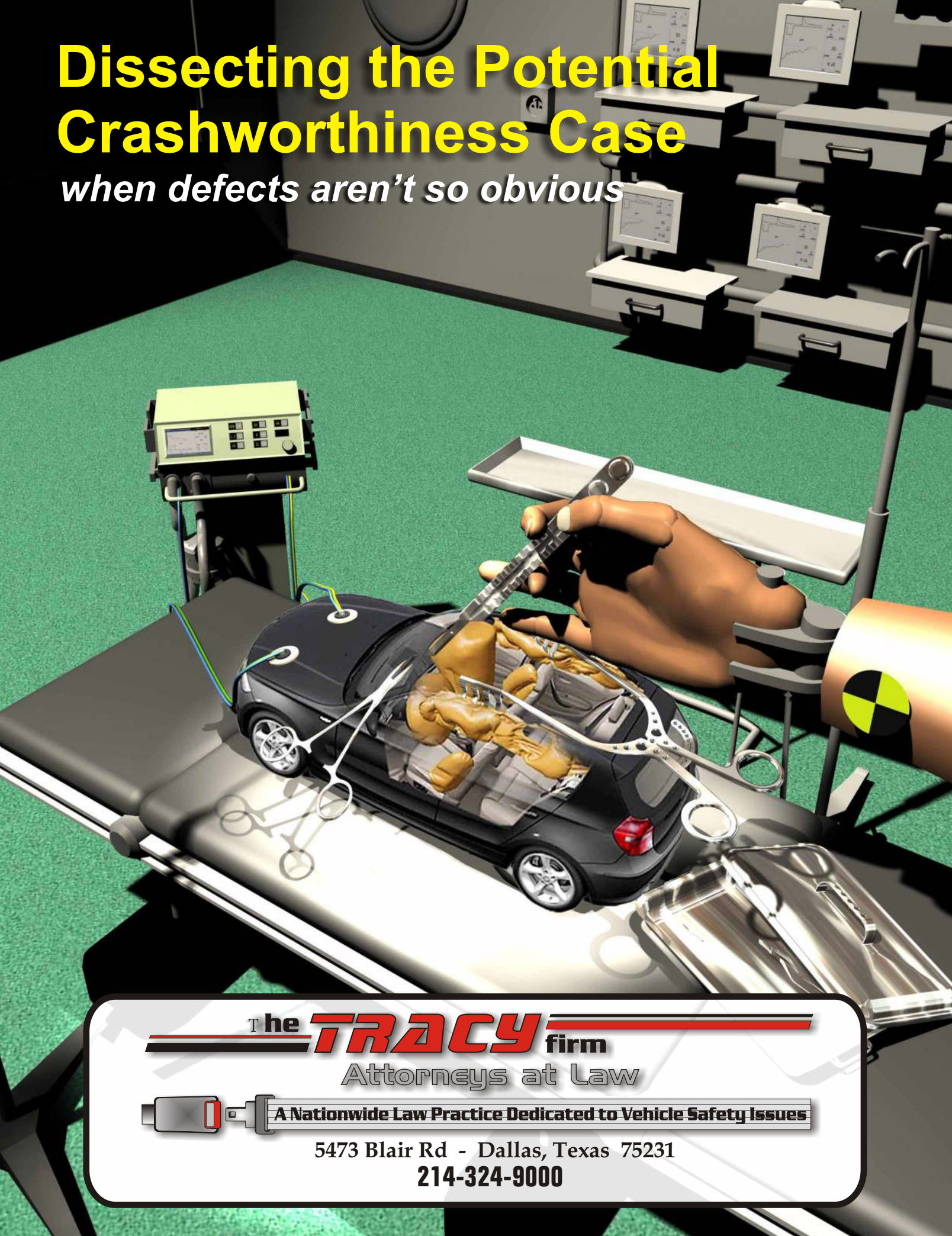
Dissecting the Potential Crashworthiness Case

when defects aren't so obvious



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Foreword

Rollover Testing Should be Mandated by the NHTSA Immediately

As an attorney focused on transportation product liability cases for the last 20 years, there have been several recurring defense theories and themes by the manufactures that have been consistent and predictable. One of the most prevalent defenses at trial is compliance with FMVSS (Federal Motor Vehicle Safety Standards.)

FMVSS are **minimum** standards produced by the government through public and industry input. However, FMVSS provisions that are ultimately adopted are minimum performance standards not safety standards as suggested by their title. The problem with the FMVSS is that they are inadequate. Why are the FMVSS's inadequate if so much input is allowed? The answer is simple: lobbying. In the past 20 years, there's been far too much industry lobbying, such that the vehicle industry has incredible influence over the NHTSA (National Highway Transportation Safety Administration). In fact, lobbying efforts by the former NHTSA administrators on behalf of the vehicle industry has become the rule, not the exception.

www.nhtsa.dot.org/cars/rules

The vehicle industry lobby has defeated every attempt by the NHTSA requiring mandatory rollover tests. The common argument - repeatability. However, many manufacturers have conducted their own dynamic roof tests for decades. European manufacturers have conducted rollover and drop testing since the 1970's to evaluate occupant protection in a rollover.

BMW's rollover facility

GM's rollover facility

Now, Toyota, Nissan and Honda routinely conduct rollover testing. GM recently built a new rollover test facility. This then begs the question - why not make rollover testing mandatory so that all vehicle manufacturers insure occupant protection during a rollover?

Volvo's rollover facility

Mercedes Benz's rollover facility

The NHTSA is charged with protecting the motoring public by enacting vehicle standards that improve occupant protection. Requiring vehicle manufacturers to conduct mandatory rollover tests would be a step in the right direction from an occupant protection standpoint. Rollover accidents are just a small percentage of accidents but account for a majority of the fatalities and catastrophic injuries. The NHTSA has had 40 years to act. The NHTSA's continued delay is mere proof of their complicity with the vehicle industry while standing by as an ineffective government watchdog with no bark and no bite. The NHTSA should immediately require rollover testing as part of a manufacturer's testing due diligence.

I. Introduction

According to the NHTSA, there were 41,059 people killed and 2,491,000 injured in motor vehicle accidents in 2007. Many of these deaths and serious injuries could have been prevented and many of the serious injuries could have been minimized had the vehicle's crashworthiness systems worked together as a system, much like links in a safety chain. *Vehicle crashworthiness is the science of preventing or minimizing fatalities and serious injuries following an accident through the use a vehicle's safety systems.* There are five principles of vehicle crashworthiness:

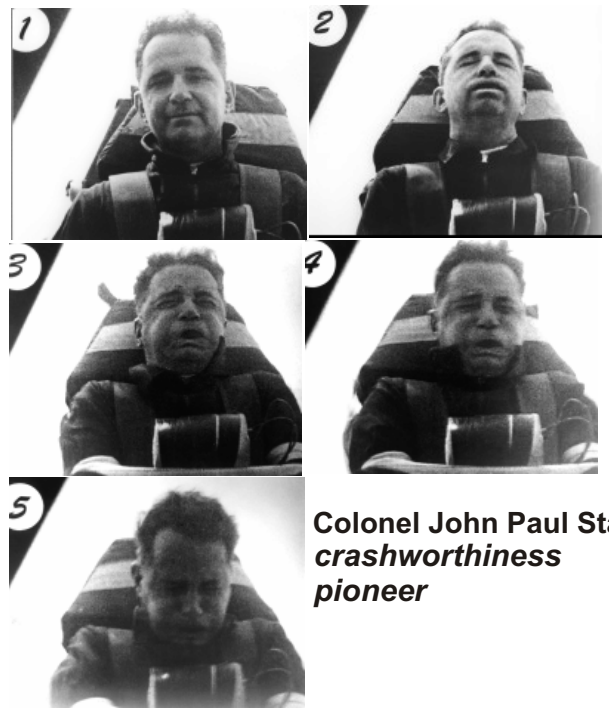
Crashworthiness:

- **Control Crush - Maintain Survival Space**
- **Restrain the Occupants**
- **Prevent Ejection**
- **Control Energy / Transfer Energy**
- **Prevent Fire**

Vehicle crashworthiness principles were initially developed during the Korean war. Hugh DeHaven and Colonel John Paul Stapp had become increasingly frustrated that soldiers were surviving aircraft (fixed wing) and helicopter crashes only to die as a result of fire. DeHaven designed a structure modeled after principles of packaging and shipping items such as televisions.

- *Place television inside a corrugated box with reinforced sides to serve as a rigid structure.*
- *Place foam inserts around the television to serve as padding, restraint and energy absorption.*
- *Wrap foam inserts with bands to provide supplemental restraint and prevent movement, inside the container.*

Once these packaging principles were applied to aircraft, designers worked on trying to minimize post crash fires in aircraft by using fuel cells, bladders inside tanks, quick disconnect lines, automatic shut-off valves, and metal braided fuel lines. Designers also developed crush zones within the airframe and rigidized the seating to reduce impact forces on the occupants. Colonel Stapp volunteered to subject himself to incredible G forces in a series of sled tests aimed at establishing limits to human tolerance in impact forces related to injuries.



Colonel John Paul Stapp *crashworthiness pioneer*

Crashworthiness principles developed by the military were then implemented into race cars. In fact, the racing industry has applied crashworthiness principles into its SAFER barrier systems which help distribute and spread out accident forces so that the crash forces do not injure the racer inside the vehicle.

Since 1968 and the adoption of the FMVSS provisions, vehicles sold in the United States have been required to voluntarily comply with crashworthiness safety principles.

Sadly, however, many of the FMVSS provisions were inadequate when first implemented and remain unchanged still today, primarily due to lobbying. Other FMVSS provisions have failed to evolve with safety improvements and still remain outdated minimum standards. Still, other FMVSS provisions remain deficient at evaluating occupant safety for all occupants in the vehicle, again due to lobbying efforts by the industry.

The purpose of this brochure is to educate people on vehicle crashworthiness cases when the defect is not so obvious. The key to this analysis is two-fold: utilize physical, medical and forensic evidence to determine if the safety system has performed properly and keep an open-mind while evaluating all aspects of the case. In short, thinking outside the box is key to this analysis.

Roof crush violates one principle of crashworthiness - maintain survival space

When a door system such as a door latch opens in an accident or the door hinges fail, the occupant is exposed to risks, hazards and dangers of ejection or partial ejection.

Door latch/hinge failures violate two principles of crashworthiness - restraint and prevent ejection

II. Some Crashworthiness Defect Issues are Obvious

On many occasions when a vehicle rolls over, the roof can crush down to the beltline and kill or seriously injure properly restrained occupants.

If a vehicle's seat belt webbing tears apart, the vehicle's primary restraint system has failed to perform properly.

Webbing failure violates three principles of crashworthiness - restraint, ejection and control energy

If a seatback bracket or support structure shears or fails and the seat collapses rearward, the front and rear seated passenger is exposed to crush injuries.

Seat failure violates two principles of crashworthiness - restraint and ejection

If a front or side airbag fails to deploy in a high speed frontal or side impact, deceleration injuries to the occupant are very likely to occur.

Airbag failure violates two principles of crashworthiness - restraint and energy control

If a vehicle fails to implement proper energy channeling designs, the vehicle will crush excessively and render the rest of the safety systems ineffective because of intrusion into the survival space.

Structural failure violates three principles of crashworthiness - maintain survival space, provide proper restraint and channel energy properly

If a vehicle's fuel tank is breached and a hole is produced, the chance of a post crash fire is increased dramatically.

Fuel tank failure violates one principle of crashworthiness - prevent fuel fed fires

III. Not So Obvious Crashworthiness Defect Issues

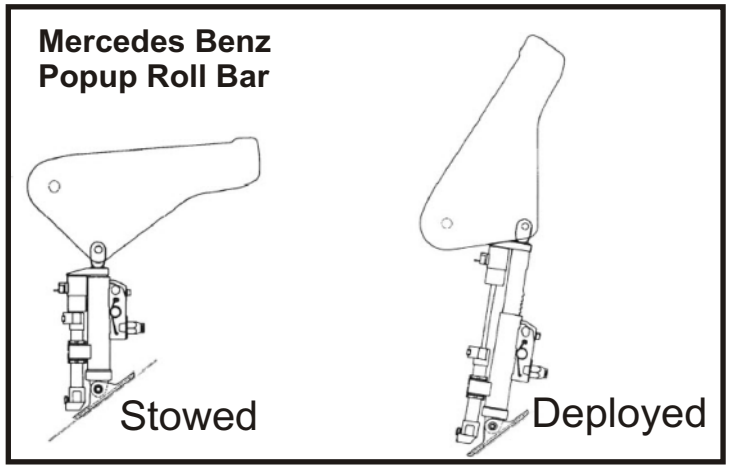
There are numerous other potential crash-worthiness cases that are not so obvious however. Many of these potential cases are likely to be missed unless the investigator is willing to think outside the box.

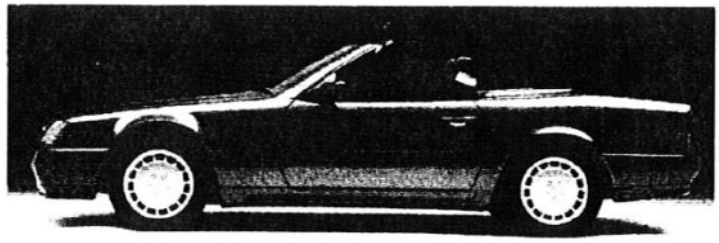
A. Maintain Occupant Space

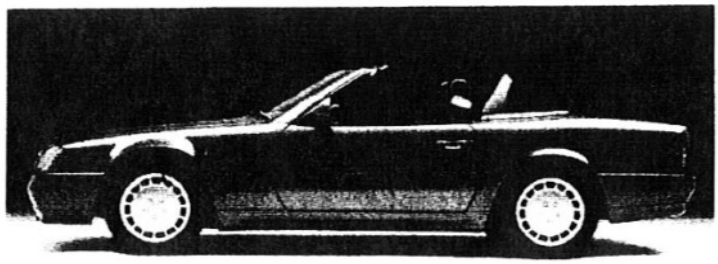
1. Convertible Vehicles

For years, vehicle crashworthiness attorneys and experts refused to handle roof crush cases involving convertible vehicles. Their rationale was simple: there were no alternative designs available that would have prevented or minimized the crush into the survival space.

In 1989, Mercedes Benz developed a pop-up roll bar system for its 2-door convertible that was triggered by two distinct sensing mechanisms. The first, a mercury switch on the rear differential and the second, a sensor on each wheel that sensed if two wheels on the same side had lifted off of the ground.





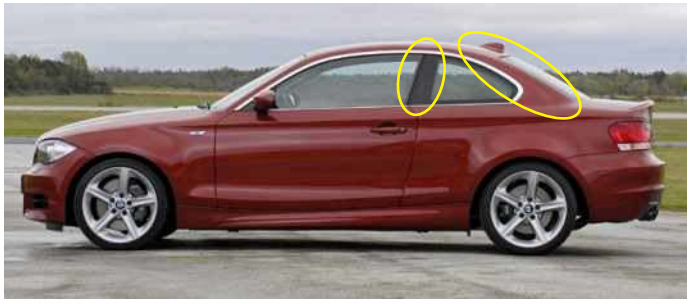


By 1997, several other vehicle manufacturers had designs that provided rollover protection for convertible users. Instead of using a pop-up roll bar, BMW, Saab, Volvo and Audi used a pyrotechnic head restraint that deployed upward 12 inches once the rollover began.

Other vehicle manufacturers used a high back reinforced seat structure as a rollover protection system.

Still others used a fixed mounted roll bar that was covered so as to blend into the design of the vehicle.

Each of these roof structure replacement designs were implemented to replace the B and C pillars that are removed when a convertible is built.



B & C Pillars Removed

Testing of ROPS (rollover protection systems) has shown that these designs provide reasonable crashworthiness protection during a rollover, provided the restraint system works properly.

One must realize however, that several convertibles still have no ROPS in place. As such, these vehicles pose an absolute risk, hazard and danger of roof crush related injuries to occupants including head, neck and asphyxia.

Looks like a high back reinforced seat, but it isn't.

The bottom line is that convertible crashworthiness cases are now viable because safer alternative designs exist that can prevent roof crush related injuries.

B. Provide Proper Restraint Throughout the Entire Accident

1. Occupant Rollout Due to Belt Fit

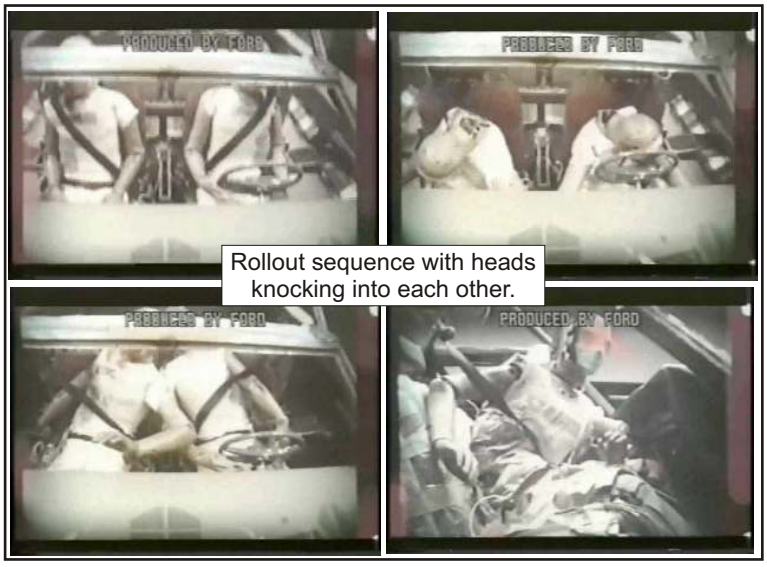
A seatbelt must fit a 5th percentile female (5'2" - 110 lbs.) up to a 95th percentile male (6'2" - 185 lbs.) and all persons in between. However, there are designs that can be used to help "tie" occupants closer to the seat including ABTS (All Belts to Seats) and adjustable D-rings.

Adjustable D-Ring

ABTS with adjustable D-Ring

Benefits of ABTS (All Belts To Seats).
Help prevent head excursion in lateral impacts.

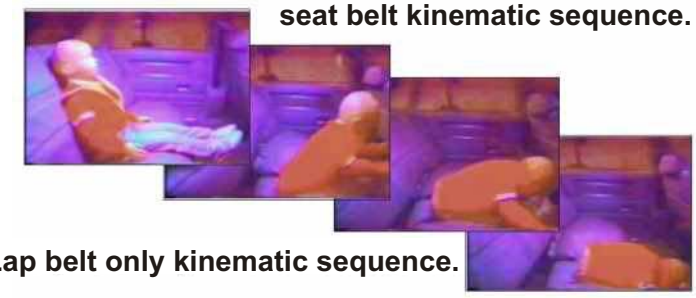
When seatbelts do not fit adult occupants properly, the upper torso can slip out from the shoulder belts and heads can impact causing traumatic brain injury.



Rollout sequence with heads knocking into each other.

When children rollout of their seat belt in the rear seat due to poor belt fit, the child will hyperflex over the lap belt, literally rendering the 3-point restraint system into a lap-belt only design. Lap belts cause severe injuries to children including internal organ injuries and paralyzing spinal injuries due to hyperflexion over the lap belt.

Rollout from 3-point seat belt kinematic sequence.



Lap belt only kinematic sequence.

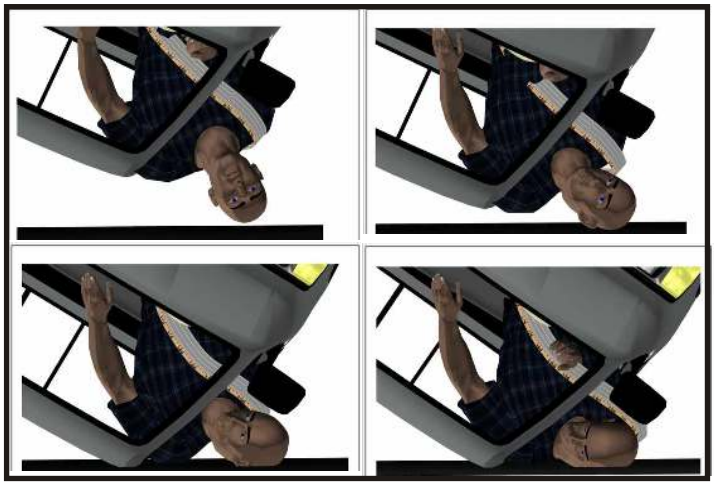
Testing conducted at the Medical College of Wisconsin has revealed that using an adjustable D-ring decreases the risk of child rollout by 13 times.

Fixed D-Ring Mount - rollout

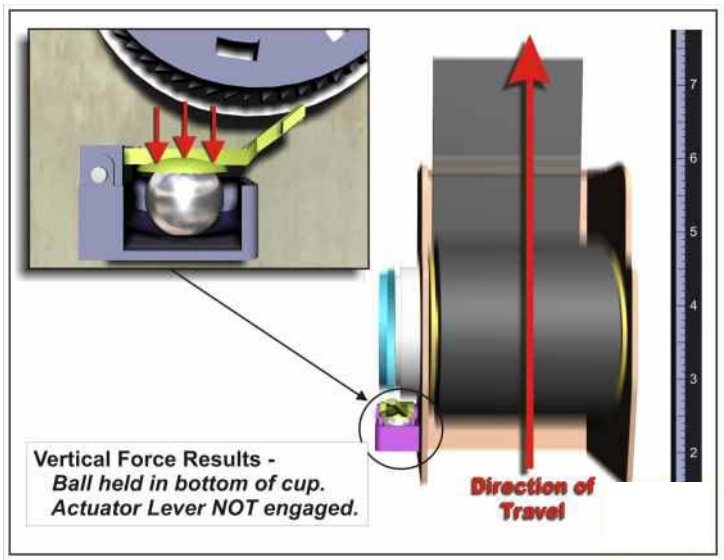
Adjustable D-Ring mount - No rollout

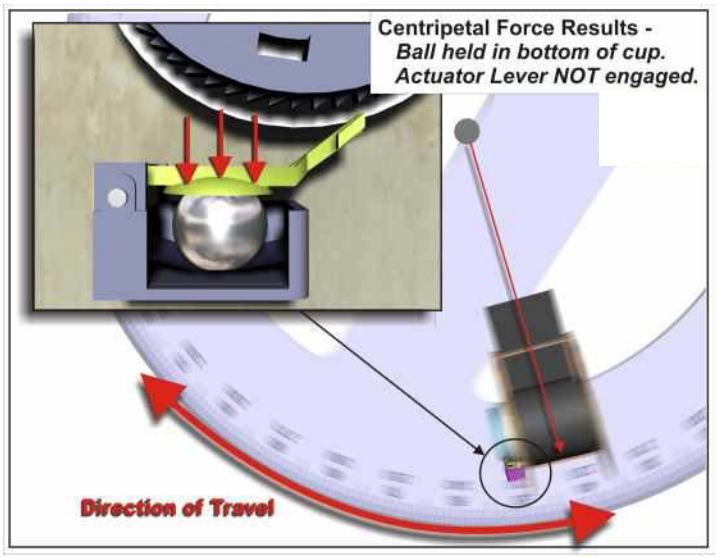
2. Seat Belt Retractor Spoolout in Rollover Accidents

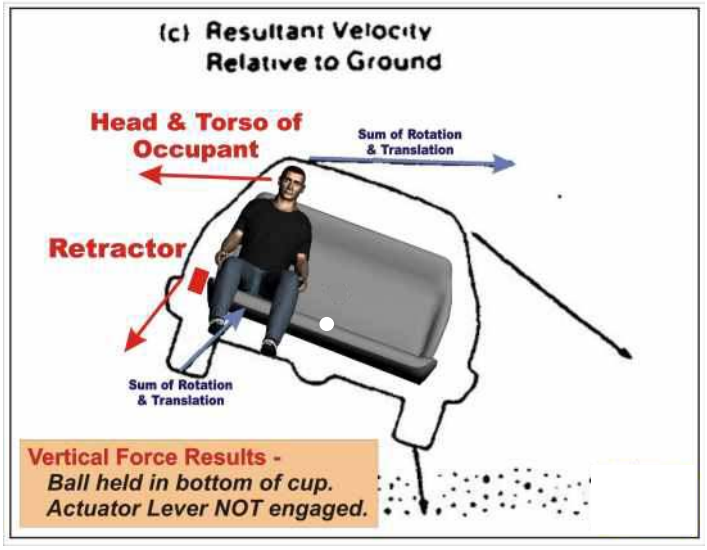
Unless a vehicle has a pretensioner or electromagnetic locking mechanism for the retractor, most retractors are susceptible to retractor spoolout in a rollover. Retractor spoolout exposes restrained occupants to the risk, hazard and danger of partial ejection. Once the restrained occupant is partially ejected, they are no longer protected by the safe confines of the vehicle structure. As such, these occupants are at risk for severe head injuries, spinal fractures and crushing torso injuries.



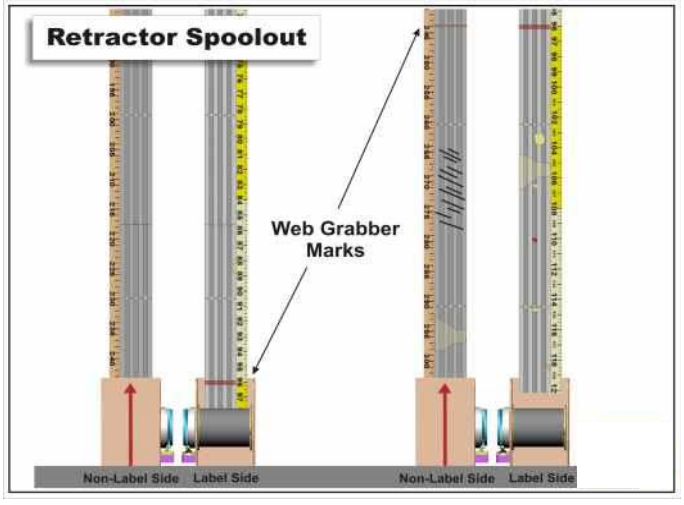
Retractors are susceptible to spoolout when vertical and centripetal accelerations are seen by the retractor and when rollover directional forces are seen. Testing by plaintiffs and defendants have all revealed that during rollover accidents, retractors will lock and unlock because the retractor mechanism goes to a neutral, unlocked position.





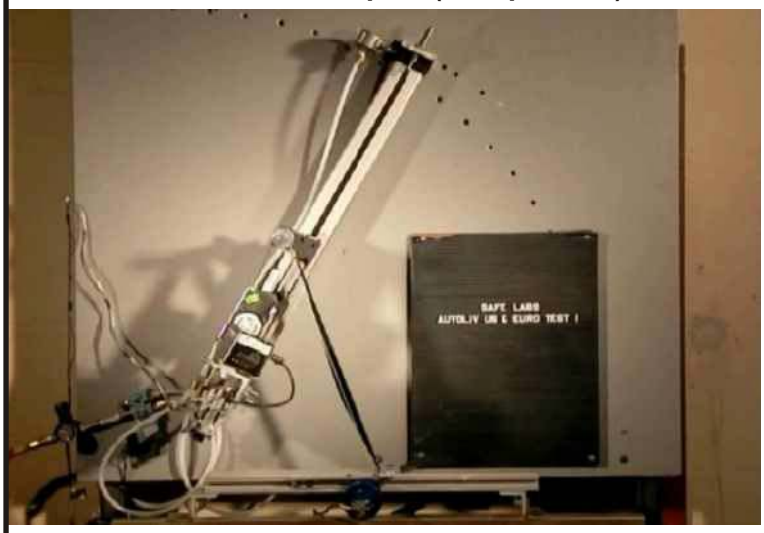


If a seatbelt retractor spools out, there will be belt evidence below the initial lockup mark and the occupant will have numerous inboard side injuries that are caused by excessive partial ejection. The key to winning a spoolout cases is a thorough analysis of the physical, medical and forensic evidence.



Testing with European designed retractors compared with their US designed counterparts have shown that retractors with a webbing withdrawl sensitivity level between .4G to 1.2G's as compared to a webbing withdrawl sensitivity of 1.2G's to 2.0G's will not spool out during a rollover.

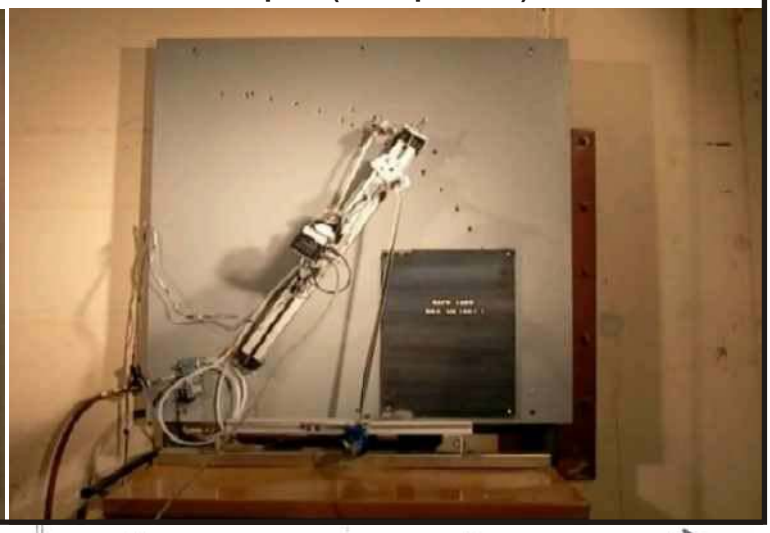
Autoliv EURO Spec. (No Spoolout)



Autoliv US Spec. (20" Spoolout)

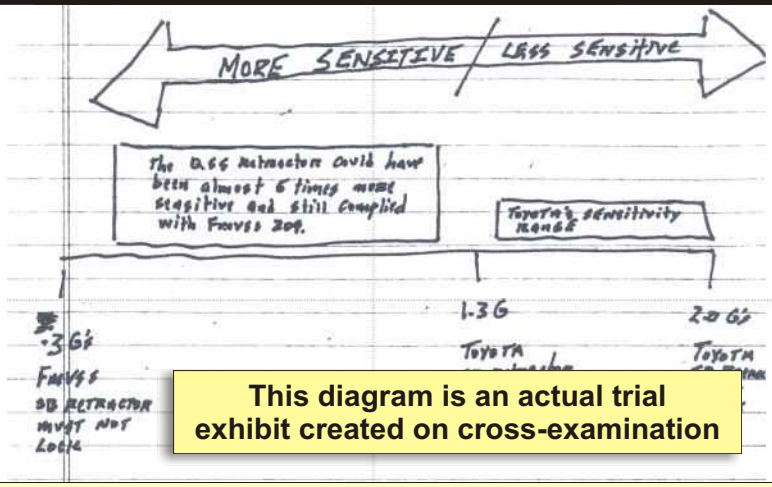
NSK EURO Spec. (No Spoolout)

NSK US Spec. (19" Spoolout)



•FMVSS 209 provides as follows:

(2) Shall not lock, if the retractor is sensitive to webbing withdrawal, before the webbing extends 2 inches when the retractor is subjected to an acceleration of 0.3g or less;



This diagram is an actual trial exhibit created on cross-examination

Spoolout was recently accepted by a Wisconsin jury in Mommsen vs. Toyota Motor Corporation where the jury unanimously found that a 1994 Toyota regular cab pickup had spooled out during a rollover.

C. Partial Ejection Due to Tempered Glass Fracture

1. Laminated vs.Tempered Glass

Until the mid 1960's, most vehicle manufacturers used laminated glass for windshields and side glass applications. Laminated glass is two layers of glass with a polybutal vinyl sandwiched between. Laminated glass will spiderweb but will rarely leave an ejection portal. Laminated glass provides ejection mitigation. Tempered glass, on the other hand, is chemically treated glass that tends to fracture into small pieces that provides no ejection mitigation.

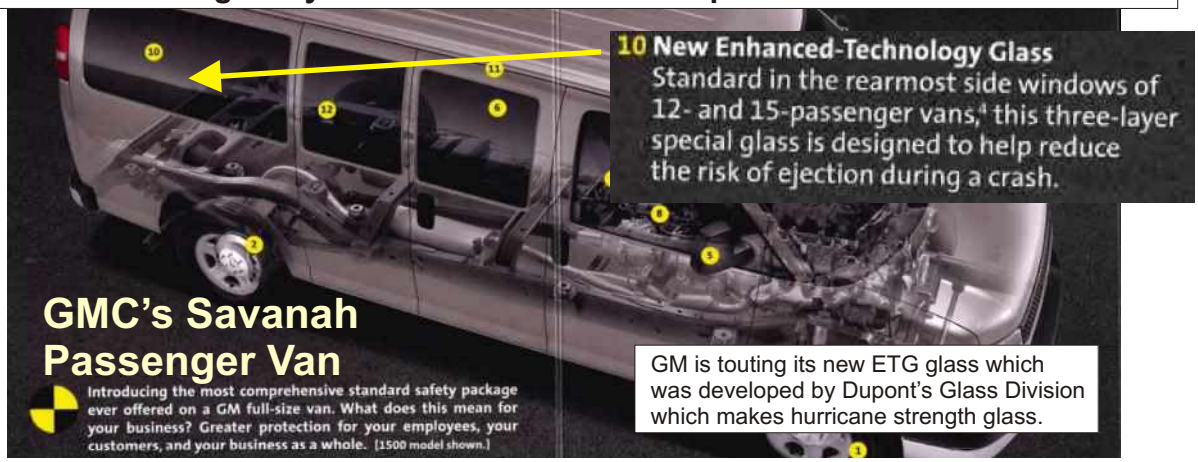
Laminated glass provides ejection mitigation.

There has been a several decade's long debate about whether tempered glass should be used in side glass applications to provide ejection mitigation. Opponents have argued that using laminated glass for side glass can lead to increased risks of head and neck injuries, difficulties with extrication following an accident and manufacturing problems.

These arguments are overshadowed by vehicle manufacturers such as Mercedes Benz, BMW and Volvo who use laminated glass in their side window applications. Further, many domestic manufacturers sell vehicles in Europe and South America that have laminated side glass. Even GM and Ford are now using laminated side glass on many of its US sold vehicles.

Tempered glass window - No ejection mitigation

The use of mitigation ejection glass is now part of safety marketing campaigns thus eliminating many of the criticisms from the past.



GM is touting its new ETG glass which was developed by Dupont's Glass Division which makes hurricane strength glass.

To pursue a laminated versus tempered glass case, the occupant must be restrained and sustain injuries due to partial ejection. If the partially ejected person is not wearing the available seat belt, laminated glass alone will not prevent ejection. In fact, testing has proven that unrestrained occupants must be restrained before laminated side glass can be an ejection mitigation barrier. In these tests of a Volvo XC90, the side canopies and sensors were disabled, the dummies were left unbelted and the performance of laminated side glass alone was evaluated in a rollover. The results were poor.

Volvo XC90 rollover test with unbelted occupants.
Vehicle equipped with laminated side glass all around - all occupants ejected.

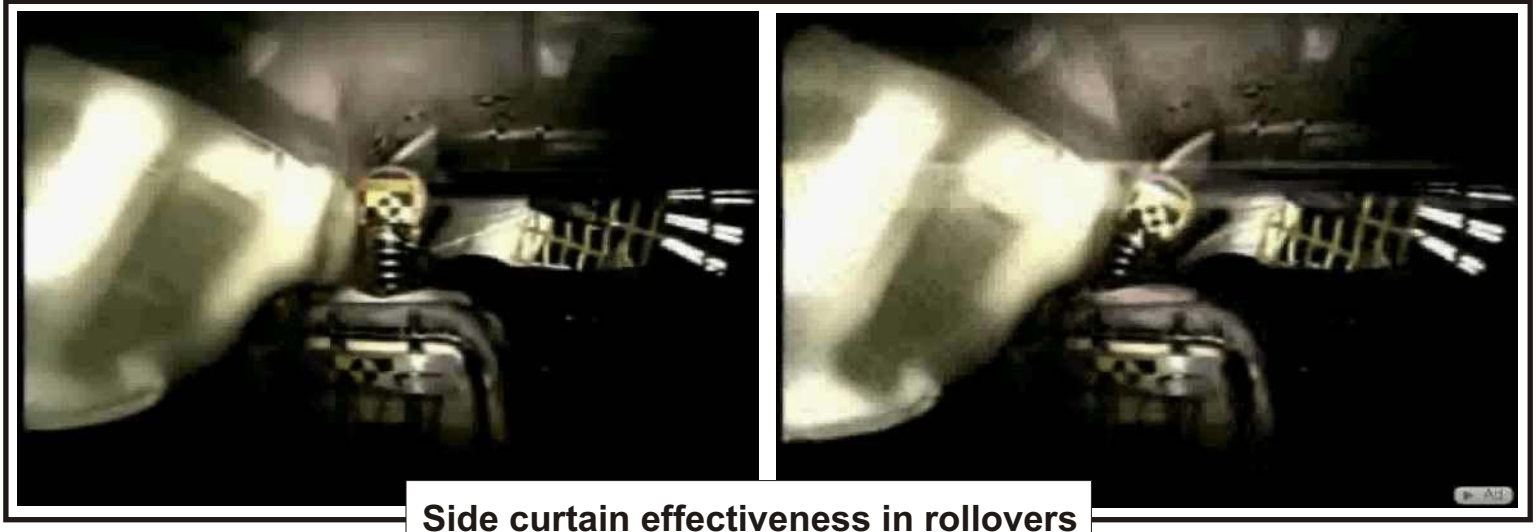
No occupant ejection

Volvo XC90 rollover test for roof strength and laminated glass structure.
Vehicle rolled 3 1/4 times during this test, no ejections.

In a series of rollover tests on a Volvo sedan, the dummies were restrained and the side curtains were disabled. No complete ejection or partial ejection was noted because the dummies were restrained and the laminated side glass stayed intact during the rollover. In short, the safety systems' worked together like links in a chain.

No occupant ejection

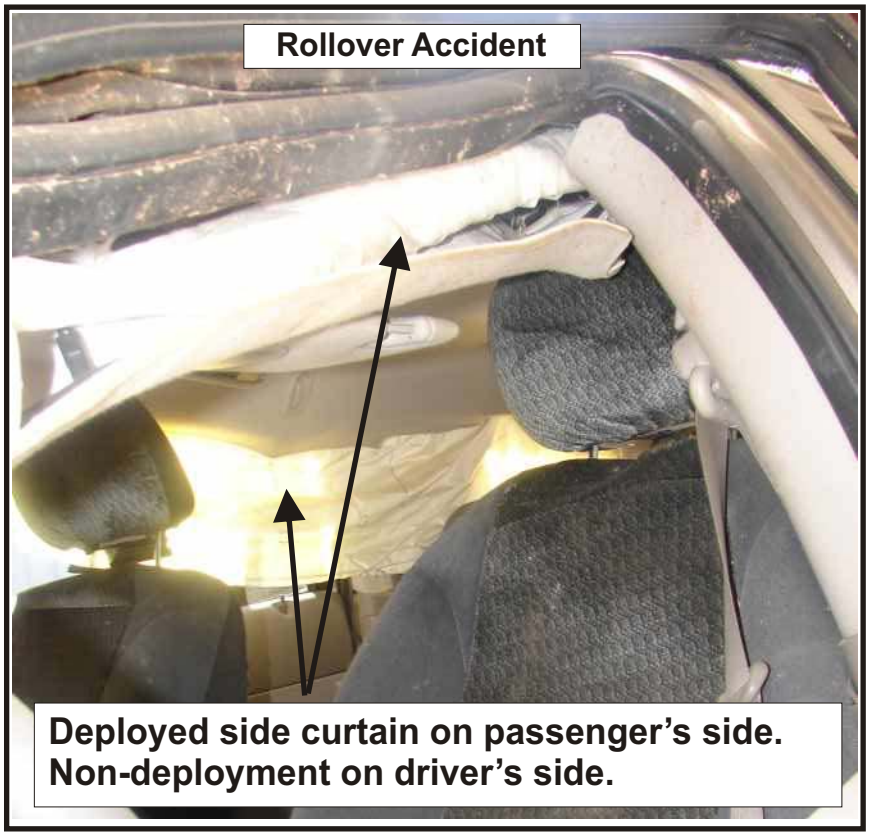
When the NHTSA closed its docket on a request to demand laminated side glass for vehicles without issuing a new FMVSS provision, most safety advocates believed that the NHTSA refused to do so because new side curtain airbag technology was becoming available. Side curtain airbags with rollover sensors stay deployed for up to 8 seconds, and have the primary responsibility for ejection mitigation for the head and limbs in rollovers. Compare this with a frontal bag which stays deployed for 1/100th of a second.



Side curtain effectiveness in rollovers

Rollover testing demonstrates how the side curtain keeps the head, shoulders and upper torso inside the passenger compartment. Manufacturers in their marketing literature are also touting the safety benefits of the side curtain airbag. This new technology should only accelerate mandatory rollover testing by the NHTSA.

The biggest problem with side curtain airbags is that most vehicles do not employ the rollover sensing technologies that have been widely available since 2004. Perhaps the most common defect seen is the failure of the side airbag curtain to deploy during a side impact crash, and if equipped with rollover sensing technologies, failure to deploy in a rollover. Often, this results from defective sensor placement or defective programming in electronic sensors that fail to detect the crash severity. All of this, of course, stems from negligent testing programs that do not address real-world crashes. This is an excellent defect allegation, and another argument for mandatory rollover testing by the manufacturers.



Deployed side curtain on passenger's side. Non-deployment on driver's side.

Some side airbags can hang up on the seat or trim panels, causing them to deploy incompletely or improperly. Also, a few side airbag systems were defectively designed to be so forceful that they can inflict serious personal injuries or even catastrophic injuries when they inflate. Such "aggressive" side air bags are particularly dangerous for children and infants. Also, there are still some vehicles that do not provide side curtain coverage for all rows of seating.

D. Insure Energy is Distributed and Channeled Properly Away From the Occupant and That Proper Padding is Provided

1. The Vehicle's Structure Must Control Crush

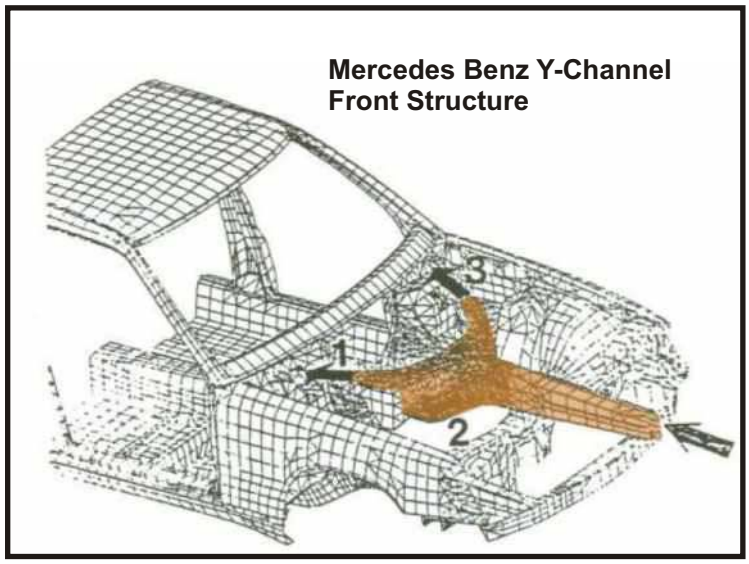
If a vehicle fails to maintain the survival space, virtually all of the safety systems are rendered ineffective.

Barrier test of an overseas vehicle.
The passenger compartment is completely destroyed.

A vehicle must crush, but it must channel and distribute energy properly. Energy should be transmitted through load bearing frame members, door beams, roof headers and convolutes.

Energy channeling and load bearing structures.
Each colored section distributes load, from front to rear, side-to-side and top to bottom.

The best way to determine if a vehicle is properly channeling energy from front to rear, side-to-side and top to bottom in a frontal impact is to conduct an offset test rather than a full frontal impact. This test is 40% more severe than a full frontal impact at the identical speeds. Rollover testing also evaluates a vehicle's energy channeling ability.



Occupant survival space destroyed in a frontal offset test.

Occupant survival space maintained in a frontal offset test.

Even one of the smallest vehicles in the world, the Smart Car, will not crush if the structure is designed properly to channel, distribute and stackup crush. When energy is controlled, deceleration and crush injuries are avoided. When energy is not controlled, deceleration and crush injuries follow.

40 mph frontal offset test.
The side windows did not even fracture.

2. Interior Padding

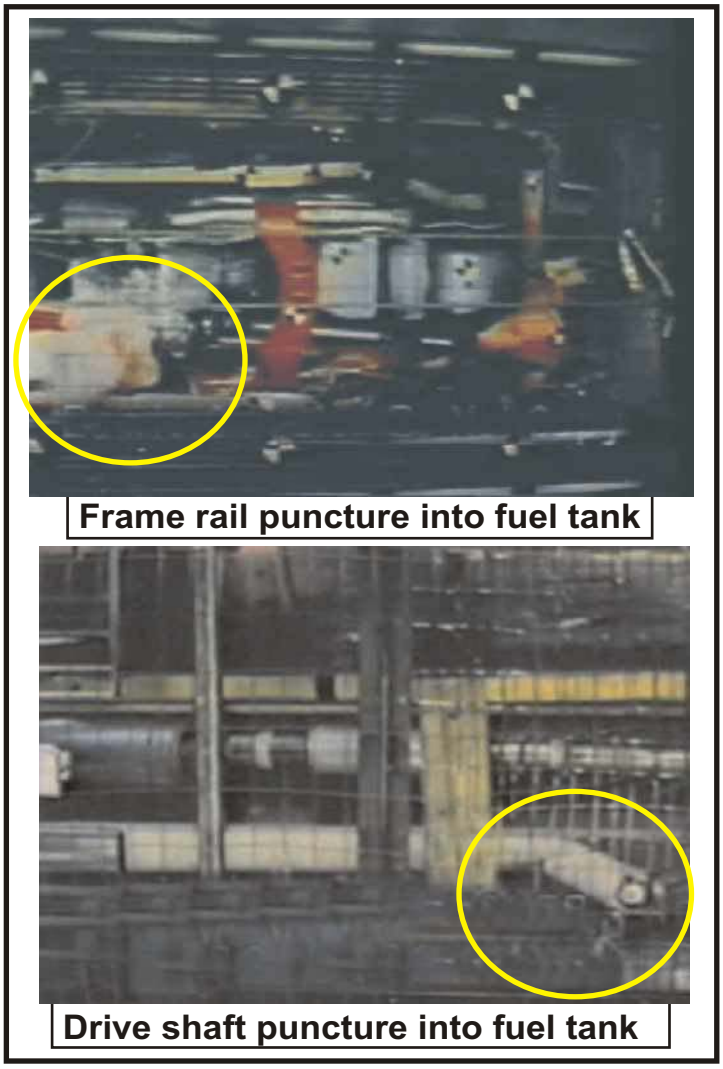
The vehicle interior must also be padded and free of knobs that protrude outward. Why? Because even properly restrained occupants can strike adjacent surfaces of the interior such as the instrument panel, the side door panels and the back of the front seats. Manufacturers admit that a properly restrained person and properly functioning restraint system will allow an occupant to strike the vehicle interior with enough force to cause injuries.

Testing with unrestrained dummies to evaluate padding has shown that as seatbacks become stronger and less prone to deflect rearward, that more seat padding is necessary. In fact, this testing has shown conclusively that polystyrene, foam material and metal air gap rather than upholstery padding is much more effective in reducing injurious head loads. This same material is also needed in doors and pillars during side impacts and rollovers.

E. Prevent Fires

Very few vehicles contain metal fuel tanks today. Efforts to reduce weight in vehicles in the last 20 years have been the primary reason for this change. As such, if a fire occurs, the fuel tank turns into a molten blob. This makes it imperative to evaluate the fire pattern and the crush pattern in conjunction to see if the structural components of the vehicle are causing a fuel tank breach.

In analyzing videos for a recent fuel tank trial, two distinct failure modes were observed.

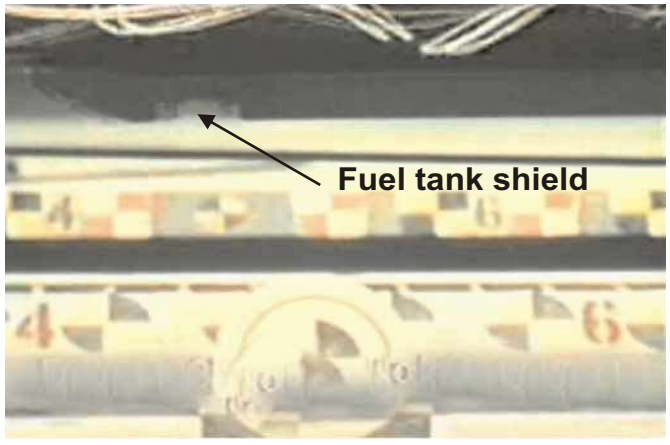


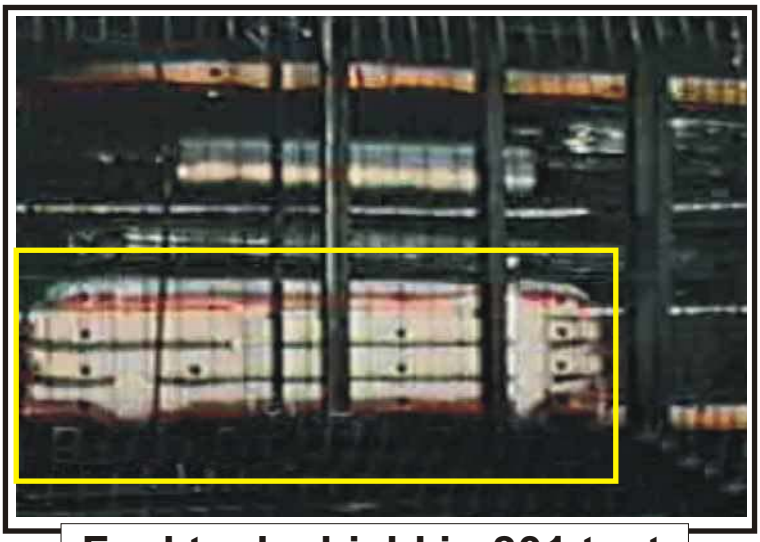
Frame rail puncture into fuel tank

Drive shaft puncture into fuel tank

In later testing by the same manufacturer, an optional fuel tank shield was used but never identified on the test report.

The use of the optional fuel tank shield violated FMVSS 301 because fuel system integrity testing must be conducted with standard equipment. Had it not been for the forensic dissection of the manufacturer's tests, this cover-up would never have been found.





Fuel tank shield in 301 test

F. Application of Vehicle Crash-worthiness Principles to Off-Road Utility Terrain Vehicles

Once in a while a mass produced, popular product that is introduced into the marketplace is a significant danger to all who use it. The Yamaha Rhino, introduced in 2003, is just such a product.

UTV's (Utility Terrain Vehicles), like the Rhino, are designed to carry multiple passengers, some of them up to 6 people, have over-the-road style vehicle controls and seating systems. This is a major departure from the traditional ATV (All Terrain Vehicle) style personal vehicle. It is a normal progression to associate crashworthiness principles to UTV's because the only difference is that these vehicles are meant for dirt rather than pavement. There are principles of vehicle crashworthiness that must be applied to off-road UTV's.

Crashworthiness:

- Maintain Survival Space
- Restrain the Occupants
- Prevent Ejection

Since its introduction, it was discovered that the Rhino UTV has a series of design defects which render it extremely susceptible to rollover at low speeds on flat level ground, without any safety provisions to protect the occupants. There have been hundreds of users injured and killed by the Yamaha Rhino, so many in fact that the CPSC (Consumer Products Safety Commission) has just become involved and may take steps to enhance the voluntary standards in which manufacturers can comply to increase safety benefits of their products.

Unfortunately, these recommendations are "voluntary" and there are no government minimum standards or testing requirements that a manufacturer must satisfy to sell these products to the American public. Essentially, litigation serves as the check and balance since there is no governmental watchdog monitoring the conduct of the UTV manufacturers.

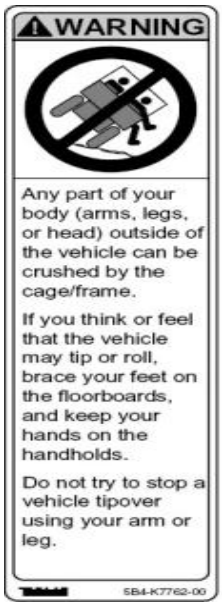
1. No Occupant Protection in Rollovers

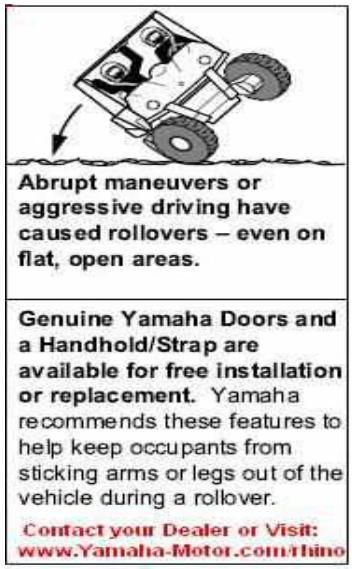
The Yamaha Rhino was designed with a high center-of-gravity and a narrow wheelbase that make it prone to rollovers, even on flat ground. The Yamaha Rhino does not have doors, side netting or containment bars so passengers aren't protected in a rollover accident. Soon after the Yamaha Rhino went on the market, people began to be injured because of the propensity of these vehicles to roll over. Without side protection, passengers in a Yamaha Rhino rollover have had their heads, hands, arms or legs caught under the Rhino, suffering crushing injuries and death due to the weight of the vehicle itself and the dynamics of the rollover. These crush injuries are in many cases more severe than simple broken bones, because they can cause nerve damage and sometimes require amputations.

Actual Rhino Tipover
with no lower leg protection

For years, instead of acknowledging the problem and recalling the Rhinos, or changing the basic design, Yamaha continued to sell its UTV without attention to the flurry of injuries. For every unit sold, the percentage of incidents has steadily increased.

Finally, in 2006 Yamaha admitted it had a problem, but failed to recall the Rhino. Instead, it sent customers new warning labels to place on their UTVs, and a letter warning its customers about rollover injuries. The following are those items sent to Rhino Owners:





Dear Rhino Owner:

Your Rhino side-by-side vehicle was designed to be a very capable off-road vehicle with a wide variety of potential uses. Regardless of how you use your Rhino, please remember that both the driver and the passenger must always buckle the seat belt when riding in the vehicle. Also the driver and passenger must wear an approved off-road motorcycle-type helmet that fits properly.

As with any off-road capable vehicle, there is a risk of tip over or rollover under certain conditions. Uneven terrain or slopes which pitch the vehicle sideways, turning too fast or sharp, or a combination of conditions increase the risk of tip over.

As your Owner's Manuel describes, "If the vehicle starts to tip, gradually steer in the downhill direction if there are no obstacles in your path. As you regain proper balance, gradually steer again in the direction you want to go."

However, if you are in a situation where the vehicle is tipping over, do not put your arm or leg outside the vehicle to try to stop it. You could be severely injured. You could suffer a crushed hard, arm, leg, or foot, if part of your body is caught underneath the vehicle. You must keep your arms and legs inside the vehicle until it has stopped moving.

To help remind you and other operators or passengers in your Rhino of this important information, Yamaha has prepared new warning labels, one for each side of the enclosure. We recommend you install these labels on your Rhino or have your authorized Yamaha dealer install them for you. An illustration of the proper location is provided on the back of this letter.

We are concerned about your safety and continued satisfaction with our products. Thank you for giving your attention to this important matter.

Sincerely,

Customer Support Group
Yamaha Motor Corporation, U.S.A.

It simply defies all engineering principles to tell a user to keep his head, arms and legs inside the passenger compartment when accident forces tend to eject these body parts. This is why passive restraints such as doors, netting and other ejection mitigation barriers must be provided with these UTV's.

2. Inherently Unstable

The Yamaha Rhino's main defect lies in its basic design. First, it is too narrow in its track width. Combined with its height from the ground and height of its seating produces an unacceptably high center of gravity. Vehicles with a narrow track width and high center of gravity like the Ford Bronco II, will rollover very easily. As a matter of fact, the Yamaha Rhino can and will rollover at 15mph on flat level ground simply by turning the vehicle sharply in either direction.

The Ford Bronco II and the Yamaha Rhino are characteristically identical.

In addition, the tires are narrow and the recommended tire pressure is low. This type of tire configuration allows for significant sideways deformation in turning maneuvers making the tires change shape and dig in to the driving surface increasing the vehicle's ability to pitch over onto its side.

It has been demonstrated that increasing the track width of the vehicle by three inches will reduce the Rhino's center of gravity enough to increase the rollover threshold to 30mph. Adding wider, higher pressure tires would also increase the margin of safety to help prevent or eliminate rollovers on flat level ground.

The Rhino was sold without any occupant retention features aside from the belt restraint. Common side restraint features include doors or bars which span the lower half of the passenger compartment at the level of the dash to the floor board. Incorporating side retention features in combination with a properly fitting seatbelt would nearly eliminate leg injuries in a rollover. If the side structure is sufficiently high enough (at least to the mid-upper arm of the occupant) a significant reduction of upper extremity injuries during a rollover type accident would be seen.

	Honda "Big Red"	Yamaha "Rhino"	Artic Cat "Prowler"	Kawasaki "Mule"	Kawasaki Teryx	Ranger Rzr
Length	114.7"	113.6"	118.5"	118.5"	115.4"	102"
Width	64"	54"	60"	62"	58.7"	50"
Height	76.9"	73"	77.5"	75.8"	75"	69"
Wheel Base	75.7"	75.2"	75"	73.6"	76"	77"
Ground Clearence	10.3"	12.1"	12.5"	6.9"	11.3"	10"
Turn Radius	13.8'	12.8'		11.2'	13.1'	9'
Front Tires	25 x 10-12	25 x 8-12	26 x 9-19	23 x 11-10	28 x 8-12	25 x 8-12
Tires	25 x 10-12	25 x 10-12	26 x 11-14	23 x 11-10	28 x 10-12	25 x 10-12
Weight	1431	1200	1200	1600	1276	945
Seat Height	34"	31"		34.2"	30.5"	23.7"

Other UTV manufacturers have configured their products for wider tracks and lower CG's making them much safer to operate. The vehicle specifications for many of these other UTVs is quite telling when compared to the Rhino.

3. Inadequate Restraint

From 2003 thru 2007, the Yamaha Rhino was sold literally void of any occupant safety features. The vehicle now, since its introduction, includes a 3-point seat belt system. Many owners however, have criticized this seat belt system as being inadequate and poorly fitting therefore minimizing its effectiveness in many types of accidents, including rollovers. Poorly fitted shoulder belts in a UTV will allow for occupant rollout in frontal and side impacts causing upper torso, spinal, facial and head injuries just like they do in a vehicle.

Yamaha has also never included a retention system at the top of the rollover protection structure (ROPS) as included equipment. This would prevent the head and shoulders from contacting the ground or being pinned or crushed during a full rollover due to partial ejection.

4. Untested Padding

In all Rhino models, the ROPS has never included padding. In the event of a rollover or frontal impact, occupants have contacted or had these structures fall onto them. Simply padding these surfaces would decrease the likelihood of injury by softening the blow during an accident or rollover. Just like vehicles have a friendly interior, UTVs must contain padded surfaces to prevent blunt force traumas should they be struck by a user.

5. Untested ROP System

Yamaha has no testing that confirms if its ROP will provide adequate structural support to maintain survival space. Without adequate structural support, other safety systems will be rendered ineffective.

6. Too Little Too Late

In 2007, Yamaha finally admitted that it had a problem due to the number of allegations of injury. Yet, it did not recall the vehicle or supply a design change for its users. Instead, it offered to install a half door and a hand hold to "help prevent leg injuries and increase rider comfort." This change coincided with new language in the owner's manual which encouraged the operator and passengers to keep their arms and legs inside the vehicle in the event of a rollover. This new language, also indicated that it is the operator and passenger's responsibility to do so. This position defies all principles of engineering ethics.

The 2008 Rhino models have the partial door and hand holds installed from the factory.Yamaha's hand hold and partial door fails to correct the risk, hazard and danger of partial ejection. The arms and upper torso need an ejection mitigation barrier. The illustration below would provide upper and lower torso protection.

NOVEMBER 4, 2008

U.S. Probes Off-Road Vehicles After a String of Accidents

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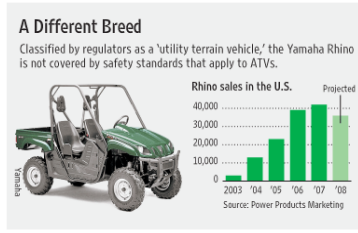
By MELANIE TROTTMAN and CHRISTOPHER CONKEY

The Yamaha Rhino, a hit in the off-road-vehicle market, promises to go "almost anywhere" with an "amazingly high level of comfort and ease." Now, federal safety regulators are investigating the vehicle following reports of some 30 deaths involving it, including those of two young girls last month.



Despite the Rhino's safety improvements in 2008, the 2008 model year also includes a significant increase in horsepower as an option to the buyer. The track width and center of gravity have not been modified. This larger power plant serves to increase the top speed of the vehicle which will logically result in more severe rollover accidents, generally negating any occupant retention systems added as standard equipment.

In November of 2008, the Wall Street Journal reported that the CPSC is investigating this product. The CPSC cited the existence of more than 200 Yamaha Rhino lawsuits and reports of 30 deaths as some of the factors leading to the investigation.

Until Yamaha redesigns and tests its UTV to include a wider track and lower center of gravity, this vehicle will remain a significant danger to the American consumer. Further, until Yamaha applies crashworthiness principles to this vehicle, consumers will continue to be seriously injured and killed because UTV's can be just as deadly and dangerous as a defective vehicle on the street Lastly, Yamaha must undertake extensive engineering analysis to insure its product is safe, rather than placing occupant safety solely on Rhino owners and users.

III. Conclusion

Crashworthiness cases must be approached with an open-mind, a willingness to dissect the details and the relentless pursuit of correlating physical, medical and forensic evidence with a given scenario. When these objectives are met, even "not so obvious" crashworthiness cases can be identified.

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