAFETY BELT BUCKLE MANUFACTURERS' RESPONSES:

The agency sent letters to the five principal manufacturers of safety belt buckles (latch assemblies) for vehicles produced for sale in the United States. Each manufacturer was asked to describe its latches and provide drawings, provide reports of complaints and lawsuits, provide all tests and studies with respect to the alleged inertial unlatching, and describe all modifications made in response to the alleged inertial unlatching problem.

These responses are summarized below:

Takata Inc.: Takata responded with only one reported lawsuit involving a 1983 GM vehicle. The vehicle was involved in a frontal collision. Takata reports, "Examination of the belt and vehicle found no defects." It reports that this type of buckle was supplied to GM for vehicles from 1977 through the present for application in several vehicle

platforms (A, F, G, H, J, L, N, W and X-body). Takata has not made any design modifications to this latch that relate to the subject condition of inertial unlatching.

General Safety Corporation: General Safety has manufactured one type of latch assembly, the GM Type 1, from 1970 to the present. This buckle has been used for Cadillac, Buick, Pontiac, Oldsmobile, and Chevrolet vehicles during that period of time. It is unaware of any complaints, field reports, accidents, lawsuits, studies or surveys that relate to the alleged defect of inertial unlatching. No modifications have been made to the design of the buckle during this period of time.

Indiana Mills and Manufacturing, Inc. (IMMI): IMMI reports receiving no complaints, field reports, lawsuits, studies, or surveys that pertain to the alleged defect of inertial unlatching. No changes have been made to its products that relate to the alleged defect, and it is not aware of any instances where latches on belts manufactured by that company opened because of inertial actuation.

TRW: TRW reports no complaints, field reports and two lawsuits. Both lawsuits alleged a possible inertial actuation of the latch during an accident. In one, the court found "no credible evidence of a design defect." The second incident, which occurred in October 1990, is still in litigation. TRW has not identified any test information that relates to the alleged defect of inertial unlatching. No changes or modifications have been made to buckles in response to the alleged defect.

Allied Signal/Bendix: Allied reports receiving no complaints or field reports, but indicated four lawsuits claiming alleged inertial release with side release type buckles. It states that in three of the four lawsuits, inspection of the vehicle and buckle revealed that the injured individuals were not wearing the safety belt. The fourth lawsuit concerns a suspected aftermarket installation of a safety belt manufactured by Irvin Industries (now Takata) allegedly using an Allied design. Allied has not yet inspected this vehicle or buckle.

As part of the design and development of its buckles, Allied conducts sled testing. It has "no evidence that such buckles have released inertially during such testing." Its buckles are also tested by independent laboratories, Hunt Laboratories and United States Testing, and they have never informed Allied that a buckle released inertially. Allied has made no design changes related to the alleged defect.

In summary, the buckle manufacturers report no complaints and several lawsuits relating to the alleged defect. These manufacturers have made no design changes relating to the alleged defect. Testing of the buckles, performed by the buckle manufacturers, or that which the buckle manufacturers are otherwise aware of, has not provided any indication of a unlatching problem that could be associated with the alleged defect. The information does not support the allegation of a real-world problem with unlatching of safety belt buckles during crashes.

END RELEASE BUCKLE PATENT HOLDER RESPONSES:

Mr. Ralph Hoar, of Ralph Hoar & Associates, sent the agency two letters in support of the IIR petition. His letters allege that the industry is aware of inertial unlatching and is active in providing design solutions to the problem as indicated by several patents. He provided copies of eight United States patents that briefly discuss inertial unlatching in some context, but not necessarily in reference to crash forces. Every patent provided by Mr. Hoar described a type of end release buckle.

The agency sent letters to the holders of seven of the eight patents for end release buckles provided by Mr. Hoar. One patent holder is a foreign firm and not readily accessible to provide a timely response for this analysis. The following patent holders have been asked to respond to the concern of inertial unlatching as it relates those specific patents that mention inertial forces. The patent holders were asked to describe inertial actuation as it relates to the patent, respond to allegations that the patent provides evidence of a problem with side release buckles, and provide any technical reports and studies discussing inertial unlatching.

Allied Signal/Bendix: Allied reports having no knowledge of inertial release of side release buckles in accident conditions. Allied reports that these patents were developed "in response to customer's specification to design an end-release buckle. In the late 1970's and early 1980's the 'parlor trick' of causing a 'side release' buckle to open by slapping it on a table was widely demonstrated in Europe and was being used by European competitors as a way to induce customers to purchase competitive buckles which were more resistant to that particular 'parlor trick.'" With respect to side release buckles, Allied explains that "web tension acts a restraining force and significantly influences the amount of button force required to cause latch movement. Latch movement can also be induced by acceleration forces if the resultant inertia force on the buckle is in the proper direction and also is capable of overcoming internal (pre-load, spring rate, frictional and damping forces) and external (web tension) restraining forces acting on the latch." Allied is not aware of any type of accident that could generate the necessary forces to cause inertial release. The end release patents were not developed because of any known deficiency causing them to be susceptible to inertial unlatching.

GM: GM responded by reporting, "although all buckles can theoretically become disengaged by inertial forces at some levels of acceleration and direction relative to the buckle, General Motors does not believe that buckles are susceptible to inertial release under normal conditions of usage, including under accident conditions." In response to the question of whether GM developed the patent to present a solution to the alleged defect of inertial unlatching, GM reports that all of its buckles, both side release and end release types, have been designed to "overcome inertial forces in real world use situations, and to avoid unwanted buckle disengagement." GM did not indicate that the incorporation of inertial considerations in the patent was indicative of a real-world problem of inertial unlatching in side release buckles.

Takata, Inc.: This manufacturer has not provided a response to the questions in the agency's information request pertaining to two Takata patents.

TRW: The TRW patent contains a statement describing possible unlatching of an end release type buckle when used in conjunction with a pyrotechnic pre-tensioning device. This is attributed to the movement and sudden stopping of the buckle during the automatic pre-tensioning phase, in which inertial forces can unlatch the buckle in this particular design application. The TRW patented features are new and not yet on vehicles sold in the United States. The TRW patent seeks to correct the conditions resulting from the pyrotechnic device and not from accident conditions. It states, "There is no evidence that real world accidents, in and of themselves, will result in buckle accelerations or occupant to buckle impacts sufficient to inertial release a buckle using a conventional side release button configuration."

IMMI: IMMI reports, "There were no theoretical, actual or alleged instances of inadvertent buckle release due to inertial actuation forces that led IMMI to develop the buckle covered by the patent." IMMI explains that it has developed the subject features in the patent to minimize the "theoretical risk of release due to inertial forces. This would also make the buckle usable with pre-tensioners, which may eventually come in our application."

The patent holders report no knowledge of real-world inertial unlatching of buckles. Certain patents show buckle designs that can be used with pyrotechnic belt pre-tensioners and those designs must anticipate the inertial forces due to the pre-tensioning device. Finally, these patent holders do not indicate that development of the end release buckle patents was in response to performance deficiencies in side release buckles.

REAL-WORLD CRASH DATA ANALYSIS:

Numerous research studies dating from 1984 to 1992 uniformly show a substantial reduction in the risk of injury to occupants in a motor vehicle accident when safety belts are used. These studies include those by the major industrialized countries of Europe, Canada, Australia, and in the United States. The results clearly indicate that, when used, lap and shoulder safety belts reduce the risk of fatal and serious injury to front seat occupants by 40 to 50 percent.

As part of the analysis related to this petition, crash files maintained by the NHTSA's National Center for Statistical Analysis (NCSA) were reviewed for reports of possible inertial unlatching of buckles. Searches were made of the computerized National Accident Sampling System (NASS)¹ database from 1988 through 1991 to identify specific crash investigations

¹ NASS is a sample of nationwide crashes investigated by NHTSA contractors. The investigation consists of vehicle inspection, crash scene analysis and occupant interviews. These

which suggest that the safety belt buckle released and for which "hard copy" files were available. This search identified 19,444 belted front seat occupants. Of these, cases were selected that indicated that a manual belt buckle opened, that the manual or automatic buckle failed, or that the occupant was restrained by a manual safety belt, but was ejected. These searches identified a total of 34 cases for review of the "hard copy" investigation file. These 34 represent 0.17 percent of the belted occupants.

The 34 reports provided no evidence of inertial buckle unlatching. The reports indicated examples of extreme vehicle damage that resulted in tearing away of the doors, the B-pillars, the belt anchorages at the floor, cutting of the webbing, shattering of the buckle housing, and structural failure of the retractor mechanism.

The agency also has conducted statistical analyses of its accident data files to determine whether the data contains any evidence of a difference in occupant crash protection between vehicles equipped with end release buckles compared with vehicles equipped with side release buckles. The analyses utilized the Fatal Accident Reporting System (FARS) files for 1985 through 1991 and selected state accident data from the CARDfile² for 1988 through 1990 (the three most recently available years). The data were analyzed to assess ejection, fatality and incapacitating injury rates for vehicles equipped with side release and end release buckles. Descriptions and summaries of the analyses conducted by NCSA are included in Appendix A.

The FARS analysis compared specific vehicles from model years 1985 and later that were equipped with either side release or end release buckles, but did not include vehicles with passive belts or air bags. Vehicles from model years 1985 and later were selected because the agency had data available to indicate whether those vehicles were equipped with end or side release buckles. A list of those "specified vehicles" studied in this analysis is given in Appendix B. Since the analysis included several categories of vehicles, differences in driver and vehicle characteristics were accounted for in the analysis. Further analysis was conducted of accident data for specific vehicles that had a production change from side release buckles to end release buckles, but with no other vehicle changes that could impact the effectiveness in the belt system. These vehicles (referred to as cross-over vehicles) changed from a side release buckle to an end release buckle. Three sets of cross-over vehicles were analyzed--Ford Taurus/Mercury Sable, Lincoln Continental, and Plymouth Voyager/Dodge Caravan. These vehicles were subjected to an additional analysis to determine whether the data suggested any discernable difference in crash protection provided by end versus side release buckles in essentially identical vehicles.

cases provide a detailed description of the crash severity and occupant injury consequences.

² CARDfile - Crash Avoidance Research Data file. CARDfile is a file incorporating six states' police-reported accident files in a standard format.

The NCSA report concludes that "there is no pattern of evidence in the crash data to support the allegation related to inadvertent unlatching for side-release systems." This analysis, based on fatal and less serious crash data, did not indicate a safety performance problem with side release buckles.

CRASH TEST DATA:

The agency has accumulated a large body of crash test data involving safety belts to restrain test dummies in both vehicle and sled tests. This includes testing of child safety seats as well. The testing has been conducted in three program areas; the Office of Vehicle Safety Compliance, Research and Development, and New Car Assessment Program (NCAP). In order to identify and understand any occurrences of the alleged problem of buckles unlatching, the agency conducted a comprehensive review of all its testing to locate specific reports of buckles unlatching during these tests.

Crash testing with belted test dummies includes front, rear, side and vehicle rollover impacts. In the frontal and side impact category, tests were conducted at both 90 degree and oblique impact angles. Table 2 shows a summary of agency crash and sled test data involving full sized belted dummies.

Table 2
Agency Crash and Sled Tests
with Belted Test Dummies

Type of Test	No. of Tests	No. of test Dummies	Latch Openings
Frontal 90 degree	1,353	2,491	8
Front Oblique	53	104	0
Rear	409	811	1
Roll Over	17	17	0
Side	235	307	0
Total	2,067	3,730	9

A total of nine buckles have opened during testing with belted test dummies. Three openings were associated with defective latches. These buckles were end release type buckles and the vehicles using these defective belt buckles with end release buttons were recalled after an

investigation conducted by the agency's Office of Defects Investigation (ODI). Four buckles opened during the rebound movement of the dummy when a portion of the dummy body contacted the release button on the buckle. These four buckles were also end release buckles. Each of these events occurred during frontal testing under the NCAP program and the impact speeds were 35 mph. The dummies were restrained during the initial impact and the recorded injury level of the dummy at the seating position of the released buckle was not significantly different from the injury level of a restrained dummy at the other seating position in which the belt remains latched. This leads to the conclusion that any belt release was after the crash event was over.

The remaining two of the nine buckles that opened were side release designs. One occurred during a frontal 30 mph barrier crash test of a 1979 International Scout II. The vehicle was equipped with a lap belt only and the buckle was found to be in an open condition during the post crash inspection. The crash test film shows the buckle not out of position but resting in the lap of the dummy. If the buckle had released during the initial impact or during any other phase of high deceleration, the belt and buckle most likely would have been forced out of position, rather than resting in a normal position on the dummy's lap. It appears that the safety belt restrained the dummy during the initial impact, but released upon rebound. The other side release buckle opened during a 35-mph rear impact test of a 1980 Honda Prelude. The dummy moved rearward upon the initial vehicle impact by a moving barrier. It does not appear from the kinematics of the vehicle during the rear impact and the reactive motion of the dummy that the backside of the buckle was impacted during the initial period of this test when the apparent buckle unlatching occurred. However the precise reason for the buckle opening cannot be determined.

A comprehensive review of all of dynamic sled testing of child safety seat tests was also conducted. A total of 239 tests were performed. Only two motor vehicle buckles opened during testing of child safety seats. Both buckles were the side release type. One buckle failed when it broke into two pieces due to a bending load applied to the buckle. During the test, the buckle was pulled across the metal bar of the child safety seat while its two ends were subjected to a tensile load in opposite directions, approximately 90 degrees apart with respect to each other. The resulting bending moment on the buckle fractured the latchplate at the webbing attachment point. The other buckle release occurred in a test of the interaction with a passenger-side air bag. The rear-facing child safety seat was intentionally positioned close to the air bag housing to test the dynamic interaction between the air bag and the child safety seat--this is contrary to all manufacturers' warnings and instructions for positioning a child safety seat in a vehicle with a passenger-side air bag. As the air bag deployed, the air bag impacted the back of the child safety seat, forcing the safety seat downward. This motion forced the vehicle's safety belt buckle under the edge of the child safety seat and into the bottom seat cushion, at which point the buckle released. Based on the direction of the application of the initial and reactive forces, there is no indication of an impact with the backside of the buckle that would be indicative of an alleged inertial unlatching.

A summary of the above reported latch openings during agency testing is in Appendix C.

In summary, the agency has reviewed all available data of testing of restrained occupants in search for evidence of alleged inertial unlatching of buckles. This review encompassed testing of a total of 3,730 belted test dummies and 239 child dummies in child safety seats. No evidence of buckle release due to alleged inertial unlatching was found.

TESTING IN SUPPORT OF PREVIOUS INVESTIGATION EA77-040

In June 1977, an Engineering Analysis (EA77-040) was opened to investigate a single complaint alleging that the seat belt buckle in a 1975 Chevrolet Monza would open if a sharp impact was applied to the back of the buckle. In support of the investigation, a test program was initiated on sample buckles from a Monza and other vehicles. The purpose of the testing was to duplicate and observe the unlatching when the buckle was impacted by a rubber mallet on the front and rear surfaces of the buckles. An impact device was constructed to provide a repeatable impact force. Testing was expanded to include other vehicles from model years 1971 through 1978. This testing included the passenger seat buckles in a total of 225 vehicles.

The testing demonstrated that buckles, including the Chevrolet Monza, would unlatch if impacted with a sharp blow to either the rear or the front face of the buckle. The expanded testing of other model years also showed that many buckles would open when hit on the rear surface with a sharp impact. It was noted that 50 of 225 buckles opened during these tests.

The test device did not simulate the portion of the human body that is in contact with the back of the buckle when the buckle is worn. Also, the impact was not selected based on a correlation of the force that might be applied by the body to the back of the buckle during a vehicle accident. The primary intent of the test device was to allow for the gathering of empirical and repeatable data that would demonstrate, in a laboratory setting, the phenomena of buckle unlatching due to a non-accident-related impact force.

While the testing demonstrated that certain impacts on the buckle not representative of real-world crashes could open a buckle, there was no correlation made to the dynamic forces that are present in real-world crashes. Thus, this testing did not establish a risk of buckles opening in real-world crashes. The Engineering Analysis in EA77-040 report indicates that there were no additional complaints in the ODI consumer complaint file of the alleged problem of buckle unlatching. Based on the lack of evidence that the alleged problem was present in the real world, EA77-040 was closed.

The report of testing done under investigation EA77-040 recommended additional work using a more realistic impact force. The recommendation specifically identified the need for data concerning rollover and corner impacts to the vehicle. The agency has done this. NHTSA has conducted a comprehensive vehicle testing program involving belted occupants in compliance, NCAP and research and development testing. As described in a prior section of

this report, the agency tested 307 full sized belted dummies in side impacts, 104 in front oblique impacts, 2,491 in frontal impacts, 811 in rear impacts, and 17 in vehicle rollovers. No evidence of inertial unlatching was reported in those tests. These tests, which represent real-world crashes, represent a thorough and comprehensive assessment of safety belt performance.

ODI COMPLAINTS:

Before Petition:

A search of the ODI database identified 1,886 records of consumer complaints regarding belt failures in accidents as of September 9, 1992, one day before the showing of the CBS "Street Stories" program. The computer print-out of these records was reviewed for allegations of seat belt buckle failures. Key words such as: buckle, buckle unlatched, unfastened, disengaged, and opened, were targeted for further review. Complaints of seat belts breaking, problems fastening, belt spooled out/pulled out, belt did not lock up, belt released (retractor), false latching, or no latching were not followed up because they are not related to the alleged defect. Out of the 1,886 records, 85 were identified as possibly relating to buckle disengagement. Full copies of these reports were retrieved and reviewed for pertinency, which included telephone calls to consumers for clarification where appropriate. The agency attempted to reach 63 complainants by telephone and successfully made contact with 40. After this process, 35 reports were identified in which it was alleged that a seat belt buckle inadvertently disengaged during an accident.

The 35 complaint reports were analyzed by type of buckle, type of accident, severity of accident, and severity of injury. The type of buckle reported is either a side release or an end release buckle. The underlying presumption for the inertial unlatching in a side release buckle to occur is that the impact necessary to release the buckle must be applied to the inside (the side next to the occupant) of the buckle. Accordingly, the reports were reviewed to determine the type of accident by principal location of impact. The location of the vehicle impact determines the initial direction of forces applied to the vehicle, occupant and the buckle.

Table 3 shows a listing of 35 complaints by model and model year. The complaints are widely distributed among many makes and models, and over many model years. Of the 35 reports, 24 were for vehicles equipped with side release buckles, and 11 were for vehicles with end release buckles. A rate comparison was made of the number of complaints for both buckle types by dividing the number of complaints by the vehicle population for each particular vehicle. The rate for side release buckles is 0.7 per 100,000 vehicles and the rate for end release buckles is 0.9 per 100,000 vehicles.

Table 3
List of Complaint Vehicles

MODEL YEAR	MANUFACTURER	MODEL	SIDE RELEASE	END RELEASE
1980	FORD	CAPEI	1	
1981	GM	CHEVETTE	2	
1984	FORD	BRONCO	1	
1984	GM	CELEBRITY	1	
1984	GM	CUTLASS	1	
1984	FORD	ESCORT	1	
1984	GM	REGAL	1	
1985	GM	ASTRO VAN	1	
1985	GM	BLAZER	1	
1985	GM	ELECTRA	1	
1985	FORD	ESCORT	2	
1985	MAZDA	GLC		1
1985	CHRYSLER	NEW YORKER	1	
1983	GM	SPRINT	1	
1983	GM	SUBURBAN	1	
1986	GM	CAMARO		1
1986	GM	LESABRE	1	
1986	MINIBUS	MIRAGE		1
1986	GM	NOVA	1	
1986	GM	REDBIRD		1
1986	MAZDA	323		1
1987	GM	SABARI VAN	1	
1988	GM	CORUCA	1	
1988	GM	CUTLASS	1	
1988	GM	CELEBRITY	1	
1988	GM	REGAL	1	
1988	CHRYSLER	SHADOW		1
1989	FORD	PROBE		1
1990	GM	CORUCA	1	
1990	CHRYSLER	DYNASTY		1
1991	FORD	EXPLORER		2
1992	GM	MINI		1
		TOTAL	24	11

Two critical conclusions are evident from these data. First, even if all of the complaints did in fact reflect instances in which the buckles actually released as a result of an accident, the complaint rate is extremely low--far below the levels indicative of a potential problem that would warrant a determination of a safety-related defect. Second, no significant difference was noted between the complaint rates for side release buckles compared to end release buckles. This is consistent with the real-world accident data analysis which demonstrated no difference in the occupant protection of side versus end release buckles.

The vehicle age at the time of the complaint was analyzed in response to the possibility that over time, buckles may be more vulnerable to inertial unlatching because of weakening of the buckle release spring. Table 4 shows the relationship of complaints to vehicle age. No trend was noted to indicate that buckle aging contributes to an increase in alleged opening of safety belt buckles in motor vehicle accidents.

Table 4
Complaints by Vehicle Age
At the Time of Alleged Failure

VEHICLE AGE (YEARS)	REPORTS	
	SIDE RELEASE	END RELEASE
9	1	0
8	0	0
7	0	0
6	2	0
5	6	0
4	1	0
3	1	2
2	5	3
1	4	2
0	4	4
TOTAL	24	11

The impact location to the vehicle was also considered. Because the buckle position is at the side of the occupant, an impact to the side of the vehicle would likely transmit the most

direct impact from the occupant to the buckle. Table 5 shows a comparison of impact location on the accident vehicle by the type of buckle. For both the end and side release buckles, most of the reported impacts were to the front and rear and not the side of the vehicle.

Table 5
Vehicle Impact Location by Buckle Type

IMPACT LOCATION	RELEASE BUTTON LOCATION	
	SIDE	END
FRONT	8	6
REAR	4	2
SIDE	8	2
ROLL	4	1
TOTAL	24	11

The reported vehicle damage or accident severity ranged from moderate to severe. Injuries were reported in 33 of the 35 accident reports. The type of injury varied and is shown in Table 6. The seriousness of the injury as measured by the type of treatment (where reported in the complaint or determined by follow-up telephone calls) is shown in Table 7.

Table 6
Type of Injury

INJURY TYPE	SIDE RELEASE	END RELEASE
NONE	1	1
ABRASION	6	1
LACERATION	2	0
BROKEN BONE	6	1
TRAUMA	3	4
CONCUSSION	1	1
NOT REPORTED	5	3
TOTAL	24	11

Table 7
Type of Treatment

TREATMENT	SIDE RELEASE	END RELEASE
NONE	4	2
EMERGENCY ROOM	3	2
HOSPITALIZED	7	1
FATAL	0	0
NOT REPORTED	9	5
TOTAL	23	10

Of the 35 complaint reports, eight alleged that a child-seat was released by the opening of the vehicle's seat belt buckle. Of the eight, five were side release buckles and three were end release buckles. The complaint rate associated with the alleged release of child seats for the side release buckles is 0.5 per 100,000 vehicles sold compared to 0.8 per 100,000 vehicles sold for the end release buckles. Again, no significant trend is noted to indicate an inertial unlatching phenomenon of the side release buckles.

After Petition:

In the 4 days immediately following the "Street Stories" program, which was broadcast on nationwide television, the agency received approximately 4,800 calls to the agency's toll-free Auto Safety Hotline. These calls represent inquiries to the Hotline requesting consumer information on a variety of subjects, including child safety seats, New Car Assessment Program crash test results, Uniform Tire Quality Grading System, drunk driving literature, etc. Additionally, these calls include callers who either want to discuss a safety issue with a Hotline contact representative or file a consumer complaint about a safety problem they have experienced with a motor vehicle or item of motor vehicle equipment. These include Hotline calls in response to the "Street Stories" and "CBS Evening News" presentations. When compared with the total phone calls received by the Hotline over the same Friday through Monday time period for the preceding 6 weeks, the 4,800 calls are very close to the average 4,400 calls over that 6-week period.

As another comparison of the public's response to the claims of safety belt buckle unlatching based on presentation in the media, the agency reviewed the number of consumer calls to the Auto Safety Hotline in two other instances where the Hotline telephone number was illustrated on national television. After a February 1990 child safety seat segment on "Good Morning America," the agency received over 8,000 calls during the next 5 days. After a February 1992 ABC broadcast concerning child safety seats, nearly 10,000 calls were received by the Hotline within 5 days. Additionally, after agency press releases announcing

the availability of consumer information on such subjects as the Uniform Tire Quality Grading System, the New Car Assessment Program, and child safety seats, the agency received between 9,000 and 25,000 requests for the information within 4 days, depending on the subject.

The relatively few number of calls to the Hotline concerning safety belt buckles as a result of broad national publicity can be taken as a strong indication that the alleged defect is not a real-world problem.

Aside from the total number of consumer calls to the Hotline, calls actually reporting a safety belt problem were analyzed. Of the calls that were in response to the "Street Stories" and "CBS Evening News" presentations, the vast majority were from those consumers who either expressed concern over what they had seen on television, including a number of persons stating "I could make my safety belt do what the show indicated," or requested information from the agency on safety belts. From the date the CBS program was shown on September 10, 1992 to September 28, 1992, only 47 callers actually reported complaints related to safety belt performance. Of the 47 complaints, 30 involved accident situations, and only 18 of these specifically alleged that the safety belt became unlatched for some reason. None of these complainants indicated or suggested that the reason for the unlatching was an impact to the backside of the buckle. Like the complaints received before the "Street Stories" program, these complaints include vehicles equipped with end release as well as side release buckles. Four of the 18 complaints were on vehicles with an end release buckle. Two reports indicated that a vehicle buckle failed to hold a child safety seat—one report each for side and end release buckles. Serious injuries were reported for both the side and end release buckles. Four reported injuries required hospitalization, three were in vehicles with side release buckles and one was in a vehicle with end release buckles.

One fatality was reported and was investigated by an independent experienced accident investigator. The investigation included examination of the crash scene, the vehicle, the belt and buckle, the autopsy report, and interviews with the police officer, the victim's relatives, and the medical examiner. The police accident report indicates that the victim was not wearing the safety belt. The investigator found no evidence to indicate that this finding was incorrect.

It is apparent that calls to the Hotline were not significantly affected by the publicity associated with the "Street Stories" and "CBS Evening News" broadcasts alleging safety belt unlatching due to inertial loading. Further, consumer complaints concerning belt unlatching in crashes have been extremely low in number. The fact that the low volume of calls to the agency's Auto Safety Hotline, and more specifically, the small number of consumer complaints specifically addressing unlatching of safety belts in crashes, suggests that the public does not consider this to be a safety concern. It also suggests that the public understands the benefits of safety belts and the protection they provide to vehicle occupants in real-world crashes. Additionally, the complaints of buckle release that were received fail to show any evidence to support an inertial release phenomena. Complaints have been

reported on both the side and end release buckle designs, but no significant difference was noted in the complaint rate between side and end release buckles for alleged unlatching incidents. Interestingly, most complainants report the unlatching occurred during a front or rear impact, which would not appear to be the direction providing the greatest susceptibility to alleged inertial unlatching of side release buckles.

RECENT TESTING:

Following the receipt of the petition, ODI initiated a test program to assess the performance of side release buckles under various conditions. The purpose of the testing was to: (1) determine the dynamic physical conditions necessary to cause side release buckles to release under inertial loading from a sharp impact to the back side of the buckle; (2) measure buckle response in crash conditions and compare these to measured and predicted conditions that would cause a buckle to unlatch due to inertial forces; and (3) measure in-vehicle conditions using a human volunteer and metal frame child seat. The full report of testing is attached as Appendix D.

Testing included full scale vehicle crash tests; bench testing of buckles involving striking the back of sample buckles with a human hand or hip, and a video cassette; and in-vehicle testing of buckles using a metal frame child seat and a human volunteer's hip. A computer model was developed to predict the required impulse, acceleration, and pulse width to the buckle that would cause a buckle to unlatch under inertial forces.

The bench testing consisted of dropping an 8 lb weight from selected heights onto the back side of a side release buckle. The buckles were equipped with accelerometers to measure the acceleration-time history of the impacts. The buckle was stretched horizontally between two posts and placed under tension. The belt/buckle tension was held at 5, 50, and 500 lbs. The back of the buckle was impacted with and without padding. Three types of padding were used, two types of foam and 1/8th inch thick dummy skin.

In addition to bench testing, accelerometers were placed on the safety belt buckles in several full scale crash tests incorporating test dummies restrained by safety belts to gather laboratory crash data for comparison with the modeling and the bench testing data. The full scale vehicle tests included the following:

- o 20 mph side impact, 1985 GM pickup truck, 2 - 50 percentile test dummies
- o 30 mph side impact, 1985 GM pickup truck, 1 - 50 percentile test dummy and 1 child seat with a 3-year old test dummy
- o 30 mph front impact, 1993 Chrysler pickup, 2 - 50 percentile test dummies
- o 50 mph oblique front impact, 1989 Taurus impacted with a 20,000 moving test buck, 1 - 50 percentile test dummy
- o 30 mph front impact, 1993 Sentra, 2 - 50 percentile test dummies
- o 30 mph front impact, 1993 Century, 2 - 50 percentile test dummies

The results of the test program shows that the phenomenon of inertial unlatching can be described in terms of the physical parameters of acceleration amplitude, duration of the acceleration pulse, and belt tension. As belt tension increases, the acceleration required to open a buckle also increases. As the pulse width decreases, the acceleration required to inertially open the buckle increases. Most importantly, the testing demonstrates that acceleration pulses needed to unlatch a safety belt are not representative of conditions experienced in real-world crashes.

These parameters are shown graphically in Figure 1. This figure shows the predicted line for inertially opening the buckle with a belt tension of 50 lb. The area above the line indicates the conditions under which it is theoretically possible to open the buckle release by inertial acceleration. Conditions below the line would not cause the buckle to release. Data points taken from the bench testing, using drop weight, video cassette, and human hip impacts are plotted to show their relation to the predicted threshold for opening. Laboratory crash data points are also shown.

No buckle releases were observed during the crash testing. The laboratory test results indicate that, while it is possible to create inertial acceleration that could cause a safety belt buckle to release, such conditions are extremely unlikely to exist in real-world crash conditions.

RECALLS:

The agency has an aggressive program to investigate alleged safety defects in motor vehicles. The agency Hotline receives complaints and these are codified and entered into a computerized database. Each and every safety defect complaint is reviewed by professional staff to look for possible defect trends. When evidence indicates a possible safety defect trend, the agency will open an investigation to analyze the basis of the complaints and identify any safety defects. Many of these investigations result in safety defect recalls. Manufacturers may also initiate safety defect recalls without direct influence by NHTSA investigations. During the past 4 years, motor vehicle manufacturers have issued ten safety recalls to correct defects in safety belt buckles and recall a total of 2,722,850 vehicles. Of these, NHTSA investigations influenced the recall of 2,371,000 vehicles in three investigations that resulted in safety recalls. Appendix E shows a listing of all safety belt buckle recalls received by the agency during the past 4 years.

A review was made of all motor vehicle safety recalls, from 1968 to the present, that reported a defect in safety belt buckles. The recalls were reviewed to determine if there was any relationship between the reported defect in the recall and the alleged defect of inertial unlatching. The defects in these recalls included a broad range of reported problems, such as improper latching, false latching, failure to unlatch, failure to remain fastened under high tensile loads, and mechanical failure (cracking and disintegration) of certain parts as a result of aging. There have been no recalls that relate to the alleged problem of inertial release of a buckle due to impact to the back of the buckle housing.

FOREIGN STANDARDS--CANADA

The agency asked representatives of the Canadian government for any information it may have of investigations and reports of inertial unlatching of safety belt buckles. An official of Transport Canada responded as follows, "First of all, I would like to say how disappointed I was with the 'Street Stories' newscast on this matter. Scare stories of this nature can undo many years of work in building public confidence in occupant restraint systems." Canada conducted many investigations into alleged release of buckles but "in NO case was it concluded that the buckle released due to inertial forces." Transport Canada tested several hundred vehicles and have "NO documented cases of inadvertent actuation of the buckle system." It reports three cases in which a buckle was found to be unlatched at the end of the test. It concludes that, in two cases the buckles were either not fastened or improperly fastened, and in the third case, it believes the dummy's hand struck the buckle release.

FOREIGN STANDARDS--UNITED KINGDOM

The Department of Transport of the United Kingdom was contacted for information related to unwanted buckle release in seat belt assemblies. The response from the United Kingdom stated that its in-depth accident investigations have shown no instances of inertial release of safety belt buckles and, that its counterpart to our defect investigations and compliance testing efforts have found no defects of this nature in its testing and investigations.

FOREIGN STANDARDS--AUSTRALIA

The Australian Federal Office of Road Safety (AFORS) was contacted for information related to unwanted buckle release in seat belt assemblies. Of particular interest were any regulations which may, either by intent or effect, discourage use of the side release buckles in Australia. AFORS commented that no such regulations existed. The agency requested any information from Australia's investigative files related to the subject buckle types. AFORS noted that review of the safety defect investigations found "no record of any alleged problems with this type of buckle in Australia."

While not containing any provisions specifically related to side release buckles, current Australian Design Rules (ADR) and Australian Standards (AS) for seat belt assemblies include several requirements intended to limit the possibility of unwanted buckle release in general. These requirements involve tests for partial engagement, inadvertent release, dynamic performance, and buckle-spring fatigue resistance. A brief discussion of each follows.

Partial engagement Clause 9a of AS 2596-1983, "Seat Belt Assemblies for Motor Vehicles," states that "the buckle shall be of a quick-release type and shall not be capable of partial engagement." Partial engagement is defined as "any stable condition, other than complete engagement, in which the buckle components will withstand a separating force of

not less than 1 N applied by tensile forces in the strap components, without disengaging. The tensile forces may be readily applied by holding one part of the buckle so that the other part tends to fall out vertically under its own weight."

Inadvertent release Clause 9b of AS 2596-1983 states that "the buckle shall not have a potential for inadvertent release by the vehicle occupants." A buckle assembly is considered free of such potential if, when tested in accordance with AS 2597.4, release is not caused. This test involves application of a flat planar surface against a latched buckle assembly such that the surface is normal to the line of action of the actuator.

Dynamic performance The seat belt assembly is subjected to dynamic forces designed to cause a nominated deceleration of a dummy of specified characteristic. A dummy with mass of 72 ± 2 kg (163 ± 5 lbs) is mounted on a test sled and restrained by the seat belt assembly to be tested. The seat belt assembly is configured in a manner consistent with its intended usage. From a nominal initial velocity of 13.6 m/s (29.0 mph) the apparatus achieves a deceleration of between 235 m/s^2 (771 ft/s^2) and 335 m/s^2 (1010 ft/s^2) within 30 ms. The deceleration must be substantially within the specified range for at least 20 ms, disregarding values outside the range that occur for periods of less than 1 ms. Upon completion of the test, the seat belt assembly is checked for separation of any components within themselves or from the anchorages and for proper release operation of the buckle.

Buckle-spring fatigue resistance Clause 4.5.3 of ADR 4/01, "Seat Belts," states that "in the case where a spring is incorporated in the unlatching mechanism of a buckle, the load required to operate the spring shall not be reduced by more than 20% after the spring has been subjected to 50,000 operations each involving a movement not less than 95% of the design movement for buckle unlatching."

CONSUMER REACTION:

As discussed earlier, the agency received a number of phone calls to the Auto Safety Hotline after the news media (September 10, 1992, "Street Stories") allegation of a buckle unlatching phenomena due to inertial loading. The Street Stories show was based on the alleged defect as discussed in this petition. Most of the calls were from consumers who were genuinely concerned about what they had seen or heard about the alleged design defect in safety belt buckles that utilize a side release buckle. Many of the callers stated that they were able to replicate the buckle unlatching by striking the backside of the buckles in their own vehicles with objects ranging from screw driver handles to books.

After listening to the concerns voiced by the callers to the Hotline, it was important to learn if the allegations made on television and in the print media about safety belts unlatching in crashes had any effect on consumers' attitudes and perceptions about the benefits of using their safety belts. In an attempt to identify and understand any consumer impacts that may have resulted from the allegation of buckle release, a number of call backs to consumers who had originally called the agency after having seen or heard about the "Street Stories"

program were conducted. The objective of these phone calls was to determine if the show had any effect on a person's decision to use safety belts when riding in a motor vehicle. The results of these telephone calls are not statistically based, but rather are indicative of consumers' reactions to the media claims of safety belt buckle unlatching.

A total of 128 persons were called, and all indicated that they use their safety belts all or most of the time. This is exactly the type of person one would expect to have called the Hotline on an issue concerning safety belts. Calls from non-belt users would not be expected, since the allegation that safety belts can become unlatched in a crash may be supportive of the reasons cited for not wearing safety belts.

Of the 128 consumers, 124 people (97%) stated that they continue to wear their safety belts. Of those 124 people, 22 also stated that because of the program, they were being more careful in ensuring that their safety belts were securely fastened. Several other consumers stated that they took extra precautions to ensure that the safety belt buckle did not come in direct contact with any hard spots on child safety seats. In most instances, the safety belt buckle does not contact rigid components of the child safety seat; however, in instances where contact does occur, consumers stated that they placed padding under the buckle. Obviously consumer actions to ensure that safety belts are securely fastened and worn correctly are beneficial to highway safety.

The remaining four consumers (3%) stated that they stopped wearing their belts altogether or use them less often. These comments are of great concern. NHTSA, in cooperation with the entire safety community, has spent many years and millions of dollars on initiatives to encourage safety belt use. Given the thousands of lives that have been saved, and the reduction in injury levels to millions of other motor vehicle occupants because of safety belts, there is no doubt that safety belts are a highly effective means of providing crash protection to occupants of motor vehicles. It is disheartening that someone may be seriously injured or killed in a motor vehicle crash simply because they no longer wear their safety belts after the media claims of safety belt buckle unlatching--especially when scientific studies, real-world crash data, and consumer reports all demonstrate that such media claims are unfounded.

SUMMARY:

The petitioner alleges that certain designs of safety belt buckles are vulnerable to unlatching caused by inertial forces that may be applied to the buckle in a crash. To support this contention, the petitioner demonstrated the unlatching of side release buckles by hitting sample buckles on the backside with a sharp impact, typically with a video cassette box, or human hip. Also, the petitioner provided consumer complaints alleging the unlatching of buckles in motor vehicle accidents.

The agency conducted an extensive review of all available information to assess the real-world risk of inadvertent unlatching of buckles. It sent information request letters to eight

vehicle manufacturers, five safety belt manufacturers, and holders of seven patents of end release buckles. The agency reviewed its accident data, consumer complaint file, and crash test data to assess this alleged problem. Further, full scale vehicle crash tests and other laboratory tests were conducted in the course of this evaluation to determine the possible real-world risk associated with the alleged inertial unlatching.

The vehicle manufacturers' information demonstrates a very low rate of complaints of alleged releasing of buckles in motor vehicle accidents. Side release buckles have been used in vehicles from all of the major manufacturers for many years. Since 1970, about 263 million vehicles have been equipped with side release buckles. The manufacturers report either no or very few complaints of alleged unlatching in that period of time. No manufacturer developed test programs to address the alleged defect because real-world data suggested there was no need. Several manufacturers point out that the level of acceleration or impact on a buckle during a motor vehicle crash is far below the level needed to release a buckle. The buckle manufacturers report no complaints and only seven lawsuits pertaining to buckle unlatching. These manufacturers have made no design changes due to the alleged defect.

Several patents for end release buckles reference the need for a design to consider the inertial effects on the performance of a buckle. The patent holders provided two reasons for this. First, some designs are intended to be used with pyrotechnic belt pre-tensioning devices. These devices can impart impact loads to the buckle and these must be anticipated in the design to prevent inadvertent unlatching. Second, all designs of buckles, both end release and side release, must operate safely without inadvertent release in real-world use.

The agency analyzed its accident data for evidence of the alleged defect. The analyses compared injury and fatality levels between vehicles using side release buckles and vehicles using end release buckles. The analyses showed no pattern of evidence to support an allegation of inadvertent unlatching of side release buckles. Specific accident files show no evidence to indicate inertial unlatching of buckles.

The agency reviewed all of its records of vehicle crash and sled test data for evidence of inertial unlatching. The agency has records on 2,067 tests involving 3,730 belted full-size test dummies and 239 tests of child dummies in child safety seats. Nine buckles unlatched in vehicle tests and one broke and one unlatched in child seat sled tests. Of the unlatched buckles, three were side release and seven were end release buckles. The agency has reviewed the written reports and films of these incidents and concluded that the test data provides no evidence of the alleged inertial unlatching phenomena.

The ODI consumer complaint database contains some complaints of alleged unlatching. However, the level of complaints is very low in comparison to the population of vehicles and is not concentrated in vehicles with side release buckles. The complaints of alleged unlatching include end release type buckles. The complaint rate for end release buckles compared to side release buckles is about the same (0.9 for end release compared to 0.7 for side release complaints per 100,000 vehicles).

A test program was conducted, including tests of belt buckles and vehicle crash tests. The laboratory data shows that, as belt tension increases, the level of acceleration required to unlatch a buckle increases. Further, the data demonstrates that accelerations necessary to inertially unlatch a belt buckle do not occur in actual vehicle crash conditions. Crash tests of vehicles shows that during the crash, the highest acceleration on the buckle occurs with significant loading of the belt. None of the buckles opened during crash tests, and the measured level of acceleration on the buckles was well below the level to cause a buckle to unlatch.

FINDINGS:

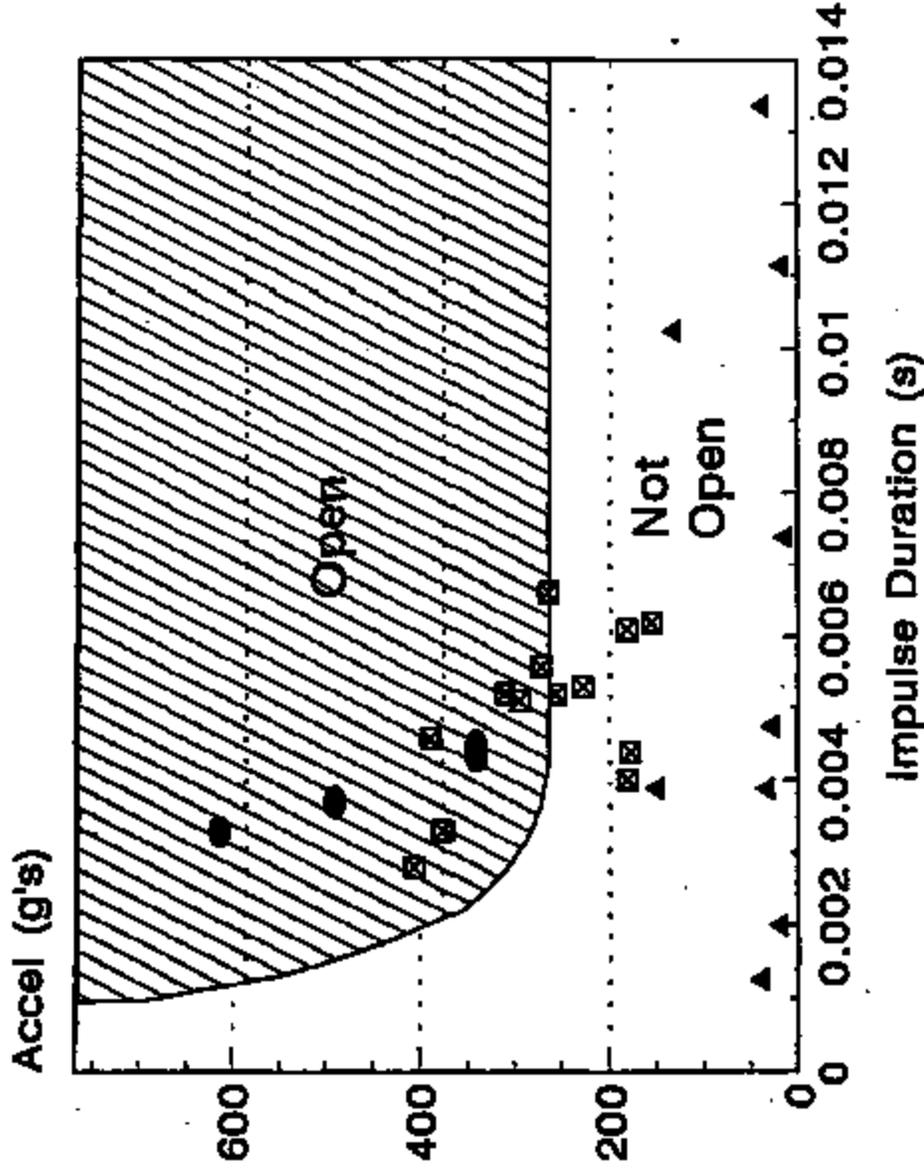
- o A comprehensive agency review of over 2,300 crash tests involving approximately 4,000 belted dummies, including frontal, oblique, rear, rollover, and side crashes, did not provide one instance of inertial unlatching. In ten of these tests, belts did come unlatched due to other reasons, e.g., external contact with the release button, manufacturing defect in the buckle. It was also found that seven of the ten buckle unlatchings involved end release buckles.
- o Laboratory testing performed in response to this petition defined the engineering characteristic which can cause inertial unlatching. Most important, this testing demonstrated that these characteristics are not present in real-world crashes.
- o Manufacturer data did not demonstrate that inertial unlatching is a safety problem. In the tens of thousands of crash tests conducted by motor vehicle and belt manufacturers, only General Motors Corporation (GM) reported what it believes may be two possible, but unverifiable, cases of inertial unlatching. Of the 30,000 tests GM has performed, it identified only these two such possible instances. No other reports were provided by either vehicle or belt manufacturers. Responses from safety belt buckle patent holders indicated that patents were sought to improve the general performance and ease of operation of buckles--not because of a safety problem associated with inertial unlatching.
- o Analysis of real-world crash data demonstrated that "there is no pattern of evidence in the crash data to support the allegation related to inadvertent unlatching for side-release systems." Thus, analysis of real-world data did not indicate the presence of a safety problem associated with inertial unlatching in side release buckles.
- o Review of consumer calls to the agency's Auto Safety Hotline did not suggest the presence of a safety problem. The complaint rate (the number of reports divided by the number of vehicles on the road) is essentially the same for vehicles with both side and end release buckles. Further, the complaint rate is extremely low compared to other safety problems reported to the agency. Additionally, the number of consumer calls to the Auto Safety Hotline subsequent to the "Street Stories" and CBS Evening News programs, the latter of which broadcast the toll-free Auto Safety

Hotline telephone number, were no higher than the number of calls normally received. Generally, national TV publicity of a safety issue, in which the Auto Safety Hotline telephone number is presented, results in large increases in Auto Safety Hotline calls. The fact that such an increase did not occur in this instance suggests that the public does not consider this do be a safety concern.

RECOMMENDATION:

This petition should be denied.

Buckle Impulse Opening Characteristics



All bench tests used 50 lb. preload and GM buckles.
Crash tests were performed full scale.

Figure 1