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Comments on Notice of Proposed Rulemaking; Roof Crush Resistance; 70 FR 49223 *et seq.*; Docket No. NHTSA-2005-22143

Introduction

Rollover crashes kill more than 10,000 people each year, accounting for one-third of all occupant deaths in vehicle crashes. This appalling loss of life is all the more tragic because so many of these deaths are preventable. Available technology and an advanced scientific understanding of rollover dynamics have created an unprecedented opportunity to significantly reduce rollover deaths, placing the National Highway Traffic Safety Administration (NHTSA) in a position to save thousands of lives each year.

The current roof crush resistance requirement, which has not been upgraded since it was first issued in 1971, is dramatically out of date. It does not make use of advances in safety technology to improve rollover crashworthiness, and the level of roof crush resistance it requires is pitifully below what is needed to protect occupants in rollovers. In addition, in recent years the problem has been exacerbated by the increase in SUVs on the road,[1] which have a rollover occupant fatality rate nearly three times that of cars,[2] making the need for an adequate roof crush resistance rule all the more dire. Ultimately, the current standard has simply not been effective in reducing occupant deaths and injuries resulting from roof crush,[3] and there continues to be an unacceptably large number of such casualties.

Astoundingly, NHTSA's proposed rule, issued after three decades without an upgrade, requires only a token increase in roof strength and fails to provide an adequate level of rollover crashworthiness consistent with current technology. In fact, the proposed rule is so *de minimis* that 70 percent of the current vehicle fleet does not need to make any improvement to meet the proposed standards,[4] and costs for vehicles requiring improvement is a measly \$10.61.[5] At a conceptual level, the proposal sets the roof strength standard without consideration of the critical role of roof crush resistance in determining the performance of other features important in protecting occupants in rollovers. This misunderstanding, which separates roof crush resistance from the dynamic event of a rollover, cripples the agency's attempt to address rollover crashworthiness.

Instead of maintaining this failed strategy, the agency should require compliance with the dolly rollover test now part of the occupant containment standard in Federal Motor Vehicle Safety Standard (FMVSS) No. 208, currently an alternative means of certifying compliance with FMVSS No. 216, the roof crush resistance rule. The 208 test is conducted regularly by all of the major manufacturers and produces repeatable results from the standpoint of occupant injury. Only a dynamic test is capable of measuring the success of the standard in preventing roof crush and consequent occupant injury.

Public Citizen anticipated the failings of the agency's proposal, and in March 2005 held a press conference at which Don Friedman, an engineer with more than 40 years of experience in vehicle design, detailed the numerous deficiencies of the agency's likely rule.[6] NHTSA ignored the evidence presented at the press conference, which was also placed in the docket, and proposed a rule that, as expected, will fail to protect occupants from roof crush.

By the agency's most generous estimate, the proposed rule will save 44 lives, approximately half of one percent of the lives lost each year in rollover crashes. It is an egregious betrayal of the public that NHTSA has for so long shirked its responsibility as a safety agency, particularly in the five years since the Ford/Firestone disaster, during which more than 50,000 people have died in rollover crashes. It is shameful that NHTSA would now consider a proposed standard that will continue to leave people exceedingly vulnerable to injury and death in rollover crashes.

With statistical legerdemain, the agency identifies the at-risk group of occupants as including 596 fatally injured occupants. Yet its rule will save only, at most, 44 occupants. This is a mere 7 percent of the total population that even NHTSA extremely low-ball estimates state could be helped by a rule – an irresponsibly paltry number and an excellent indication that NHTSA should return to the drawing board to develop a substantially more protective standard. Experts on roof crush, such as Don Friedman, have proven in this docket that a strong roof crush rule would save thousands of lives.

In general, NHTSA repeatedly uses residual information (post-crash vehicles) to ascertain correlation with a dynamic event in which a vehicle's roof acts elastic and spring-like. Its assertion that roof crush deformation patterns "look similar" to its static test results therefore fails to establish any scientific value for its test. This mistake permeates NHTSA's analysis of affected populations, as the agency repeatedly references post-crash intrusion in determining whether an occupant was at risk for injury from the roof. Yet post-crash intrusion has literally no descriptive value in determining the roof's behavior during the rollover or whether an injury was the result of roof contact.[7]

Moreover, the agency systematically excludes any consideration of benefits to fully ejected belted occupants or all unbelted occupants. These exclusions are similarly unscientific and evince a basic lack of understanding about the role of the roof in maintaining compartment integrity.

NHTSA must issue a supplementary notice of proposed rulemaking requiring a dynamic compliance test and establishing a roof crush resistance standard that protects occupants from contact with crushing roofs and crush-related ejection, and makes possible the proper interaction of other safety systems, such as safety belts, side impact air bags, side window glazing and door lock retention. In this supplemental notice, NHTSA should also retract its harmful and unnecessary statements on preemption.

NHTSA has received industry testing documents related to the Ford Explorer and Volvo XC-90 from several sources in the course of this rulemaking. The mere fact that the agency is refusing to allow members of the public to view this part of the docket does not diminish its obligation to consider the information submitted in developing the rule. In addition, NHTSA must also consider all information initially submitted to the previous docket on the request for comments.

Roof Crush Resistance is Critical for Occupant Safety in Rollover Crashes

Roof crush resistance is critical for protecting occupants from death and injury in rollover crashes. In a rollover, a vehicle's roof will crush or buckle inward in one of several known patterns of deformation, exposing occupants to the risk of head and neck injuries. In addition, a crushed roof can compromise other vehicle safety systems important in preventing ejection.

A strong roof that resists crush is a basic tenet of auto safety. All race cars are equipped with roll cages, and vehicles used in industry rollover propensity tests are specially designed with increased roof strength to protect drivers. It is well known that most major manufacturers began using vehicles with reinforced roofs to test vehicle stability after a test driver died when his vehicle rolled over. NHTSA too has long recognized, to some degree, the danger of roof crush, as evidenced by the issuance of the roof crush resistance rule in 1971.

Yet industry mouthpieces have for decades suggested that roof crush does not cause occupant injury in rollover crashes. The discrepancy between these claims of industry officials and the work of industry engineers, however, provides insights into the validity of the claim that roof crush does not cause occupant injury. In internal documents, engineers for Volvo, a wholly owned subsidiary of Ford, identified "strengthened upper body structure" that "prevent[s] the body structure to impact the occupant and partial ejection" as one of the "3 legs to improve rollover performance in passive safety."[8] In contrast, Daimler Chrysler's comments to NHTSA concerning roof crush state "[I]ncrease in roof strength is not likely to significantly reduce neck or head injury potential of rollover events nor reduce occupant ejection from the vehicle."[9]

More than intuitively implausible, the industry's argument, so far as it concerns injury resulting from roof intrusion contacting occupants, was exposed as false in a recent independent scientific analysis of dynamic SUV rollover tests by Martha Bidez, Ph.D. The report, "Roof Crush as a Source of Injury in Rollover Crashes," using the industry's own tests, which were recently made available through litigation, showed a "clear causal relationship between compressive upper neck forces (F_z) and lower neck movements (M_y and M_x) and maximum roof/pillar crush."[10]

In addition to preventing a crushing or buckling roof from contacting occupants in a rollover, a strong roof is also crucial to preventing occupant ejection, as noted above by Volvo's engineers. In a rollover, the roof is the backbone of the vehicle; adequate roof performance is necessary to enable the performance of other vehicle safety systems critical for protecting occupants during a rollover. When the roof deforms in a rollover, occupants face a greater likelihood of ejection, as a deformed roof compromises the performance of features important for mitigating ejection. A deformed roof can shatter windows and undermine door integrity, creating potential ejection portals. It can also alter safety belt geometry, undermining restraint ability, and impact the efficacy of side curtain airbags. This combination of open ejection portals and compromised restraint systems is part of what makes rollovers so deadly. Additionally, a deformed roof can subject even properly restrained occupants to partial ejection if the roof shifts such that an occupant in an upright seated position would protrude through a window or other portal. (*See* Appendix A.)

Rollovers are dynamic events that demand performance of many different safety systems to ensure occupant protection. Preventing occupant deaths and injuries in rollovers requires a comprehensive approach that focuses on each component safety system, as well as their interconnections. Necessarily, though, at the crux of a truly comprehensive approach is the strength of the vehicle's roof.

NHTSA's Proposal Insufficiently Improves Safety

The proposed rule insufficiently improves safety and will produce only a minimal reduction in rollover injuries and fatalities. According to NHTSA's most generous benefits calculation, the rule will save 44 lives annually – one-half of one percent of the number of lives lost each year in rollover crashes. Because of errors in the agency's benefit analysis, this estimate is low. Nonetheless**,** the proposal will fail to provide the level of protection from roof crush injuries that is technologically feasible, practicable, and cost-effective, resulting in minimal benefits.

<u>The proposed rule will only minimally increase roof strength in vehicle fleet.</u>

NHTSA is clearly concerned about injuries resulting from roof intrusion and agrees that roof intrusion is a source of injury in rollovers, yet the proposal requires only a minimal increase in roof strength. According to NHTSA, nearly 70 percent of the current vehicle fleet requires no upgrade to meet the proposed standard.[11]

A standard that amounts to, on average, an increase from a 1.5 to a 1.64 strength-to-weight (SWR) in the terms of the current standard will fail to protect occupants from the dangers of a buckling or collapsing roof, as evidenced by the agency's estimate that the proposed rule will prevent only one-half of one percent of rollover deaths. The proposed increased in roof strength requirement is far too weak given the scientific consensus that roof crush is a significant source of injuries and deaths in rollover crashes**.**

- *The required increase in force-load to 2.5 is undercut by the increase in intrusion allowance.*

NHTSA proposes to increase the force that a vehicle's roof must withstand to 2.5 times the vehicle's unloaded weight, an increase of 67 percent from the current force-load requirement. The increase is misleading, however, as changes in the test conditions allow, in most cases, more roof intrusion to occur than under the current rule, substantially undercutting the impact in the increase in vehicle SWR to 2.5. The equivalent on the current test would be approximately 1.64 SWR, though it would vary from vehicle to vehicle.

Under the current rule, a vehicle's roof must not allow more than 5" of roof crush when subjected to a force 1.5 times the vehicle's weight. NHTSA is proposing to replace the current 5-inch limit with the requirement that a vehicle's roof must not contact the head of a 50th percentile Hybrid III dummy when subjected to a force equal to 2.5 times the vehicle's weight. In a study cited by NHTSA in the notice of proposed rulemaking (NPRM) and used to justify the agency's decision to require a 2.5 SWR, the nine vehicles that were tested averaged 7.63" of crush before the roofs contacted the heads of a 50th percentile Hybrid III dummy.[12] The proposed rule, then, would allow greater roof crush when testing vehicles, offsetting the increase in force load that would otherwise come from the increased SWR.

Stephen Batzer, Ph.D., P.E., of The Engineering Institute, Inc., submitted comments to the docket showing that the proposal would require an SWR equivalent to a 1.64 SWR under the current rule.[13] Far from a 67 percent increase in roof strength, Dr. Batzer's analysis shows that the average required increase in roof strength under the proposed rule amounts to an increase of only 9 percent over the current standard.[14] It is even conceivable that for some vehicles with a large amount of headroom, the proposed rule would require less roof strength than the current rule. For this reason, Public Citizen and the Vermont Public Interest Group (VPIRG) believe that, at least, the proposal should support rather than replace the current standard.

The degree of roof crush, irrespective of headroom, is important in protecting occupants from ejection. If the roof of a vehicle resists more than 3" of crush, the side windows are much less likely to break.[15] Also, with less roof crush, safety belts better retain their original geometry, doors are more likely to stay locked and able to readily open as needed, and side curtain airbags, which are critical in preventing ejection in rollover crashes, are more likely to perform properly. Yet maintenance of headroom to prevent injuries resulting from roof intrusion contacting occupants is also critically important in rollover crashes. NHTSA should require that vehicles resist more than 3" of roof crush as well as maintain a minimum amount of headroom.

- *The roof strength required by the proposal is only a token increase over the current level.*

The required roof strength under the proposed rule represents a token increase that will prevent a minimal number of deaths and injuries. Dynamic rollover tests show that a roofs significantly stronger than what the proposal requires, when measured under the current roof crush test, can fail to provide adequate occupant protection in a real-world rollover.[16] In light of such testing, independent engineers have estimated that an SWR of 3.5 as measured by the current test may be required to provide sufficient rollover crashworthiness.[17]

In the NPRM, NHTSA implicitly admits the absolute inadequacy of current roof strength levels in most vehicles, stating that in dynamic rollover tests, it had difficulty distinguishing between good and bad performing roofs.[18] But if the agency had tested the Volvo XC90, which has a roof sufficiently strong to prevent significant intrusion in rollovers, it would have realized that the problem was not with the test, but with the vehicles, all of which had dangerously bad roofs.[19]

The agency's proposed increase in roof strength is so minimal that the required roof strength under the proposal is less than the internal requirements of manufacturers, such as Ford, which maintained an internal guideline of 1.875 SWR in the late 1990s.[20] The proposed increase will not adequately protect occupants in rollover crashes; does not even equal or exceed internal standards used by auto manufacturers, as the agency knows from documents submitted previously by Sean Kane to this docket; and is already met by 70 percent of the current vehicle fleet, therefore does not constitute an "upgrade" in roof strength, as required in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

- *The proposal sets the level for roof strength without considering occupant injury.*

Incomprehensibly, NHTSA proposes to set the roof strength requirement irrespective of its efficacy in preventing occupant injury and death in rollover crashes. The purpose of FMVSS No. 216 is to reduce occupant injury and deaths from roof intrusion, as is also required by the mandate concerning rollover safety in SAFETEA-LU.[21]

Clearly, the agency should consider the effect on occupant injury in setting the level of protection provided by its standard. Yet NHTSA makes no mention of occupant injury in its explanation of adoption of the 2.5 SWR. Rather, in support of its decision to require a 2.5 SWR, NHTSA relies exclusively upon a mechanical study by Glen Rains and Michael Van Voorhis.[22] The abstract of the study states that "[t]he objective was to determine the correlation between roof crush performance measured quasi-statically and dynamically."[23] The study does not address, nor even attempt to measure, occupant injury levels.

- *The proposal instead wrongly lets cost be the driver in setting the level of protection.*

NHTSA considers effect of the predetermined level of roof strength on occupant injury in the agency's cost-benefit analysis (CBA). By the agency's most generous analysis, a 2.5 force load requirement will save 44 lives and, by comparison, a 3.0 force load will save 135 lives. Despite the far greater number of lives saved under the 3.0 alternative, the agency proposes the 2.5 force load. NHTSA's CBA determines that the 3.0 would be more expensive, yet cost alone should not drive the agency's decision in setting a roof crush resistance standard.

Moreover, the agency's decision violates its duty as a safety agency. In June 2002, Public Citizen joined with other consumer safety groups to sue NHTSA because its final rule on tire pressure monitoring systems would have allowed manufacturers to choose to install an inferior (indirect) system. A year later, in August 2003, a unanimous three-judge panel of the United States Court of Appeals for the Second Circuit ordered NHTSA to rewrite the rule, agreeing with Public Citizen and others that NHTSA acted in an arbitrary and capricious manner by allowing installation of a clearly faulty (indirect) system.

In its decision, the Court reminded NHTSA that the notion that "cheapest is best" is contrary to Supreme Court precedent that safety improvements are a core responsibility of federal regulators. The court also reminded NHTSA that, in doing its cost-benefit calculations, the agency is supposed to "place a thumb on the safety side of the scale."[24]

Regardless, stronger roofs are not very expensive. The agency estimates in the preliminary regulatory impact analysis (PRIA) that a roof crush resistance standard of 3 times a vehicle's weight would require an average compliance cost of $43.13 per vehicle.[25] Additionally, increases to roof strength become dramatically more cost-effective once roofs are strengthened to a level sufficient to protect occupants, which independent engineers have estimated at, minimally, 3.5 SWR. The current roof crush standard is so far below what is needed to protect occupants that benefits are not realized until a significant increase in SWR.

- *The proposal does not set roof strength requirements consistent with available technology currently in vehicle fleet.*

Available safety technology allows a more stringent roof crush resistance standard, one that will provide occupants with adequate protection in rollovers. Manufacturers can, and do, make vehicles -- such as the Volvo XC90, which shows good performance in real-world rollover crashes[26] has a 3.5 SWR, and high strength, non-buckling, steel rollover and side impact structure -- that adequately protect occupants in rollovers.

- *NHTSA must increase the roof crush resistance standard to adequately protect occupants from the dangers of ejection.*

NHTSA estimates that approximately 64 percent of rollover fatalities are ejected. Most of the fatally injured are ejected through side windows or doors. In an actual rollover, after an impact, window glass breaks and ejection portals are opened. The roof also moves back and forth over the occupants during the rollover ("matchboxing").

NHTSA recognizes the importance of door retention and ejection mitigation features such as side curtain airbags and safety belt pretensioners, all of which are mentioned in the proposal in the agency's "comprehensive response" to rollover.[27] In a rollover, performance of these safety features is contingent upon performance of the roof, and NHTSA admits as much. Yet the proposal does not provide for the fact that roof deformation will compromise the effectiveness of safety belts, side curtain airbags, windows, and door retention. Also, the proposed standard does not even address roof strength to prevent partial ejection in cases in which the roof shifts such that an occupant in an upright seated position would protrude through a window or other portal. In contrast, if roof crush is limited to less than 3", side windows do not break and the limited deformation of the vehicle enables the safety performance of belts, door locks and side impact air bags.

NHTSA must re-assess the level of roof crush resistance required in the proposal to prevent ejection, which would result in a higher standard with greatly augmented benefits.

NHTSA's "Comprehensive Response" Is Neither Comprehensive Nor a Response

NHTSA notes that this rule is merely part of what it labels a "comprehensive response" to prevent rollover deaths and injuries. Public Citizen and VPIRG agree that reduction of rollover deaths and injuries will require an approach that improves both pre-crash factors and vehicle crashworthiness in rollovers. Yet NHTSA fails to note that this road has been well paved with broken promises by this agency. In 1991, Congress passed the Intermodal Surface Transportation Efficiency Act (ISTEA), which required NHTSA to address means of protecting motorists from "unreasonable risk of rollovers" in passenger vehicles.[28] The auto industry blocked language that would have required the agency to issue a standard. In response, NHTSA asked the public to comment on a standard prohibiting an unreasonable risk of rollover.

In 1994, the agency, in response to industry pressure and relying in part on obsolete data from the late 1980s regarding the low number of SUVs in the vehicle population, terminated its work on a rollover propensity standard by promising that a series of improvements in rollover crashworthiness and consumer information were forthcoming.[29] The rules promised in 1994 included advanced window glazing to prevent ejections and a rule on stronger roofs. In the mid-1990s, NHTSA made additional promises in subsequent public statements that it would require improvements in door latches and hinges. We waited until 2002 for a dynamic consumer information program which, which had to be required by Congress in the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act. We are only now, more than a decade later, addressing the issue of roof strength and are not even at the final rule stage. We are still waiting for any definitive steps on the other items.

NHTSA's lackadaisical attitude, at 70 FR 49228 and 49236, that we should rely on the agency to stem the growing carnage from rollovers with a mixture of New Car Assessment Program (NCAP) consumer information, "continued research" on electronic stability control and other systems and driving law enforcement, is far from reassuring.

NHTSA's reliance on NCAP is particularly troubling in light of the fact that NCAP currently lacks a rollover crashworthiness component; that an audit by the General Accounting Office (GAO) last spring raised grave questions about NCAP's ineffectiveness, which have not been responded to by NHTSA; and that NCAP is not well known by consumers and is not nearly as effective in improving safety performance as a federal minimum standard.[30]

Of the crashworthiness items cited by the agency, ejection mitigation rules and door retention systems are now required by SAFETEA-LU, and must be completed prior to Congressionally mandated guidelines. Future documents must reflect that completion of these are now required.

In general, vague references, without goals or deadlines, to a "comprehensive" plan do not allay the serious deficiencies of this proposed rule on roof crush resistance. Nor could NHTSA succeed in reducing rollover casualties by developing any plan that is without reference to the interaction among the protection provided by constituent safety systems.

<u>The proposal relies upon flawed testing procedures and requirements, reducing its benefits.</u>

In setting a roof crush resistance standard, it is critical to establish testing procedures that simulate real-world rollover crashes to the greatest degree possible. The testing procedures and requirements in the proposal, however, fail to account for crash dynamics in real-world rollovers that play a significant role in occupant injury levels. This undercuts the ability of the rule to protect occupants in real-world rollovers.

The agency's proposed static test fails in many ways to account for crash dynamics in real-world rollovers. The test can be improved to better simulate a rollover; yet fundamentally, a static test is inappropriate for a roof crush test. Rather, a dynamic test must be used to measures component roof strength under conditions that replicate real-world rollovers, as well as the effect of roof crush on ejection-mitigation safety features. NHTSA recognized this in 1971, when it issued FMVSS No. 208 with a temporary voluntary standard for a dolly rollover dynamic test for roof crush. Unfortunately, the agency never followed through to make the voluntary standard permanent, undermining the original intent underlying the development of the dolly rollover test.

Moreover, the proposed test will not measure relationship between roof crush resistance and the failure of other safety systems, even those anticipated in the agency's comprehensive approach to rollover safety. In a rollover, roof performance affects the performance of other systems, which in turn affects injury outcome. Yet the proposed static test measures only roof crush. Rollover crashes are dynamic events, and roof crush affects a number of vehicle safety systems that protect occupants from roof intrusion and ejection. A static test cannot measure the effect of roof crush on the efficacy of other safety systems -- such as safety belts, side curtain airbags, seatbacks, windows, and doors -- in protecting occupants from roof intrusion or ejection. NHTSA stresses the importance of a "comprehensive" approach to reducing injuries and fatalities in rollovers that includes ejection mitigation, yet the agency proposes a static test that does not test for the effect of roof crush on ejection. NHTSA's proposed rule, therefore, will fail to indicate, on a scientific basis, that its comprehensive approach is sound.

- *The headroom requirement is flawed.*

The headroom requirement, which would replace the current limit of 5" inches of crush in the agency's static test, suffers from a number of flaws that compromise occupant safety. The proposal only requires maintenance of headroom sufficient for a 50th percentile male, neglecting both taller and shorter populations. In fact, these populations may require greater protection in rollovers, as the heads of taller occupants are likely to be closer to the roof, and shorter occupants are likely to be closer to the A-pillar, which neither the current nor the proposed rule tests sufficiently. NHTSA should require tests with both a 95th percentile male dummy and a 5th percentile female dummy.

Another flaw is that the dummy's head position in the NHTSA proposal is not realistic. In real-world rollovers, even belted occupants are thrown toward the roof and A-pillar due to centrifugal forces and the vehicle's pitch angle. Occupants' heads, thus, are higher and further forward in a rollover than when they are in a static seated position.

Measuring headroom for a dummy in a static seated position does not provide an accurate representation of occupant head position in a rollover. In the NPRM, NHTSA notes that in agency testing of restraints in rollover conditions, "the maximum head excursion was much higher during the test (when dummy was upside down in the restraint), compared to static pre-and post-test head excursion measurements."[31] It is incomprehensible, then, why the agency would set the headroom requirement based on static headroom. In real-world rollovers, occupants will be thrown within the range of roof intrusion allowed under the proposal. The agency's proposed headroom requirement will fail to prevent roof intrusion from contacting occupants during a rollover crash.

The headroom requirement, however, provides improved protection over the current rule for occupants in vehicles with low rooflines. NHTSA cites the inadequacy of the current 5" roof crush limit for low roofline vehicles in proposing the headroom requirement,[32] yet then requests comments on alternative compliance tests for low roofline vehicles that would not meet the more stringent requirement.

The agency's solicitation of the possibility that it exempt low roofline vehicles from the proposal would wipe out the major benefits of the changes it proposes to make to the testing conditions. Indeed, the agency's changes to allow incursion up to the headroom of a 50th percentile male dummy would benefit mainly those occupants of low roofline vehicles.

Although NHTSA states that its concern is that "even minimal deformation resulting from the application of the required force would lead to test failure,"[33] in real-world rollover crashes this would be an actual failure of the structure to provide any reasonable protection for occupants. Similarly, if a dummy has relatively little headroom, so would a person. NHTSA has no less an obligation to protect these individuals, and should not carve out an exemption for those vehicles which may prove to be among the most risky for occupants in an actual rollover crash.

- *The proposal tests for only two quarter turns and does not apply force to the roof in a manner that ensures injuries would be prevented in actual real-world rollovers.*

The proposal tests for the impact of only two quarter turns – the "near side" impact only – and fails to comply with new legislative requirements for a two-sided test, which would better simulate crush patterns in real-world rollovers and improve rollover crashworthiness.

The new law (SAFETEA-LU) enacted by Congress in August 2005 requires an upgrade in roof protection for both the "driver and passenger sides," *see* Title X, Subtitle C, Sec. 10301, and thereby requires issuance of a two-sided standard. This requirement is consistent with injury patterns in rollover crashes. Occupants seated beneath the second, or far side, of the vehicle's roof to impact the ground in a rollover crash are more likely to suffer serious to fatal injuries in a rollover crash.[34] This is because the roll angle is greater for the far side of a vehicle and loads forces towards the center of the roof, away from the stronger B-pillar. Also, the windshield breaks after the first impact, significantly reducing roof strength on the trailing side of the roof. A test of only one side of the vehicle roof fails to improve roof crush resistance where it is most needed for occupant survival. (*See* Appendix B.)

Like the current test, the proposed test would use a pitch angle of 5 degrees, which is not reflective of the pitch angle in real-world rollovers. SUVs and pickups are front-heavy and pitch forward during a rollover to an angle of 10 degrees or more. The low pitch angle for the platen in the current and proposed test allows the B-pillar to take up the load. In an actual rollover, however, force is concentrated on the more forward A-pillar, over an occupant's head thrown forward by the pitch of the vehicle. (*See* Appendix C.) NHTSA should revise the test procedure to more accurately reflect the pitch angle in real-world rollovers.

NHTSA's reasoning for rejecting a two-sided test is dubious. To evaluate the merits of a two-sided test, NHTSA conducted six tests subjecting both sides of a vehicle to forces at current FMVSS No. 216 plate angles. In the tests, NHTSA noticed that some vehicles showed reduced strength in second side testing, yet some vehicles showed no reduction or an increase in strength on the second side. NHTSA concluded from the tests that "some vehicles may have weakened or strengthened far side roof structures as a result of a near side impact."[35] NHTSA, however, did not subject the second side of the vehicles to forces at pitch and roll angles experienced on the second side of vehicles in real-world rollovers. The difference between force angles is one of the basic reasons for subjecting vehicles to a two-sided roof crush test. Moreover, the paltry number of vehicles tested greatly undermines any scientific value of these results.

Also, in its discussion of two-sided testing, NHTSA addresses a recent paper by researchers at Delphi Automotive and Saab that showed that far-side occupants are more than 12 times as likely to suffer serious injury as near-side occupants. In response, NHTSA cites an analysis of the paper by JP Research, Inc. NHTSA notes that the JP Research, Inc., paper identified errors in the Delphi study, which, when corrected, change the ratio from 12-to-1 to 2.4-to-1. Yet even with the corrections, the study still shows that occupants on the far side are *more than twice* as likely to suffer serious injury in rollover crashes. The agency nonetheless illogically concludes that "there is no significant increase in risk for far side belted, non-ejected occupants."[36]

NHTSA uses as justification for its conclusion a National Automotive Sampling System-Crashworthiness Data System (NASS-CDS) analysis, which it does not make public, similar to the Delphi study that showed a 1-to-1 risk ratio for near- and far-side occupants. However, NHTSA, without explanation, limited the analysis to vehicles that rolled only two to four quarter turns, unlike the Delphi study. This restriction likely biased the agency's analysis, yet NHTSA provides no evidence that this added restriction is justified. In contrast to NHTSA's study, a prior DOT analysis of NASS data and dolly rollover tests found generally "more damage occurred to the vehicle side opposite the side which first contacted the ground."[37] Additionally, in all of the 16 valid NASS-CDS cases NHTSA uses in its PRIA, a far-side, restrained occupant suffered fatal injuries from substantial roof crush.[38]

- *The proposed wrongly allows window strength to be measured in roof strength test.*

Another failing of the proposal is that it permits windshield strength to be measured in a test for roof crush resistance, even though windshields and windshield bonding often do not provide protection for occupants beyond the first two quarter turns of an actual rollover crash. Vehicle windshields are frequently broken or separated from their bonding in rollovers where there is significant crush at the front of the roof. Therefore, manufacturers should not be permitted to use the strength of the windshield or its bonding to comply with a roof crush standard.

NHTSA claims in the NPRM that an examination of real-world rollovers shows that windshields rarely separate from the vehicle, yet the agency does not provide any supporting data. NHTSA also claims that in recent roof crush resistance tests, some vehicles showed little or no reduction in strength after the windshield integrity was compromised.[39] However, clearly, then, other vehicles tested showed reduction in roof strength after the windshield strength was compromised. Data submitted by Don Friedman and Carl Nash to the prior docket clearly indicates a diminishment in roof strength following windshield breakage after the first roll. To test without windshields would be to test under conditions that do not reflect real-world rollovers for these vehicles, and would result in a less stringent rule. In its claim, NHTSA merely points to the exception to the rule. NHTSA is also contradicted by industry engineer Ivar Arums, who found in tests that vehicle roof strength decreased by approximately one-third after the bonded windshields broke.[40]

- *The proposed test does not account for roof buckling as a source of injury.*

The proposed static test would not prevent roof buckling or show that it is a source of injury. Yet roof buckling and structural collapse are a key source of injury in rollover crashes. NHTSA fails to acknowledge and consider the ample evidence that roof intrusion occurs at speeds up to 22 mph and can cause devastating spinal and thoracic as well as head, face and neck injuries to both restrained and unrestrained occupants. Separate comments to this docket from Carl Nash and Don Friedman explain that the speed of roof buckling is significantly greater for weaker roofs. Buckling at a 1.8 SWR is about 30 percent faster (11 mph) than at a 2.5 SWR, which is 60 percent faster (8 mph) than a 3.5 SWR (5 mph). Also, without a design requirement limiting buckling, buckling can undermine the benefits of an increased SWR.

Reducing buckling is especially important for a comprehensive approach to reducing death and injury in rollovers, as safety belts tend to hold occupants in seated positions where they are more vulnerable to impacts by rapidly intruding roof components.

The proposal does not test for rear-seat occupants. Because of their small size, children in the back seat are at as great a risk of ejection as occupants in the front seat. It is important for NHTSA to test for roof intrusion and its effect on the likelihood of injury for back seat occupants. Additionally, the vehicle weight used in the test should include the vehicle plus two occupants.

Other Comments on Testing Procedures

<u>Headroom clearance concerns require NHTSA to retain the current test and use proposed standard as supplemental testing protocol.</u>

The excursion of occupants from safety belts, as shown by the agency's own testing cited in the NPRM, is the reason that vehicles with more than 5" of headroom are not in "over compliance," as NHTSA stated in the opening of the proposal. Rather than acting from any concern about an "excess" of headroom in particular vehicles, NHTSA should seek to maximize headroom clearance. Head injuries, are, after all, the most devastating type of injury.

The best way to ensure that vehicles will not lose headroom due to issuance of the agency's proposal is to maintain both tests as the standard. This imposes only a minimum testing burden, as both tests can be conducted consecutively on the same vehicle. The new rule should supplement, but not replace, the current standard.

<u>There should be no exemption to FMVSS No. 216 requirements for 15-passenger vans.</u>

Public Citizen and VPIRG object strenuously to the notion that 15-passenger vans could be permitted, under the agency's proposal, to alternatively certify compliance to FMVSS 220, *School Bus rollover Protection*. First, improving the safety of 15-passenger vans are clearly of real concern to Congress and NHTSA, which included targeted provisions in the recent enactment of SAFETEA-LU, and evidenced by the numerous safety advisories issued by NHTSA. These vehicles are extremely dangerous for occupants, who deserve a significant upgrade in safety over current levels.

While we agree that NHTSA should not exempt all vehicles in this category, it also should not provide a new loophole for 15-passenger vans to escape compliance with FMVSS 216. If NHTSA preserves another compliance option for multi-stage vehicles in general (rather than requiring these vehicles to meet 216) it should, at a minimum, specify that all 15-passnger vans within that class must meet the requirements of the revised 216 test as a supplement to the current test. Fifteen-passenger vans should not be permitted to certify compliance with FMVSS 220 as an alternative.

<u>NHTSA's research on different platen angle loading is incomplete and unscientific.</u>

NHTSA's discussion of the tests and roof damage patterns related to 10-45 degree platen application in the test is inconclusive and unhelpful. While the agency acknowledges that the "force distribution applied to the front and back of the load plate changed considerably between the two test configurations," and the 10-45 degree positioning applied "almost all of the force to the forward ram located near the front of the load plate," and that the 10-45 test had "some additional lateral damage," NHTSA nonetheless concludes, without further explication, that the roof damage from the two configuration was "generally similar." NHTSA's assessment lacks scientific value, as defined by the Data Quality Act, as its assessment would not enable replication of its results to produce the same outcome.

The relevant objection from safety groups and others to the agency's pitch and roll angle determinations is that they lack any correspondence to far-side damage patterns from real-world rollover crashes and thus are not predictive of occupant injury. None of the evaluations on this point, at 70 FR 39238, evince any analysis of the connection of roof deformation to the relevant criterion – occupant injury levels.

First, the NASS-CDS comparison is flawed by its reliance on post-crash evidence of deformation. Because roof structures behave as a spring, post-crash roof crush will not show anything about the elastic response of roof ("matchboxing" or other deformation) that occurred during crash. These elastic responses are observable in any dynamic rollover test, including industry testing such as the Malibu tests. For this reason, comparing a static roof deformation pattern to a post-crash NASS vehicle image is totally unscientific.

Second, the Nissan test is limited to one roof-to-ground impact and therefore says nothing about far side impact angles. Third, the finite element modeling study produced only one set of results useful to the agency (hardly a representative sample). NHTSA states only that the different roll and pitch angles produced "similar amounts of deformation." Of course, the critical question is whether the "amount" of deformation accurately depicts real-world risks. NHTSA's work is silent.

In contrast, the ample investigations of Don Friedman and Carl Nash, submitted to the agency and yet unaccountably ignored by this discussion in the NPRM, demonstrate that the actual pitch and roll angle experienced by vehicles in dynamic rollover events are 10 and 45 degrees, respectively. This has also been demonstrated in crash test videos showing rollovers at these angles. Evidence of this more severe pitch and roll angle can be found in the NASS cases by the amount and type of front fender damage shown on rolled vehicles.

The angles are in part the result of variations in roof structure and geometry, as well as vehicle weight distribution. Because these variations also impact rollover dynamics in real-world rollover crashes, they provide further evidence of the superiority of a dynamic test, which involves a far more realistic treatment of the total rollover event.

<u>The definition of "no-contact" should encompass all roof components.</u>

Public Citizen and VPIRG support the definition of "no-contact" as encompassing all roof components, including the A and B pillars, the headers, roof side rails, roof and interior trim. Any contact may be injurious to occupants; the avoidance of contact of occupants with vehicle components is the key notion to basic safety design principles from William Haddon that occupants should be contained in a "cocoon of safety."

NHTSA Illegitimately Maintains the Static Test and Rejects a Dynamic Test

NHTSA states in the NPRM that it "determined that the roof crush patterns observed in quasi-static tests provide a good representation of the real-world roof deformations. This finding, coupled with the better consistency and repeatability of the quasi-static procedure, led the agency to conclude that the quasi-static procedure provides a suitable representation of the real world dynamic loading conditions, and the most appropriate one on which to focus our upgrade efforts."[41]

NHTSA claims that the agency's static test is capable of producing crush patterns consistent with those that occur in real-world rollovers. However, post-crash crush patterns do not indicate dynamic crush patterns. Without measuring roof crush patterns experienced during a rollover, not residual crush patterns, the agency cannot claim that the static test produces similar patterns as those experienced in real-world rollovers. Additionally, as the agency notes, dolly tests produce severe roof crush patterns—[42] more severe than those witnessed in NHTSA's static test. Yet dolly tests best simulate real-world rollovers, as vehicles actually undergo a rollover, and, according to NHTSA, produce crush patterns similar to those in real-world crashes.[43] That the roof crush in dolly tests is so much more severe than in the static tests indicates that the static test does not apply forces consistent with those experienced in real-world rollover crashes.

The agency states that it is unaware of any dynamic test procedure that provides a sufficiently repeatable test environment, and chooses instead to continue to use a static test. Dolly rollover tests, however, are repeatable from the perspective of occupant injury levels, which are more relevant than crush patterns. Injury levels are appropriately the criteria used for other safety standards such as front and side crash test requirements. Martha Bidez, Ph. D. documents the repeatability of the FMVSS 208 dolly rollover test. She states that the dolly rollover tests she analyzed were "very reliable when viewed from an occupant protection (vehicle-based) frame of reference," and were "remarkably similar in predicting the time of occurrence of absolute maximum neck loads."[44]

The Bidez work analyzing the repeatability of occupant injury metrics in industry dynamic tests should lay to rest any objection from industry that dolly rollover tests lack repeatability. The repeatability objection, generally speaking, is a canard. The auto industry first protested the "repeatability" of dynamic tests in the late 1960's in opposition to NHTSA's then-new frontal crash barrier tests – now a standard compliance test. Industry lodged similar objections over the crash test parameters for NHTSA's New Car Assessment Program for rollover propensity, which is now an accepted measurement. In each case, the industry claimed that a repeatable dynamic test could not be formulated — and yet one was developed and used by agency without serious objection.

Inherently, static roof crush tests cannot simulate real-world rollovers. A static roof crush test, such as the one proposed by the agency, is merely a component test, measuring the crush resistance of a vehicle's roof as a component part. A static test cannot measure the relationship between the roof and the other safety systems that affect injury outcome in rollovers. Only dynamic tests are capable of measuring the interrelated performance of safety features in protecting occupants from roof crush in rollovers.

In summary, a dynamic test is far superior because:

- It includes the lateral, or sliding, velocity of the road as it moves beneath the vehicle;
- It tests *both sides* of the roof – passengers sitting in the seat below the second, or trailing edge, of the roll, are the ones most often severely injured or killed.

- It shows the harm after the windshield shatters in the first impact. Although a windshield breaks on the first impact with the roof, it typically provides up to one-third of the roof's strength in the static test.
- The test shows the real dynamic of crush as a function of roof geometry (roundness, curvature, etc.).

NHTSA should subject vehicles to an FMVSS No. 208 dolly rollover test. The agency already offers the FMVSS No. 208 test as an alternative compliance option to the FMVSS No. 216 static test, clearly considering it appropriate as a roof crush resistance test. The superiority of the FMVSS No. 208 test over the agency's current static is evidenced by internal industry testing. In testing the XC90, Volvo's engineers used the FMVSS No. 208 test to measure occupant and vehicle performance in rollovers.[45] Volvo used the FMVSS No. 216 test, on the other hand, only to measure compliance with NHTSA's roof crush requirement,[46] clearly finding it bankrupt of value as a test of rollover crashworthiness or occupant containment.

The agency should subject vehicles to a dolly test that will measure occupant ejection level and contact with the vehicle's roof. This will test for all roof-crush related injuries, and all relevant safety systems to protect occupants in rollovers. The agency should develop a dummy that will accurately measure forces in a rollover, as the Hybrid III is not appropriate for use rollover tests.[47]

NHTSA should also thoroughly investigate the Jordan Rollover System (JRS) test, a repeatable rollover dynamic test. The agency has neglected to respond to multiple invitations to view the operation of this test device. It should follow up on its stated willingness, in the NPRM, to investigate this test.

The Proposal Is Based on Flawed Analysis, Evaluation of Dynamic Test Is Needed as First Step

The proposal is based on the agency's belief that "there is a relationship between the amount of roof intrusion and the risk of injury to belted occupants in rollover events."[48] While this is true, as proven by Martha Bidez's study "Roof Crush as a Source of Injury in Rollover Crashes," NHTSA provides in support a fundamentally flawed study by Kanianthra and Rains.[49] The study relies on post-crash evidence, which does not account for actual forces that cause injury in a real-world rollover, to determine if headroom reduction is related to occupant injury.

Post-crash headroom does not necessarily reflect roof crush patterns experienced during a crash. Vehicle roofs are elastic, and will often spring back from the greatest level of roof crush, resulting in post-crash roof crush that is far less than the greatest level of crush experienced during the crash. In fact, in comments to the docket, Martha Bidez notes that 2 of 3 dolly rollover tests resulted in 1 to 3 inches of increased headroom over passenger dummies that had injurious neckloads due to roof crush. A number of studies have committed the mistake of relying on post-crash headroom to determine dynamic headroom – including Austin *et al*,[50] which NHTSA cites in the agency's PRIA and uses to calculate the proposed rule's benefits[51] -- resulting in mixed conclusions that have clouded the debate on roof crush. Post-crash analyses will not allow valid conclusions as to whether roof crush causes occupant injury. Rather, analyses must rely on dynamic rollover tests that measure dummy injury levels and dynamic roof crush, such as in "Roof Crush as a Source of Injury in Rollover Crashes." *See* video submission to docket of Malibu tests.

NHTSA, however, fails to meaningfully evaluate dynamic tests, despite encouragement from lawmakers to do so in SAFETEA-LU. Dynamic tests, which allow the agency to observe rollover dynamics in real time, provide the following insights into rollover crashes, which the proposal fails to consider:

- Pitch and roll angle in real-world rollovers are greater than what is required by NHTSA's proposed static test.
- Damage to the roof occurs as the vehicle is rolling onto the second, or trailing side, of the roof at an angle greater than the 25° angle specified in the proposed rule. In addition, a majority of vehicles that roll over and injure occupants show damage to front fenders that can occur only if the vehicle's pitch angle is around 10°: substantially more than the 5° pitch angle specified in the proposed rule.
- The 5° pitch angle permits the B-pillar structure to contribute an unrealistically high proportion of the roof crush force in the proposed test.
- When the roof crushes less than 3", safety glass in side window integrity is preserved, limiting ejection.
- A 3.5 SWR is more protective than a 3.0 SWR and substantially more protective than 2.5 SWR.
- Roof crush resistance determines the performance of other vehicle safety systems.
- Residual headroom is irrelevant to an understanding of the effect of the dynamic forces in a crash, though the NPRM uses post-crash vertical-headroom as the metric for occupant injury. Auto industry dolly rollover testing shows that post-crash headroom can be greater than initial headroom, even where injurious head and neck loads are recorded during the rollover event

The Two Improvements in the Proposal over the Current Rule Should be Retained

The proposal contains two improvements over the current rule: extending application of the rule to vehicles 10,000 pounds or less, and eliminating the 5,000 pound limit on force applied to vehicles' roofs. These changes are consistent with the stated purpose of FMVSS 216, "to reduce deaths and injuries due to the crushing of the roof into the occupant compartment in rollover crashes."[52] Extending application of the rule to vehicles 10,000 pounds or less is a step towards providing occupants with adequate protection in rollover and constitutes an update to reflect current vehicle weights and uses. In 1971, such heavy vehicles were not used for passenger travel. Today, they are.

As NHTSA notes in the NPRM, more than 44 percent of new light trucks, which includes SUVs, registered in 2003 weighed more than 6,000 pounds, exempting them from the roof crush resistance standard. This loophole has left consumers without any assurance of roof crush resistance in a rollover. It is not surprising, then, that vehicles over 6,000 pounds involved in rollovers are more likely to experience average roof intrusion of at least 5.9".[53] Moreover, of vehicles over 6,000 pounds in rollover crashes, by far the greatest percentage experienced roof crush between 5.9 and 11.4 inches.[54] The proposed extension is especially critical in light of NHTSA's recent analysis showing that the rollover fatality rate for light trucks is over twice that of lighter passenger cars.[55]

The elimination of the 5,000 pound limit on force applied to vehicles' roofs will similarly hold all vehicles to the full roof crush resistance requirements. Under the current rule, vehicles weighing more than 3,333 pounds were held to a less stringent roof crush resistance standard as a result of the force limit. NHTSA's data show that vehicles weighing over 3,333 pounds experience rollover crashes. There is no reason why these vehicles should be held to a less stringent standard.

NHTSA's Cost-Benefit Analysis is Riddled with Errors and Must be Fixed

The agency's CBA suffers from errors at all levels which result in a massive underestimation of the rule's benefits and, as a result, its cost-effectiveness. NHTSA must correct these errors and re-analyze their impact on the safety standard it is developing.

<u>NHTSA slices and dices the data, statistically narrowing the benefits of the proposal.</u>

NHTSA limits its benefit analysis to "front outboard occupants who were belted, not fully ejected from their vehicles, whose most severe injury was associated with roof contact, and whose seating position was located below a roof component that experienced vertical intrusion as a result of a rollover crash."[56] The narrow scope to which NHTSA limits its analysis excludes many rollover cases in which a stronger roof likely would have reduced occupant injury. (*See* Appendix D.) This results in a substantial underestimation of the proposed rule's benefits, which creates the illusion that roof strength is ineffective in reducing occupant death and injury in rollover crashes.

- *NHTSA should not disregard ejection reduction benefits*

Probably the most glaring mistake in NHTSA's benefit analysis is that the agency neglects to consider injury and fatality reduction resulting from ejection mitigation. The benefit analysis fails to consider the detrimental effect of roof deformation on performance of other safety systems in a rollover and fails to consider the beneficial effect that increased roof strength will have on vehicles with these features.

NHTSA admits that "roof crush resistance is an integral part of the occupant protection system, necessary to ensure benefits can be obtained from designing other rollover mitigation tools (such as padding and the restraint system) to provide better protection against injuries resulting from rollover. We note that seriously and fatally injured occupants who had a non-MAIS roof contact injury may also derive some benefit from decreased roof intrusion."[57] Despite acknowledgement of these benefits, NHTSA wholly excludes ejection reduction from its benefit analysis, as well as from the design of the rule itself.

Proper performance of safety belts and side curtain airbags is important in reducing injuries suffered by occupants from contacting the inside of a vehicle during a rollover as well as in preventing ejection. Moreover, as belt use increases, the risk of partial ejection of belted occupants and of harm from roof crush increases. The proposal fails to analyze the relationship between roof crush resistance and the failure of other safety systems, even those anticipated in its comprehensive approach to rollover safety. A roof capable of deformation in a rollover crash will compromise the geometry of restraint systems attached to roof pillars and side curtain airbags, substantially reducing the ejection mitigation benefits of these systems.

- *Unbelted occupants would benefit from improved roof strength.*

The analysis also neglects unrestrained occupants, failing to recognize that roof collapse and intrusion cause a significant number of injuries to unrestrained occupants. Additionally, because roof crush can undermine belt efficacy, belted occupants are sometimes fully ejected during rollover crashes. It is likely that a number of "unbelted/ejected" occupants were actually wearing safety belts, yet were mischaracterized in data reports because they were ejected. Roof reinforcements that are strong enough to limit crush to 3" or less will greatly help to retain side window glass, thereby limiting ejection of unbelted occupants.

- *Excludes relevant cases likely to be mischaracterized in NASS.*

The analysis neglects all cases in which no injury occurred from roof contact, yet this neglects injuries without observable external symptoms. Also, as dynamic roof crush may be far greater than residual roof crush, post-crash roof deformation may suggest no contact with occupants, even though contact did occur.

The analysis also neglects cases in which no roof crush occurred, yet post-crash roof crush does not indicate dynamic roof crush, and some vehicles may exhibit no post-crash roof crush, even though roof crush occurred during the crash.

<u>NHTSA's reliance on post-crash headroom measurements is invalid and underestimates benefits.</u>

The benefit analysis also relies on post-crash analyses of rollover incidents, committing the common error of using post-crash headroom as a predictor of occupant injury levels. Looking at real-world rollover cases, the agency calculated the benefits of the proposed rule "based upon the predicted change in post-crash headroom"[58] resulting from the required increase in roof strength. NHTSA deemed that the proposed rule would have been effective in preventing occupant injury in a certain case if it would have maintained headroom where under the current rule the roof crushed to create negative or no headroom, resulting in occupant injury. As discussed above, post-crash headroom is not an accurate indicator of dynamic headroom. It is very likely that some of the occupants in the rollover cases that NHTSA used in its analysis suffered injury from roof intrusion resulting in occupant contact, even though post-crash measurements showed remaining headroom. The proposed rule may provide injury reduction in these cases, though NHTSA does not account for this in its benefit analysis.

<u>NHTSA's cost estimates lack credibility and breadth.</u>

NHTSA's cost estimates are out of date. They are based on modifications to vehicles designed more than 10 years ago and on finite element analyses of only four vehicles, and consider only using thicker metal or moderate increases in material strength. They do not consider the benefits of improved or alternative materials or designs, which auto supplier comments to the docket indicate are available.[59] For example, the Volvo XC-90 is well-known for its uses of Boron steel, a lightweight, high-strength material.

There are also several errors in the analysis. First, the agency, without any evidence or data, posits in its cost calculations that manufacturers will exceed the compliance margins by 20 percent. Yet the agency fails to include cost calculations for vehicles that currently meet or barely exceed 25 SWR and will need to similarly raise the compliance margin. These costs are likely to be significant, and could render the rule an economically significance rulemaking. Second, NHTSA compares apples and oranges by failing to calculate the effects of the 20 percent overcompliance on benefits to occupants; which for 2.5 SWR would be 3.0 and for 3.0 SWR would 3.6.

The overall effect of its current approach is to enlarge the cost estimates while minimizing the benefits. NHTSA must calculate the benefits of protection at these levels for an accurate figure on net benefits. At the least, NHTSA should provide a range of estimates and confidence bounds. At 3.6 SWR, ejection benefits for unbelted occupants will be realized.

It is also important that NHTSA provide some evidence for its assertion that vehicles will generally over-comply with the standard. As we know, Ford made the decision to creep exceedingly close to the compliance margin on the Ford Explorer. NHTSA must not claim benefits that it cannot demonstrate flow from its rule.

NHTSA's analysis, in addition, is skewed, relying upon scant and highly limited (cherry-picked) crash data. NHTSA's fundamental analysis of the benefits expected from its FMVSS 216 proposal is based on only 31 NASS cases from 1997-2002 in which there was a fatal head, face or neck injury to a restrained occupant with evidence of roof contact in the rollover of a light vehicle that was not a convertible. In twelve of these cases, the primary roof crush and injuries are a consequence of a severe pre-rollover impact. Several cases involved unrestrained or only partially restrained occupants.[60] One case was a T-top Camaro which should be considered to be a convertible. Fifteen of the 31 cases were model year 1988 to 1995 vehicles.

The NASS cases NHTSA uses in its benefits analysis do not even meet NHTSA's criteria for relevant cases. NHTSA excludes from its benefits analysis unbelted occupants, yet one and possibly two of the NASS cases involved unbelted occupants, and two occupants were wearing only either a lap belt or a shoulder belt, but not both. In addition, in twelve of the cases, vehicles suffered primary damage prior to rollover such that roof damage is not related to rollover roof damage. This kind of damage is not the subject of the damage tested for in FMVSS No. 216.

Also, NHTSA's failure to consider the benefits of an increase beyond 3 SWR is not justified and renders its analysis stunningly incomplete. Independent engineers estimate that an SWR of at least 3.5 measured under the current test is needed to adequately protect occupants in real-world rollovers. Until this base level of protection is reached, benefits from a roof crush resistance will be small, and required increases in roof strength will become more and more costly per life saved. However, once roofs are strengthened to this level, benefits will increase dramatically, greatly reducing the cost per life saved of a roof crush resistance rule. Increases in roof strength up to at least 3.5 SWR will produce minimal increases in benefits, as roof crush resistance is similarly inadequate to protect occupants in rollover crashes, though the increases will substantially increase costs. NHTSA must include a 3.5 SWR in its CBA. The relationship between benefits and roof crush resistance is not linear. Until roof strength is increased sufficiently to protect occupants, a roof crush regulation will return little benefits.

<u>NHTSA's calculation of equivalent lives saved is deficient.</u>

NHTSA calculates equivalent lives saved by assigning MAIS injuries a value that is a percentage of a fatality. For instance, according to NHTSA, the occurrence of the most severe MAIS injury is equal to .7124 deaths, and the .least severe MAIS injury is equal to .0031 deaths. However, severe MAIS injuries from rollover crashes can result in enormous medical and quality of life costs that far exceed the value assigned as a fraction of the cost of a fatality. As just one check on the validity of these numbers, NHTSA's 3.5 million estimate is far from what juries award to rollover victims. In many cases, juries award rollover victims with a sum greater than 10 times of the value NHTSA places on a life. These awards are based on detailed damages calculations of the cost and caring needed for the plaintiff and are thus a far more sensitive metric of actual costs in the case of a catastrophic injury.

<u>NHTSA's analysis also suffers from mathematical errors.</u>

In Table VII-1 on page VII-2 of the PRIA, NHTSA miscalculates the number of equivalent fatalities produces by MAIS 5 and MAIS 4 injuries. Given the conversion factor of .7124 that the agency uses for MAIS 5 injuries, 1 injury would produce .7 equivalent fatalities rounded to the nearest tenth, not .5, as the agency calculates. Also, given the conversion factor of .2153 that the agency uses for MAIS 4 injuries, 0 fatalities would produce 0 equivalent fatalities, not .1, and 65 fatalities would produce 14 equivalent fatalities, not 1.2. Correcting for these errors, the total number of equivalent lives saved under a 2.5 load factor according to approach A is 39.3, not 39.4, and for approach B is 68.4, not 55.4.

NHTSA's PRIA replicates many of the errors inherent in the general enterprise of cost-benefit analysis.

The cost-benefit and cost-utility analyses of the PRIA do not employ neutral assessments but, instead, encode value choices at every step, starting with such fundamental choices as the selection of methodology.[61]

Discounting to present value the monetization of lives saved and injuries averted using a three or seven percent discount rate is an ethically challenged approach that skews the cost-benefit comparison in favor of less stringent standards[62] and is particularly detrimental in the auto safety context, given the lag time before the new roof crush rule is fully realized in vehicles on the road. The use of industry cost estimates is another distorting choice, given the long history of industry overestimation of costs[63] and the failure to consider that imposing a stringent standard will induce the auto industry to invest in research and development that will result in innovations that, in turn, will allow the industry to come into compliance more quickly and cheaply than estimated in the PRIA.[64]

Using any cost-benefit analysis (CBA) as a roadmap for regulatory policy decisions runs the risk of distorting protective priorities. A recent article from law professor Lisa Heinzerling and economist Frank Ackerman took several major environmental and public health regulations that have long been proven beneficial, such as the ban on lead in gasoline, and showed that if we had applied currently prevailing CBA methodologies when those regulations were proposed in the 970s, CBA would have counseled against them.[65]

The use of cost estimates in policy decisions ignores another crucial equity consideration: not all costs have the same moral or ethical value. Some regulatory costs represent the cost to industry of what it should have done as a good corporate citizen in the absence of regulation, and are thus merely the appropriate price of participation in society. In this case, automakers have known for years about the costs of inaction for occupants and have instead resisted or even acted to aggravate risks.

One example of such behavior is that the Ford Explorer's roof strength was successively degraded throughout the late 1990s despite intimate knowledge of the consequences of such decisions. For another example, the Volvo XC-90 is available with safety glass in side windows in every marketplace in the world except for in the U.S., where pressure from Ford Motor Company forced its subsidiary to remove this option for consumers' improved safety.

Political decisions to do the wrong thing or a longstanding neglect of what is needed for safety should not translate into a regulatory boon that counts such items as "costs" or "burdens" on manufacturers. Economics notoriously excludes distributional and other social justice-related impacts; policy makers should not compound this error by ignoring these significant deficiencies in the practice of regulatory accounting.

NHTSA's Claim That Increasing Vehicle Weight Will Lead to Decreased Stability is Unsupported and Incorrect

NHTSA asserts that its rule should preempt state tort law jury verdicts. The agency argues that a state performance requirement for greater levels of roof crush resistance would "frustrate the agency's objectives by upsetting the balance between efforts to increase roof strength and reduce rollover propensity."[66]

In another section, NHTSA's NPRM states that "manufacturers will comply with this standard by strengthening reinforcements in roof pillars, by increasing the gauge of steel used in roofs or by using higher strength materials." At least one of these options for manufacturers would likely incur no weight change whatsoever, while the other two may incur no to minimal weight impacts. The agency's own research, cited in the NPRM, into reinforcements of a Nissan vehicle showed that such reinforcements made no measurable difference in vehicle center of gravity (CG). Similar results were reached in all other NHTSA examinations cited in the NPRM of the effects of very modest changes in weight on vehicle CG. So the agency's statements on the risk of weight changes to the roof therefore are therefore speculative and utterly unproven by evidence in the regulatory record.

Overall, NHTSA's claim that a higher standard would make vehicles more rollover prone is unsupported. Designs, materials and technologies are available (and in use in production vehicles) that can substantially increase roof crush resistance without adding significant weight to the vehicle above the center of gravity. These include eliminating weak points in current roof designs (open section structural members, holes in structural members, inadequately strong joints between structural elements, and so on) and using high strength steels, plastic inserts[67] or structural foam at key points in structural elements. Also, advanced steels and other lightweight materials can strengthen roofs without a weight increase.

Furthermore, NHTSA provides no examples of vehicles with elevated rollover risks due to the weight of the roof, making the agency's concerns at best theoretical. Rather, an examination of the vehicle fleet would show that NHTSA's concerns are unfounded, as the Volvo XC90 far exceeds NHTSA's standard and yet is one of the safest SUVs on the road. Moreover, NHTSA's own data show that "increases in roof structural strength will not have a physically measurable influence on the CG height."[68] Also, from the perspective of lives saved, NHTSA's argument is flawed. The benefit of greater occupant protection achieved by increased roof strength, and other rollover occupant protection technologies, would substantially offset any additional rollover risk created by miniscule changes in the height of a vehicle's CG.

The agency also provides no data in support of its assertion that any "requirement" beyond the 2.5 SWR would even risk weight increases or negative impacts on rollover propensity. The only study made available in the docket merely proves the obverse – that weight alterations at the 2.5 level are insignificant in their impact on CG. Nor does the agency show any impact from its assumption, in its cost analysis, that manufacturers will exceed the compliance standard by 20 percent to assure compliance. As real-world roof strength, if the agency is correct, will hover 20 percent above the standard, NHTSA's purely philosophical position that 2.5 is a magic number falls apart under the barest scrutiny. At best, it is a position rendered incoherent by NHTSA's own cost analysis.

Because the agency is statutorily charged with setting performance, and not design, standards, NHTSA's regulatory scheme can actually provide no assurance that setting the standard at 2.5 rather than 3.0 or 3.5 SWR will yield a result that does not trigger some countermanding decision by a manufacturer to respond to the rule by increasing rollover propensity. The best check on such an unintended consequence, and incentive for safe designs, is the tort system. Furthermore, NHTSA does not propose a limit to roof strength in order to prevent increases in rollover propensity, nor does it provides disincentives for when vehicles exceed the standard. NHTSA does not even suggest that it would be unsafe to exceed the standard.

Moreover, given that the agency's rule, in its own estimation, will save merely 7 percent of the affected population, its statements on preemption, and the risk that they will destroy any incentive to exceed its *de minimis* standard or to save the remaining 93 percent of affected occupants is a serious abrogation of the agency's mandate.

The agency's discussion of "requirements" is also misleading and inaccurate. No tort verdict commands a certain outcome – manufacturers are always at liberty to disregard the significance of the verdict and to pay that or future compensatory verdicts that arise. In the case of roof crush, the major domestic manufacturers have demonstrably chosen just a course, for the past decade or more, despite intense and growing media and public interest in the issue.

Because it is clear that automakers will not strengthen the roof without a regulatory requirement that they must do so, NHTSA must issue stronger regulations than contemplated in the NPRM in this area. Numerous cases challenging the weak roof crush resistance of vehicles on the road under the current standard were brought by injured plaintiffs beginning in the early 1990s and increasing in number throughout the decade. Yet automakers did not respond to those cases by increasing the strength of vehicle roof crush resistance, as one might expect. They instead dug in their heels, litigated every case, paid out settlements and imposed gag orders to keep plaintiffs from sharing evidence of the hazard with the public.

Even with regard to the particular vehicles at issue in the litigation, little effort was made to improve roof strength. For example, as NHTSA is aware from documents submitted to the agency as part of the Duncan case, throughout the late 1990s the roof of the highly controversial Ford Explorer became successively weaker. In fact, Ford Motor Company had to issue internal deviations for the vehicle, which violated the company's internal standard for roof crush resistance by a substantial margin in some model years. Yet cases concerning the adequacy of the Ford Explorer roof and its effect in exposing victims to injuries and death from roof crush were brought in the mid-1990s and only accelerated throughout the same period.

Moreover, Ford should have long been on notice of serious problems with this vehicle, as the design for the Explorer was based on the hotly litigated Ford Bronco, a notoriously rollover-prone and deadly vehicle. Bronco cases began to be litigated as early as 1988. Ford's knowledge of the poor performance of the Bronco can be seen in the company's decision to move away from naming its new model the Bronco II. Early proving ground test documents uncovered in the Ford/Firestone fiasco that show the engineers were very concerned about the poor rollover performance of the vehicle.[69]

This sad history shows that automakers' recalcitrance to make definitive safety advances in the area of roof crush resistance means that major safety advances often require regulatory action. Indeed, production of vehicles that exceed the *de minimis* NHTSA standard would enhance NHTSA's objectives in this standard and under the statutory goals of SAFETEA-LU, which are to save lives and enhance occupant protection in rollover crashes. On the positive side, the tort system has provided the agency and the public with a vastly valuable trove of industry documents showing the feasibility of the solutions and the auto manufacturers' own engineers' assessment of the risks.

Similarly, NHTSA's suggestion that a higher standard would interfere with its "comprehensive" package of rollover safety measures gets it exactly backwards. Without a strong roof, the geometry of safety belts is ruined by roof crush, making them far less effective. Without a strong roof, side windows will shatter and allow side curtain air bags to flop out through the broken window, providing little protection and increasing the risk of deadly full or partial ejection. A stronger, not a weaker, roof is required for a successful, truly comprehensive approach to rollover injury reduction.

The agency also gets it backwards in proposing preemption of the tort system to counter potential increases in rollover propensity resulting from increased roof strength. NHTSA does not propose a cap on roof strength or disincentives for vehicles that exceed a level of roof strength, such as the Subaru Forester, which tested at a SWR of 4.0. The tort system, then, would provide the best incentive for automakers to make design decisions that will not increase rollover propensity.

Effective Safety Belts Needed to Properly Restrain Occupants in Rollover Crashes; Response to Agency's Request for Comments[70]

Effective safety belts are a critical component in reducing occupant death and injury in rollover crashes. Yet research has shown for years that standard safety belt systems fail to effectively restrain occupants' motion in rollover crashes.[71] A study performed by James Pywell using rollover tests shows that a conventional safety belt system permits enough vertical and lateral movement to allow a person's head to pass through a broken side door window.[72]

According to government data for 2002, about 17 percent of belted persons killed in rollover crashes were either totally or partially ejected from their vehicle. SUV occupants fare even worse: About 1 in 5 *belted* sport utility rollover occupant fatalities were totally or partially ejected.[73] While safety belts inarguably reduce ejections in rollovers, they do not effectively prevent ejection, as they could with better design.

<u>NHTSA must update safety belt standards.</u>

Thirty years ago, NHTSA issued safety standards for belts based on simple static laboratory procedures, and the agency has not since seriously evaluated the actual real world effectiveness and relevance of those procedures and their benefit for safety. Although NHTSA has done an admirable job of devoting resources to safety belt use campaigns, the agency has simply neglected the issue of the relevance of the existing Federal Motor Vehicle Safety Standards to real-world rollover crash experience.

Safety belts need to be re-designed to better restrain occupants in rollover crashes. One design improvement is to add pretensioners. NHTSA cites research in the NPRM showing safety belt pretensioners to be effective in reducing vertical head movement,[74] yet then provides as a counter-example a Nissan study that found no reduction in occupant injury levels for dummies restrained by safety belt with pretensioner and dummies restrained by safety belt without pretensioner in modified FMVSS No. 208 rollover test. The study is flawed, however, and should not guide agency policy regarding safety belt pretensioners. The pretensioners used for the study were not designed to restrain occupants in rollovers, making the test inapplicable to pretensioners that are designed for rollover crashes.[75] Additionally, the study's finding does not necessarily mean that the pretensioners failed to restrain occupants, as occupant injury could have resulted from roof intrusion, not from the pretensioners' failure to provide additional restraint.

There are numerous on-the-shelf restraint technologies available that would significantly improve the performance of existing safety belts in rollovers, but they are not installed in the vast majority of vehicles on the road or new vehicles being produced. Proposals for various technologies and design changes to upgrade belt performance are described below.

- *Safety belts should include rollover pretensioners to eliminate dangerous amounts of belt slack in a roll.*

A pretensioner is a safety device that generates tension forces in the shoulder and/or lap belt immediately after it is activated by a crash sensing system similar to those currently used for airbag deployment, allowing for rapid removal of safety belt slack in the very early stages of a crash. (*See* Appendix E, Figure 1.) At the very beginning of a roll, the pretensioners reduce slack in the belt, drawing the occupant towards the seat and away from the roof and vehicle interior.[76]

Current production-level safety belts allow a significant amount of upper torso movement that makes occupant contact with the roof, the window, or the A or B pillars of the vehicle "very likely."[77] Emergency locking retractors — the paws within the belt system that prevent release of more belt length during a crash — may appear to lock, but they fail to roll up any belt slack that exists before the crash, allowing enough slack that the occupant's head makes contact with the roof.[78]

Simulated rollover tests show that pretensioners can reduce lateral (side-to-side) occupant movement by 15 percent and vertical (up-and-down) occupant movement by 41 percent — effectively limiting much of the motion that causes head injuries. Moreover, pretensioned belts reduce neck movement and loading on occupants by approximately 10 percent.[79]

- *Most vehicles lack rollover sensors to activate safety devices such as pretensioners when the vehicle begins to roll.*

For safety devices, such as belt pretensioners and side air bags, to be most effective, they must be triggered by a rollover sensor when a rollover is imminent, before occupants are thrown to the side by the lateral momentum of the roll. Researchers observe that an occupant's body shifts some two to three inches in the first 25 degrees of rotation of a rollover crash,[80] showing the need for a quick response.

While rollover sensors are a relatively simple technology that has been used in aviation for a long time, only the Volvo XC90, and the Mercedes SL convertible with rollover pop-up bar, currently offer a rollover sensor and pretensioner as standard equipment.

- *Emergency locking retractors must prevent belt "spool out."*

A critical aspect of safety belt performance is preventing additional webbing from coming out of the retractor after it locks. (*See* Appendix E, Figure 2.) However, a variety of belt systems allow belt webbing to spool out during a crash. Additional spool-out of webbing can allow the occupant to strike the interior of the vehicle, or even be fully or partially ejected.

Researcher Mark Arndt carried out studies using production level Emergency Locking Retractors with the vehicle upside down. Although the retractors initially locked in each test, there was a varying degree of subsequent spooling out of the belt webbing, from both rotation of the retractor spool and film spooling, which includes spooling due to simple tightening of the webbing on the retractor. The spooled-out webbing allowed an additional 18-35 mm of displacement of the vehicle's occupant.

- *The lap belt anchorage points are too far behind the occupant to effectively keep a person in the seat during a rollover.*

Motor vehicle manufacturers anchor safety belts at various locations in the vehicle. The angles created by the location of each anchor point significantly affect belt performance in a rollover crash. Because current lap belt designs are anchored behind the occupant, the belt wraps up around the occupant at an angle that is less than effective at stopping a belted passenger from moving upward when the vehicle is turning upside down. (*See* Appendix E, Figure 3.)

Tests show that three-point belt systems with a lap belt anchorage point placed more forward — and therefore under the occupant — decrease the upward occupant motion in rollovers by as much as 75 percent — thus reducing the risk that the occupant is exposed to partial ejection or contact with the roof.[81]

- *Belt buckle locks should be designed to prevent any kind of inertial unlatching.*

In addition to the other failures detailed above, some belts completely unlock during a rollover, leaving the occupant without any benefit at all.

Inertial unlatching occurs when the safety belt buckle opens due to an impact to the buckle during a crash, whether from a person's hip, a flailing limb, or even just crash forces and poor belt design. Although automakers publicly maintain that inertial unlatching does not occur, more than 150 lock-for-the-latch patents have been issued in attempts to address the continuing, but unaddressed, problem.[82]

Because inertial unlatching can be caused by the rigid connections between the buckle and floorboard or seat, merely adding a rubber isolator to the stalk could mitigate this risk. In addition, tests show that preloading of the lap belt decreases the chance that inertial unlatching will occur, suggesting that pretensioners might reduce inertial unlatching. [83]

- *Safety belts should be integrated into the seat to transfer crash energy away from the occupant.*

One of the best options to ensure the adequate fit and effectiveness of safety belts is to integrate them into the passenger seat, which often means the seat must be substantially strengthened. In integrated seats, the safety belt components are functionally incorporated into the seat, as opposed to being anchored to the body of the vehicle. This improves the ability of the safety belt system to join the occupant to the seat during a rollover, and conveys crash forces into the vehicle structure rather than the occupant.

Tests of restraint systems in which the lap and shoulder belts were integrated with the seats demonstrate that integration reduces vertical displacement by 12 percent and lateral head displacement by 13 percent. When a pretensioner was added, the integrated systems demonstrated reductions in vertical and lateral occupant displacement by 63 and 31 percent respectively.[84]

Integrated restraints increase fit and safety, but are standard in only 20 percent of the 2003 model year vehicles examined under the government's New Car Assessment Program, which tests the most widely sold vehicles.[85] (*See* Appendix F.)

- *Four-point safety belts are demonstrably more effective than three-point systems.*

Four-point restraints are standard for race car drivers but have yet to make the transition to passenger vehicles, despite their undeniable benefit of more firmly restraining a person's torso in a crash. In early 2001, Ford announced that two new four-point belts were under study, one with two shoulder belts dropping down and connecting to a center belt, the other with two shoulder belts that criss-cross the chest, but neither has been introduced into commercial vehicles to date.[86]

- *A tightened D-ring shoulder belt adjuster reduces occupant movement during a rollover.*

The adjustable D-ring is a popular enhancement to belt systems that allows vehicle occupants to adjust the tension and fit of the shoulder belt. Dynamic rollover tests have demonstrated that having the D-ring in an upper position, which produces the greatest shoulder belt tension, can reduce vertical head excursion by 8 percent compared to when the D-ring is in a lower position. The upper D-ring position also significantly reduces horizontal and lateral head excursion.[87]

- *Cinching safety belt latch plates reduces occupant movement upwards.*

Safety belts with "pass-through" latch plates, used in most vehicles and depicted below, have generally not performed well in simulated rollover "spit" tests and staged rollovers.

Cinching latch plate designs, like the ones used in airplanes that allow occupants to tighten the belt on their laps, do better in rollovers.[88] Studies comparing pass-through and cinching latch plate designs have found that cinching latch plates can provide as much as a six inch reduction in occupant movement upwards — preventing roof contact.[89]

- *Inflatable safety belts would improve belt performance in rollovers.*

Inflatable Tubular Torso Restraint (ITTR), an inflatable section integrated into a shoulder belt portion, (*see* Appendix E, Figure 4) is currently available in only a very limited number of vehicles. However, rollover tests with the ITTR show a 60 to 75 percent reduction in horizontal and vertical vehicle occupant excursion compared to use of a standard three-point restraint.[90] This technology was first demonstrated in the 1970s by Chrysler in NHTSA's Research Safety Vehicle program.

Conclusion

NHTSA's proposal insufficiently improves the safety of occupants in rollover crashes. It fails to increase roof strength to protect against injuries resulting from roof intrusion contact and entirely neglects to account for injuries resulting from roof crush–related ejection, as well as the proper interaction of safety systems that are contingent upon roof performance. The proposal will provide only minimal benefits in reducing occupant death and injury in rollover crashes.

Additionally, the proposed compliance test fails to simulate real-world rollover crash dynamics, rendering it near-worthless as a measure of roof performance in rollover crashes and undermining the value of the proposed roof crush resistance standard.

NHTSA must issue a supplementary notice of proposed rulemaking that establishes a roof crush resistance standard that protects occupants from contact with crushing roofs as well as crush-related ejection, ensuring proper interaction between the roof and other safety systems. Because of the inherent deficiencies of a static test, the agency must require a dynamic test a dynamic compliance test. In this supplemental notice, NHTSA should also retract its harmful and unnecessary statements on preemption.

Endnotes

[1] According to NHTSA, SUV registrations increased in 2004 by 11 percent from 2003. *See* National Center for Statistics and Analysis, National Highway Traffic Safety Administration, 2004 Annual Assessment of Motor Vehicle Crashes. Washington, DC: NHTSA, August 2005, at 92.
[2] National Center for Statistics and Analysis, National Highway Traffic Safety Administration, 2004 Annual Assessment of Motor Vehicle Crashes. Washington, DC: NHTSA, August 2005, at 96.
[3] Kahane, C.J., "An Evaluation of Door Locks and Roof Crush Resistance of Passenger Cars," NHTSA Report Number DOT HS 807 489, November, 1989.
[4] 70 FR 49243.
[5] 70 FR 49225.
[6] Don Friedman's statement is available at http://www.citizen.org/documents/ACFA5C.pdf. His presentation is available at http://www.citizen.org/documents/ACFB370.pdf.
[7] *See* "B-Pillar_spltscrn,"video submission from Public Citizen to the docket, November 21, 2005., which shows elasticity of roof and dynamic headroom.
[8] Volvo, "Safety Product Development -- XC90," slide 20.
[9] Mathew Reynolds, Daimler Chrysler; Letter to Dr. Runge, December 3, 2001; NHTSA-1999-5572-18.
[10] Martha W. Bidez, Ph.D.; John E Cochran, Ph.D., J.D., P.E.; and Dottie King, M.A. "Roof Crush as a Source of Injury in Rollover Crashes; An Independent Analysis of Autoliv SUV Rollover Tests B190043, B190042, B180220, B180219." March 30, 2005, at 25.
[11] 70 FR 49243.
[12] Glen C. Rains and Michael A. Van Voorhis, "Quasi Static and Dynamic Roof Crush Testing," National Highway Traffic Safety Administration, June 1998, at 18.
[13] Stephen A. Batzer, NHTSA-2005-22143-72, September 29, 2005, at 2. Available at http://dmses.dot.gov/docimages/pdf93/347017_web.pdf.
[14] *Id.*
[15] Don Friedman, "Deficiencies of NHTSA's Current and Proposed Static, One-Sided Test of Roof Strength, FMVSS 216," April 11, 2005 at 22.
[16] Carl Nash, Ph.D., Jack Bnish, Ph.D., Allan Paskin, and Donald Friedman; "Amending the Roof Crush Resistance Standard;" August 31, 2004; at 4. Submitted as attachment to NHTSA-1999-5572-97, available at http://dmses.dot.gov/docimages/pdf89/295078_web.pdf.
[17] Carl Nash, Ph.D., Jack Bnish, Ph.D., Allan Paskin, and Donald Friedman; "Amending the Roof Crush Resistance Standard;" August 31, 2004; at 4. Submitted as attachment to NHTSA-1999-5572-97, available at http://dmses.dot.gov/docimages/pdf89/295078_web.pdf.
[18] 70 FR 49230. The agency does not submit the dynamic tests to the public.
[19] *See* "XC90_rollover_slomo,"video submission from Public Citizen to the docket, November 21, 2005. which shows good roof performance in dolly rollover test of Volvo XC90.
[20] Plungis, Jeff. "Memos: Fprd Made Explorer Roof Weaker," *Detroit News*, Mar. 29, 2005.
[21] Title X, Subtitle C, Sec. 10301, available at http://thomas.loc.gov/cgi-bin/query/D?c109:2:./temp/~c109H0HGim::
[22] Glen C. Rains and Michael A. Van Voorhis, "Quasi Static and Dynamic Roof Crush Testing," National Highway Traffic Safety Administration, June 1998.
[23] *Id* at i.
[24] *Public Citizen v. Mineta*, 340 F.3d 39, (2nd Cir. 2003).
[25] Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis; "FMVSS 216, Upgrade Roof Crush Resistance"; NHTSA, August 2005, at V-12.
[26] Real-world rollover performance of an XC90 showing good structural integrity was recorded in NASS-2003-79-57.
[27] 70 FR 49228.
[28] *See* the Intermodal Surface Transportation Efficiency Act of 1991: USCA § 1392 at sec. 2503.
[29] *See* 59 F.R. 33254, 33255 (June 8, 1994).
[30] *See* Comments of Public Citizen, 49 CFR Parts 575: Docket No. NHTSA-2001-9663; Notice 2: "Consumer Information Regulations; Federal Motor Vehicle Safety Standards; Rollover Resistance."
[31] 70 FR 49241.
[32] 70 FR 49237.

[33] 70 FR at 49237.
[34] Parenteau, Chantal, Madana Gopal, David Viano. ''Near and Far-Side Adult Front Passenger Kinematics in a Vehicle Rollover.'' SAE Technical Paper 2001–01–0176, SAE 2001 World Congress, March 2001.
[35] 70 FR 49239.
[36] 70 FR 49239.
[37] Michael J. Leigh, and Donald T. Willke, "Upgraded Rollover Roof Crush Protection; Rollover Test and NASS Case Analyses," June 1992 at 3 and 4.
[38] Carl Nash, Ph.D., "NASS Cases Analyzed by NHTSA for Proposed Amendment of FMVSSS 216, submitted to NHTSA-2005-22143.
[39] 70 FR 49238 – 49239.
[40] Don Friedman, "Deficiencies of NHTSA's Current and Proposed Static, One-Sided Test of Roof Strength, FMVSS 216," April 11, 2005 at 20 and 21.
[41] 70 FR 49231.
[42] 70 FR 49231.
[43] Michael J. Leigh, and Donald T. Willke, "Upgraded Rollover Roof Crush Protection; Rollover Test and NASS Case Analyses," June 1992 at 30.
[44] Martha W. Bidez, Ph.D.; John E Cochran, Ph.D., J.D., P.E.; and Dottie King, M.A. "Roof Crush as a Source of Injury in Rollover Crashes; An Independent Analysis of Autoliv SUV Rollover Tests B190043, B190042, B180220, B180219." March 30, 2005, at 29.
[45] Volvo, "Safety Product Development -- XC90," slide 18.
[46] Volvo, "Safety Product Development -- XC90," slide 18.
[47] Don Friedman and Keith Friedman, "Upper Interior Head, Face and Neck Injury Experiments," Paper Number 98-S8-P-11, at 1773.
[48] 70 FR 49231.
[49] Joseph Kanianthra and Glen Rains, "Determination of the Significance of Roof Crush on Head and Neck Injury to Passenger Vehicle Occupants in Rollover Crashes," SAE Paper 950655, Society of Automotive Engineers, Warrendale, PA, 1994.
[50] Rory Austin, Maurice Hicks, Stephen Summers. "The Role of Post-Crash Headroom in Predicting Roof Contact Injuries to the Head, Neck, or Face During FMVSS 216 Rollovers," NHTSA, 2003, internal report, not yet published.
[51] Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis; "FMVSS 216, Upgrade Roof Crush Resistance"; NHTSA, August 2005, at IV-2.
[52] 49 C.F.R. 571.216.S2.
[53] 70 FR 29233.
[54] 70 FR 49229.
[55] National Center for Statistics and Analysis, National Highway Traffic Safety Administration, 2004 Annual Assessment of Motor Vehicle Crashes. Washington, DC: NHTSA, August 2005, at 96.
[56] 70 FR 49224.
[57] 70 FR 49229.
[58] Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis; "FMVSS 216, Upgrade Roof Crush Resistance"; NHTSA, August 2005, at IV-4.
[59] *See* NHTSA-2005-22143-87 at http://dmses.dot.gov/docimages/pdf93/364709_web.pdf.
[60] One was wearing only the lap belt while one was wearing only the automatic shoulder belt. One was unrestrained and one was described in the crash description as being unrestrained while he was coded as being restrained.
[61] David Driesen, *Is Cost-Benefit Analysis Neutral?: An Analysis of the Bush Administration's Approach to Environmental, Health, and Safety Protections* (Center for Progressive Reform White Paper No. 507, June 2005), *available at* http://progressiveregulation.org/articles/CBA_Driesen_507.pdf; Lisa Heinzerling, *The Rights of Statistical People*, 24 HARV. ENVTL. L. REV. 189 (2000).
[62] *See* Lisa Heinzerling, *Discounting Our Future*, 34 Land & Water L. Rev. 39 (1999); Lisa Heinzerling, *The Perils of Precision*, ENVTL. FORUM, Sept.-Oct. 1998, at 38; Lisa Heinzerling, *Regulatory Costs of Mythic Proportion*, 107 YALE L.J. 1981 (1997-98); Richard W. Parker, *Is Government Regulation Irrational?: A Reply to Morrall and Hahn*, working paper available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=588881 (2004).

[63] *See* OMB Watch, *The Going-Out-of-Business Myth* (July 2005), *available at* http://www.ombwatch.org/regs/cba/outofbusinessmyth.pdf; Ruth Ruttenberg & Assocs., Public Citizen, *Not Too Costly, After All: An Examination of the Inflated Cost-Estimates of Health, Safety, and Environmental Protections* (2004), *available at* http://www.citizen.org/documents/ACF187.pdf; Thomas O. McGarity & Ruth Ruttenberg, *Counting the Cost of Health, Safety, and Environmental Regulation*, 80 TEXAS L. REV. 1197 (2002); Eban Goodstein, *Polluted Data*, AMERICAN PROSPECT, Nov.-Dec. 1997, at 64, *available at* http://www.prospect.org/web/page.ww?section=root&name=ViewPrint&articleId=4757 ; Office of Tech. Assessment, U.S. Cong., *Gauging Control Technology and Regulatory Impacts in Occupational Safety and Health: An Appraisal of OSHA's Analytical Approach* (Rep. No. OTA-ENV-635, Sep. 1995), *available at* http://www.wws.princeton.edu/~ota/disk1/1995/9531_n.html.

[64] OMB Watch, *Regulation and Competitiveness* (Aug. 2005), *available at* http://www.ombwatch.org/regs/2005/issuebriefs/competitiveness.pdf; David M. Driesen, *Design, Trading, and Innovation*, *forthcoming in* MOVING TO MARKETS IN ENVIRONMENTAL PROTECTION: LESSONS AFTER 20 YEARS OF EXPERIENCE (Jody Freeman & Charles Kolstad eds., Oxford UP), *available at* < http://papers.ssrn.com/sol3/papers.cfm?abstract_id=770424>.

[65] Frank Ackerman, Lisa Heinzerling, & Rachel Massey, *Applying Cost-Benefit to Past Decisions: Was Environmental Protection* Ever *a Good Idea?*, 57 ADMIN. L. REV. 155 (2005).

[66] 70 FR 49245.

[67] L & L Products has an innovative approach to using Composite Body Solutions, plastic inserts at weak points in structural elements, to improve structural crashworthiness performance.

[68] 70 FR 49234.

[69] The documents are available on the Public Citizen Web site at: http://www.citizen.org/autosafety/suvsafety/ford_frstone/

[70] Public Citizen submitted an in-depth report addressing the dangers of safety belt failure in rollover crashes to NHTSA-1999-5572. The agency makes no mention of the report in the current proposed rulemaking. NHTSA should consider the report in the current rulemaking, particularly in addressing safety belt performance in rollover crashes. The report is available at NHTSA-1999-5572-111.

[71] Friedman, Donald *at el.*, *Roof Collapse and the Risk of Severe Head and Neck Injury* (Paper S6-O-11), Paris: 13th ESV Conference, Dec. 1991, at 753

[72] Pywell, James *et al.*, *Characterization of Belt Restraint Systems in Quasistatic Vehicle Rollover Tests* (SAE Paper 973334), 1997, at 269, 270.

[73] National Center for Statistics and Analysis, National Highway Traffic Safety Administration, Occupant Fatalities in Vehicles with Frontal Impact, Side Impact, Rear Impact, or Rollover, by Year, Restraint Use, Ejection, and Vehicle Body Type. FARS 1992-2001 FINAL & 2002 ARF, Washington, DC: NCSA, Sept. 2003.

[74] Pywell, James *et al.*, ''Characterization of Belt Restraint Systems in Quasi-Static Vehicle Rollover Tests,'' SAE Paper 973334, Society of Automotive Engineers, Warrendale, PA, 1997; and Moffatt, Edward *et al.*, ''Head Excursion of Seat Belted Cadaver, Volunteers and Hybrid III ATD in a Dynamic/Static Rollover Fixture,'' SAE Paper 973347, Society of Automotive Engineers, Warrendale, PA, 1997.

[75] M.G.C. Rekveldt, MSc., and K. Labibes, Ph.D., "Literature Survey on In-vehicle Safety Sevices," TNO Automotive, May 9, 2003 at 14.

[76] Herbst, Brian; Stephen Forrest; Philip Wang; David Chng; Donald Friedman. *The Ability of Three-Point Safety Belts to Restrain Occupants in Rollover Crashes* (ESV Paper 96-S5-0-12), Melbourne: 15th ESV Conference, 1996. 847.

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[79] *Id.* at 270-271.

[80] Pywell, James; Stephen Rouhana; Joseph McCleary; Kenneth DeSaele. *Characterization of Belt Restraint Systems in Quasistatic Vehicle Rollover Tests* (SEA Paper 973334), 1997. 269, 270.

[81] Herbst, Brian; Stephen Forrest; Philip Wang; David Chng; Donald Friedman. *The Ability of Three-Point Safety Belts to Restrain Occupants in Rollover Crashes* (ESV Paper 96-S5-0-12), Melbourne: 15th ESV Conference, 1996. 846.

[82] Andrews, Stanley; H. Alex Roberts; Joseph F. Partain; David A. Renfroe. *Dynamic Characteristics of End Release Seatbelt Buckles* (ESV Paper 97), Farmington: Renfroe Engineering, Inc., 2001. 1, 2.
[83] *Id.* at 1, 8.
[84] Pywell, James; Stephen Rouhana; Joseph McCleary; Kenneth DeSaele. *Characterization of Belt Restraint Systems in Quasistatic Vehicle Rollover Tests* (SEA Paper 973334), 1997. 271.
[85] *Buying a New Car 2003*. National Traffic Safety Administration, 20 Nov. 2003. <http://www.nhtsa.dot.gov/cars/testing/NCAP/BASC2003/safe1.html>.
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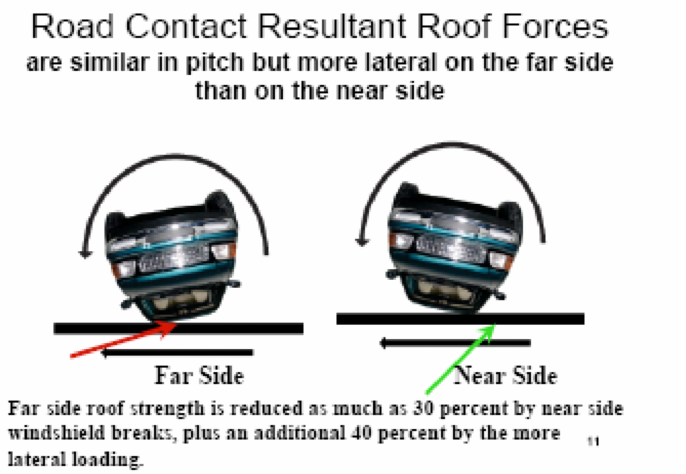
[87] Rains, Glen; Jeff Elias; Greg Mowry. *Evaluation of Restraints Effectiveness in Simulated Rollover Conditions* (ESV Paper 98-S8-W-34), Washington, DC: National Highway Traffic Safety Administration, 1998. 1899-1904.
[88] A "spit" rollover test involves a testing device that grasps the vehicle on ether end of its horizontal longitudinal axis, and, holding the vehicle upside down, moves the vehicle down at an angle until it contacts a simulated moving roadway and completes one roll. The test accurately simulates real-world rollover damage and injuries, and the test is repeatable.
[89] Dr. Carley C. Ward, Belt Loads with Passive Restraint Systems, paper presented at 1996 Annual Meeting, American Academy of Forensic Sciences.
[90] Rains, Glen; Jeff Elias; Greg Mowry. *Evaluation of Restraints Effectiveness in Simulated Rollover Conditions* (ESV Paper 98-S8-W-34), Washington, DC: National Highway Traffic Safety Administration, 1998. 1900, 1908.

Appendix A

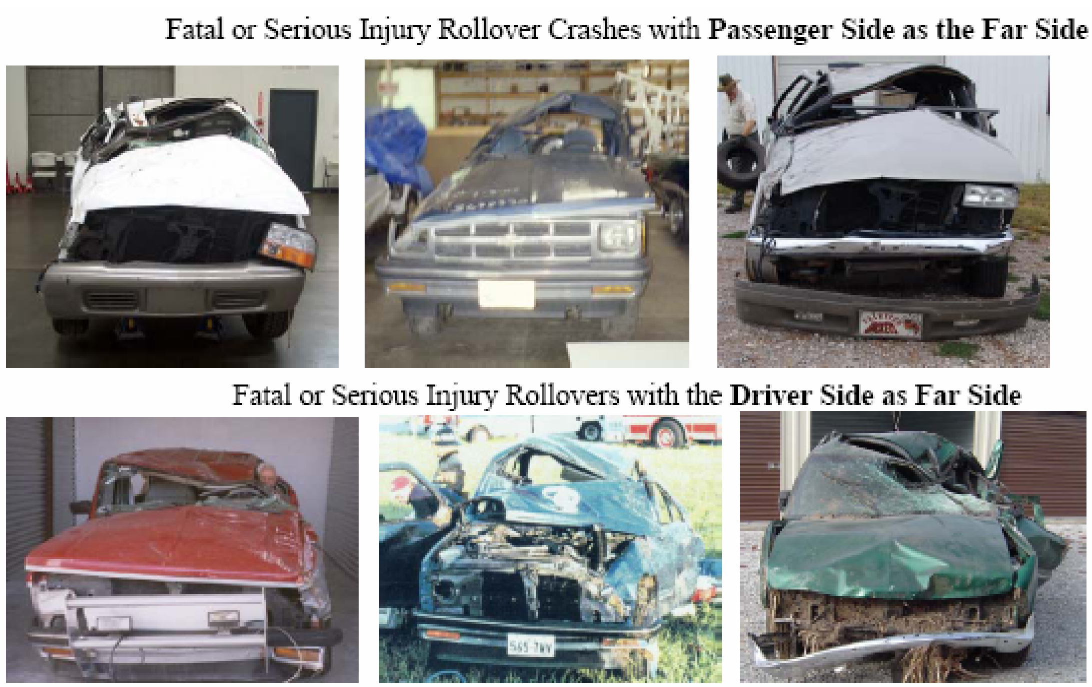
Roof crush can result in distortion that shifts a roof to the side of its original position over occupants' heads. In cases in which this occurs, properly restrained occupants in an upright seating position can be partially ejected through side windows, which are likely to shatter. The picture below demonstrates this danger.

Appendix B

In a rollover, the far side of a vehicle experiences loading at greater roll angle, moving crash forces away from the B-pillar and towards the center of the roof, which is less structurally sound.

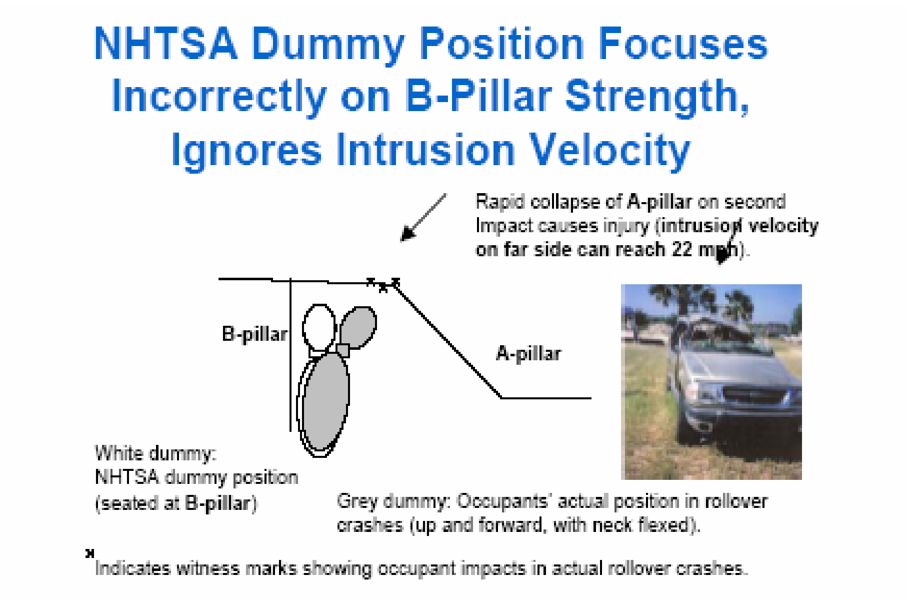


Below are vehicles involved in real-world rollover crashes showing severe roof crush to the far side of the vehicle.



Appendix C

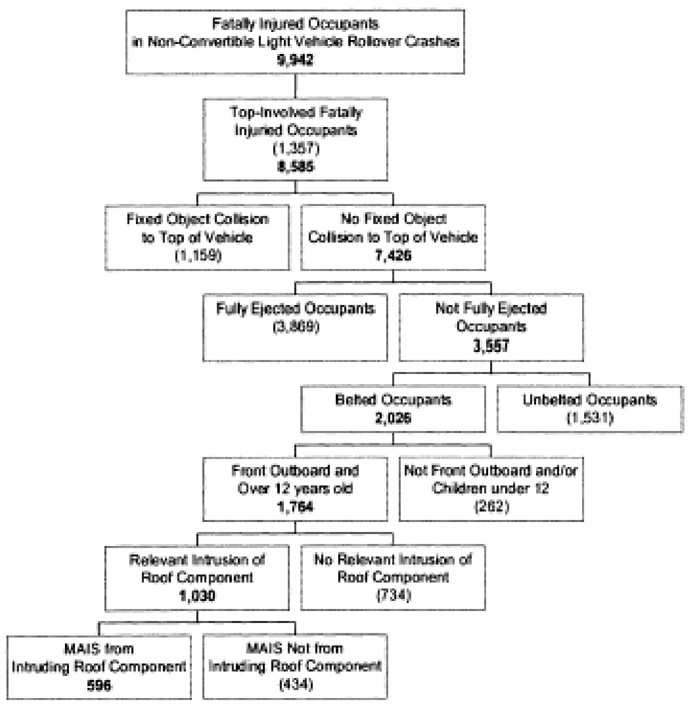
Due to the weight of the engine, vehicles pitch forward in rollovers at an angle of 10 degrees or more, which throws occupants forwards toward the A-pillar. NHTSA's proposed test applies force to vehicles' roofs at an angle of 5 degrees, exerting force mostly to the B-pillar and not the A-pillar. Without being stringently tested by NHTSA's roof crush test, A-pillars in the vehicle fleet are weak, exposing occupants to significant danger of head or neck injury in rollovers.



Appendix D

NHTSA's analysis whittles away the population affected by the rule to arrive at the estimate that the rule offers potential benefits for only 596 of 9,942 non-convertible rollover fatalities. The agency neglects key portions of the population that would benefit from increased roof strength such as fully ejected and unbelted occupants.

Population Affected by this Proposal.



Source: NHTSA – 70 FR 49230.

Appendix E

Figure 1

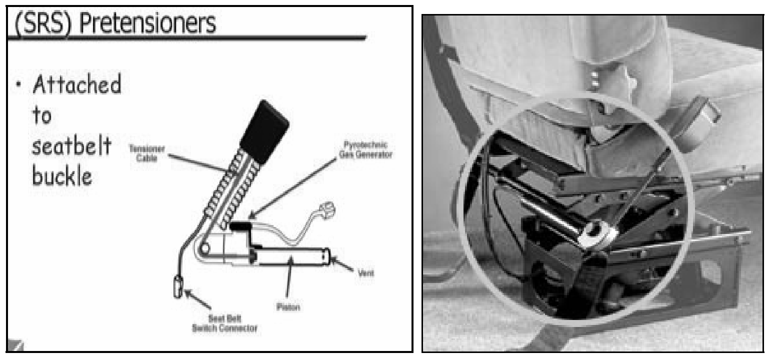


Figure 2

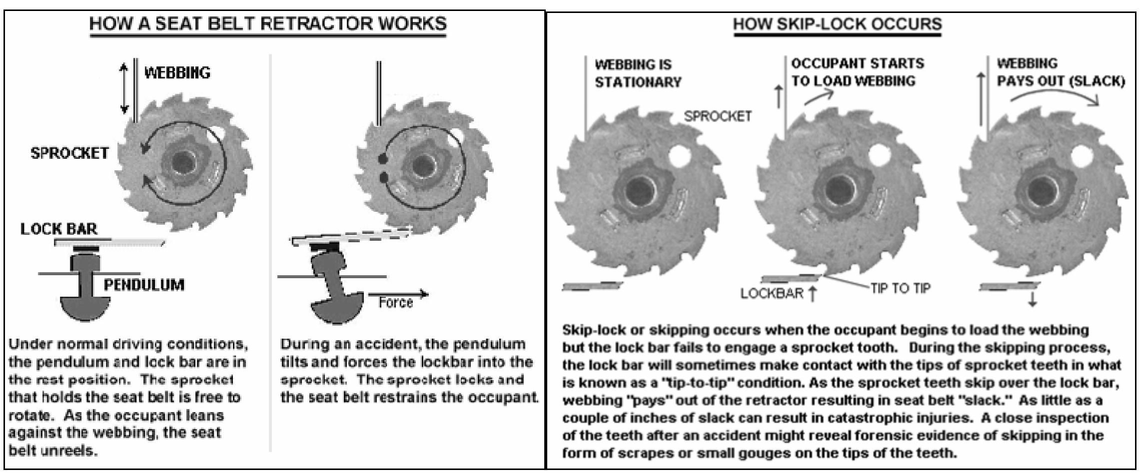


Figure 3

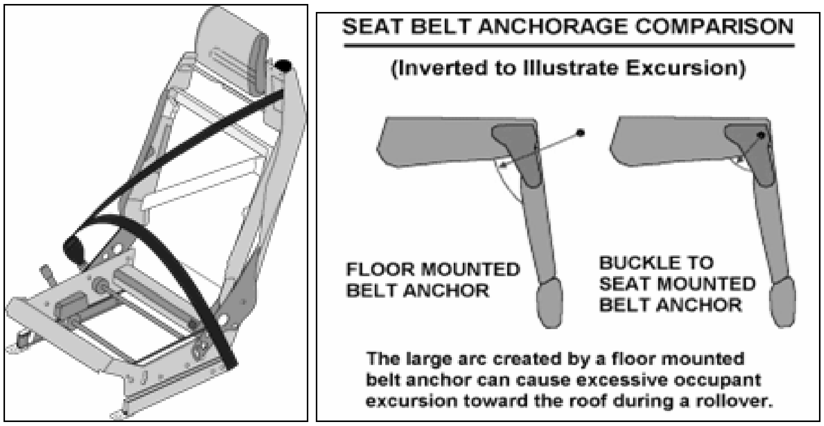


Figure 4

Source: "General ITTR Information Forward-facing Seat Application," Inflatable Safety Systems, Simula Safety Systems, Inc. Available at: http://www.tslaerospace.com/product/simula/PDF/ITTR%20Forward%20Facing%20Flyer.pdf.

Appendix F

NCAP-TESTED 2003 MODEL YEAR VEHICLES WITH INTEGRATED SAFETY BELTS

Key: S = Standard
A = Available

Make	Model	Integrated Seat Belt
Acura	MDX	S
BMW	3 Series	S
BMW	3 Series/M3 2-DR	S
BMW	3 Series/M3 Convertible	S
BMW	3 Series Sports Wagon	S
BMW	5 Series	S
BMW	7 Series	S
BMW	Alpina Roadster	S
BMW	X5	S
Buick	LeSabre	S
Buick	Park Avenue	S
Cadillac	CTS	S
Cadillac	De Ville	S
Cadillac	Escalade	S
Cadillac	Escalade EXT	S
Cadillac	ESV	S
Cadillac	Seville	S
Chevrolet	Avalanche	S
Chevrolet	Silverado	S
Chevrolet	Silverado Crew Cab	S
Chevrolet	Silverado ExCab	S
Chevrolet	SSR	S
Chevrolet	Suburban	S
Chevrolet	Tahoe	S
Chevrolet	Trailblazer	S
Chevrolet	Trailblazer EXT	S
Chrysler	Sebring Convertible	S
Ferrari	456 M	S
Ford	Expedition	S
Ford	Explorer	S
Ford	Explorer Sport Trac	S
Ford	F-150 ExCab	A
Ford	F-150 King Ranch Crew	S
GMC	Envoy	S
GMC	Envoy XL	S
GMC	Sierra	S
GMC	Sierra Crew Cab	S
GMC	Sierra ExCab	S
GMC	Yukon	S
GMC	Yukon XL	S
GMC	Yukon Denali	S
GMC	Yukon Denali XL	S
Honda	Insight	S
Honda	Odyssey	S
Honda	Pilot	S
Hyundai	Elantra	S
Isuzu	Ascender	S
Lexus	GX470	S
Lexus	LX470	S
Lexus	RX300	S
Lincoln	Aviator	S
Lincoln	Navigator	S
Mercedes Benz	CL-Class	S
Mercedes Benz	SL-Class Convertible	S
MINI	Cooper/ Cooper S	S
Oldsmobile	Aurora	S
Oldsmobile	Bravada	S
Pontiac	Bonneville	S
Saturn	VUE	S
Toyota	4-Runner	S
Toyota	Highlander	S
Toyota	Land Cruiser	S
Toyota	Sequoia	S
Volvo	V40	S
Volvo	V70	S
Volvo	XC70	S

Source: National Highway Traffic Safety Administration

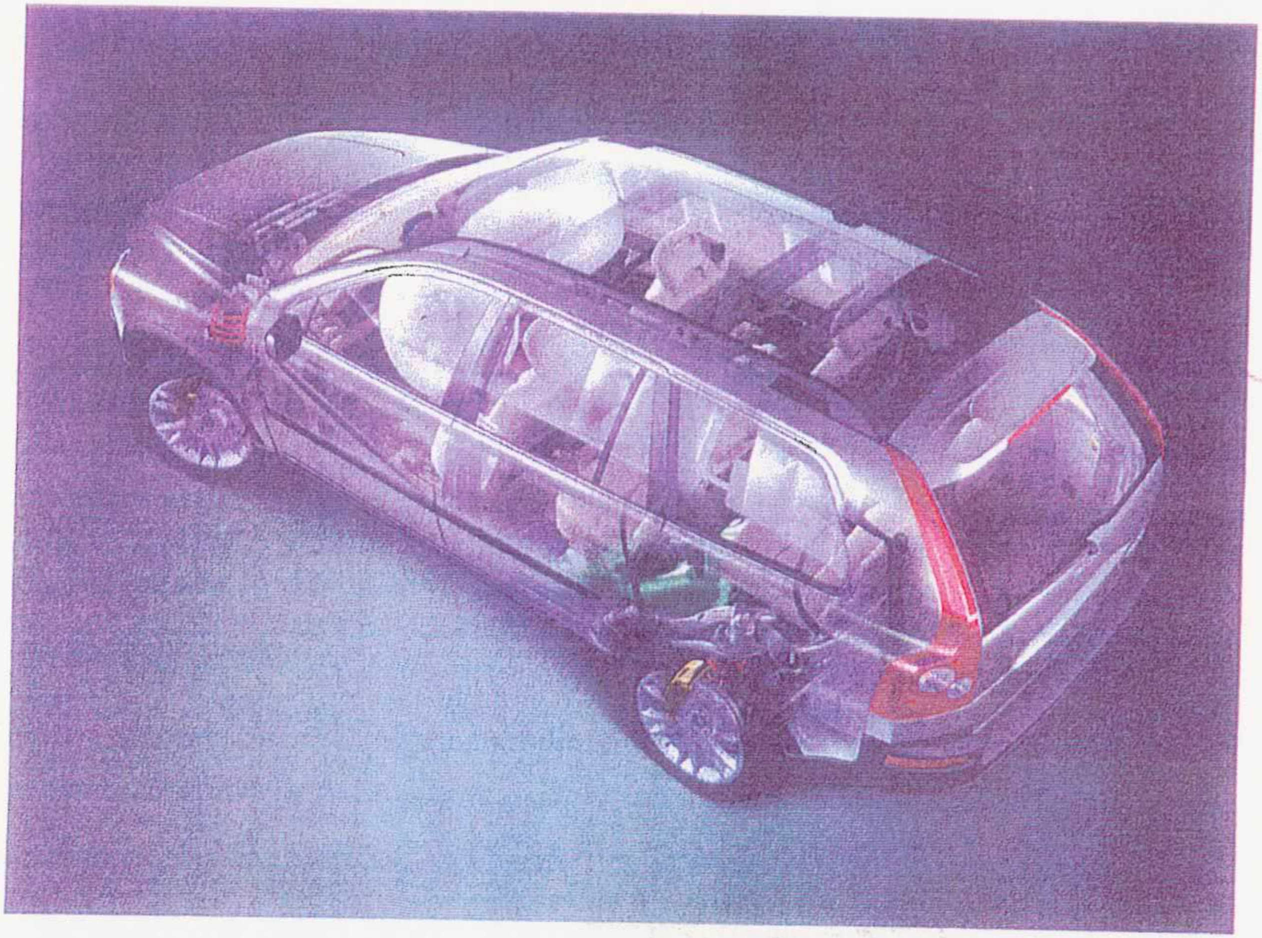
Appendix G

Following is an internal document used in the development of the Volvo XC90.

5-4-04 PM
EXHIBIT
WIKMAN 9

PRODUCED BY FORD SUBJECT TO A NON-SHARING PROTECTIVE ORDER

Safety Product Development - XC90



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XC90 Safety Target

Make a safe car for the occupants and the traffic environment

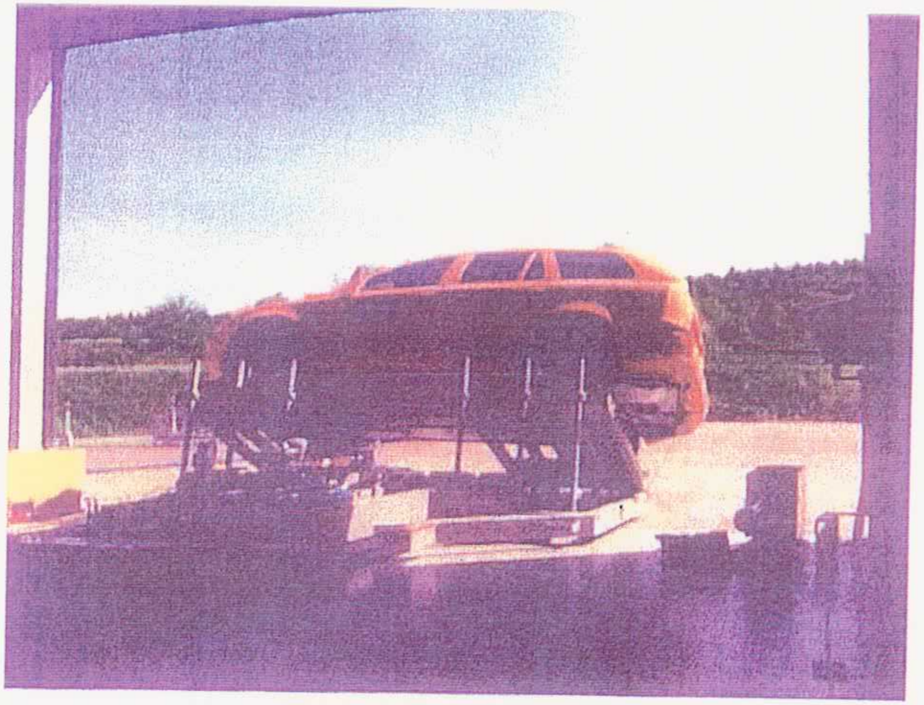
- Real life safety!

XC90 Safety Challenge

Focused areas when creating a Volvo SUV, based on field accident research:

- Rollover
  - Prevention
  - Protection
- Compatibility
  - Must cover all crash situations including.
  - SUV vs. other Cars
- Third row seat safety
  - Rear, Side and Rollover

XC90
Rollover Protection



XC90 Safety Product Development
Slide 4

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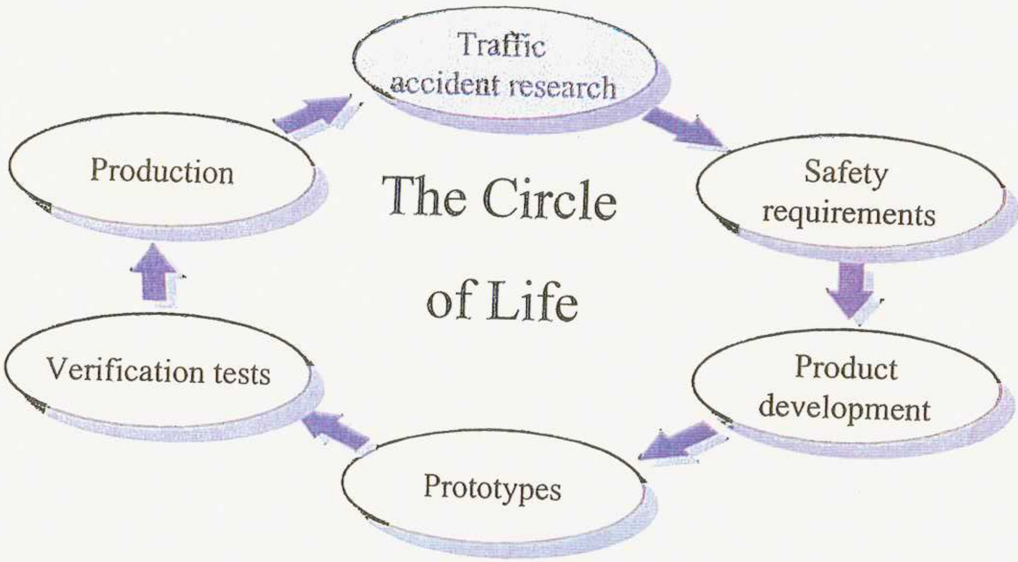
Volvo Safety Work

Continuously improving real life safety

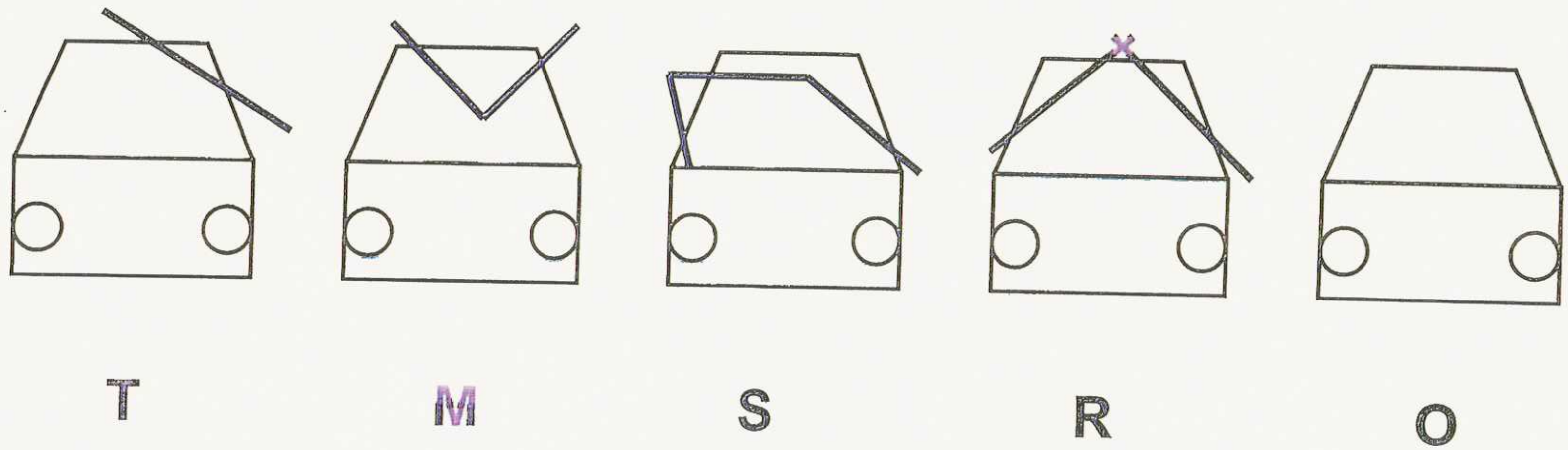


Findings from the statistical databases (STO, NASS):

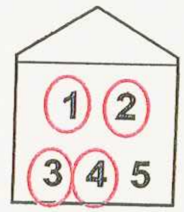
- Head and neck/spine are most frequently injured
- Higher amount of chest injuries in NASS compared to STO
- In-depth sample slightly more extensive car deformation
- Number of turns and ground contacts show similarities between samples

Traffic accident research

Upper Structure Deformation Modes



Traffic accident research



Field case D

Max roof def. 25 cm at passenger side

Driver: (F 27 yr)
AIS 0

Pass (2): (M 31 yr, 77 kg)
AIS 6 head, face: crush inj

- inj head in contact with roof, ground

Pass (3): (F 1yr - ejected, unbelted)
AIS 5 head: concussion
AIS 3 head: fracture
AIS 3 chest: lung rupture

ejected

Pass (4): (F 2yr - unbelted)
AIS 1 spine: cut

unbelted

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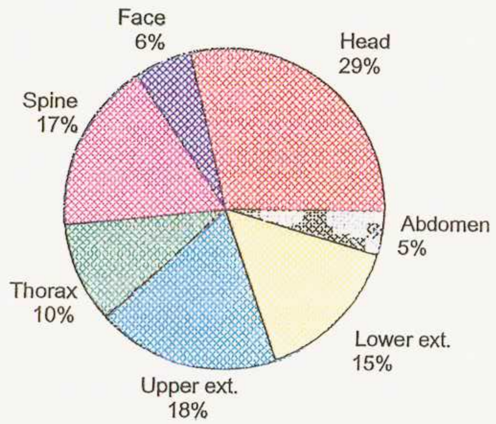
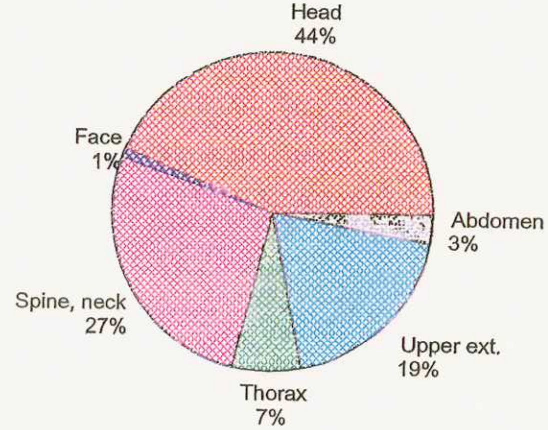
Traffic accident research

Distribution of AIS 2+ injuries by body area
Belted occupants NASS 93-95



Rollovers and multiple events including rollover
87 injuries AIS 2+

Distribution of AIS 2+ injuries by body area
Belted occupants Volvo database



"Pure" rollovers (no multiple events)
101 injuries AIS 2+

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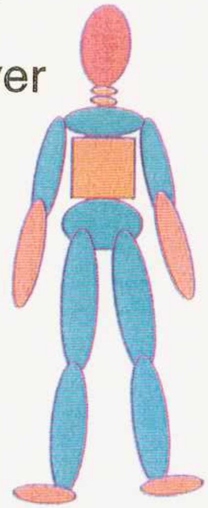
Traffic accident research

Conclusions

Belted occupants:

- The head and neck/spine were found to be the most frequently injured body parts
- Partial ejection of the head caused the most severe injuries
- New rollover requirements and test methods needed to cover real life situations



Unbelted occupants:

Will have no benefit from improved seatbelt
also less benefit from improved roof structure

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Fact

- Field data with belted occupants shows that the majority of injuries in rollover accidents are related to the head and spine caused by impacts and partial ejection

Main design objective

- Eliminate head impacts and partial ejection in rollover accidents

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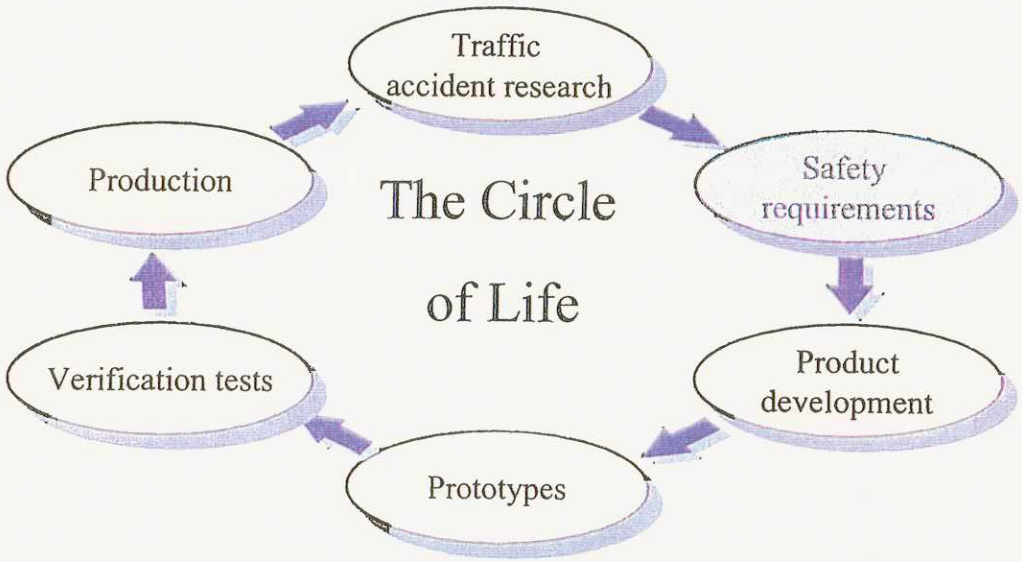


Requirements on a new Volvo SUV

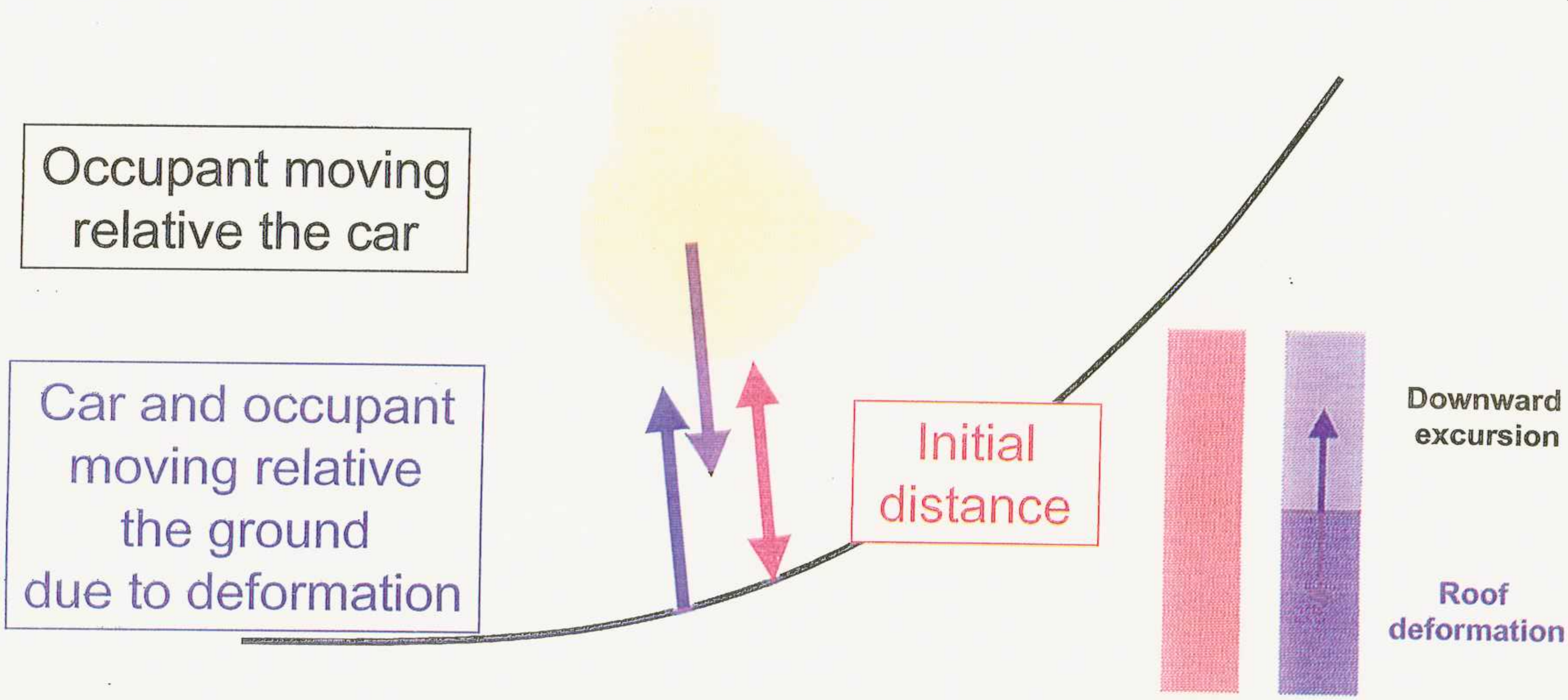
- Same injury mechanisms in cars and SUV's.
- SUV's in general more exposed to rollover accidents

Main design objective

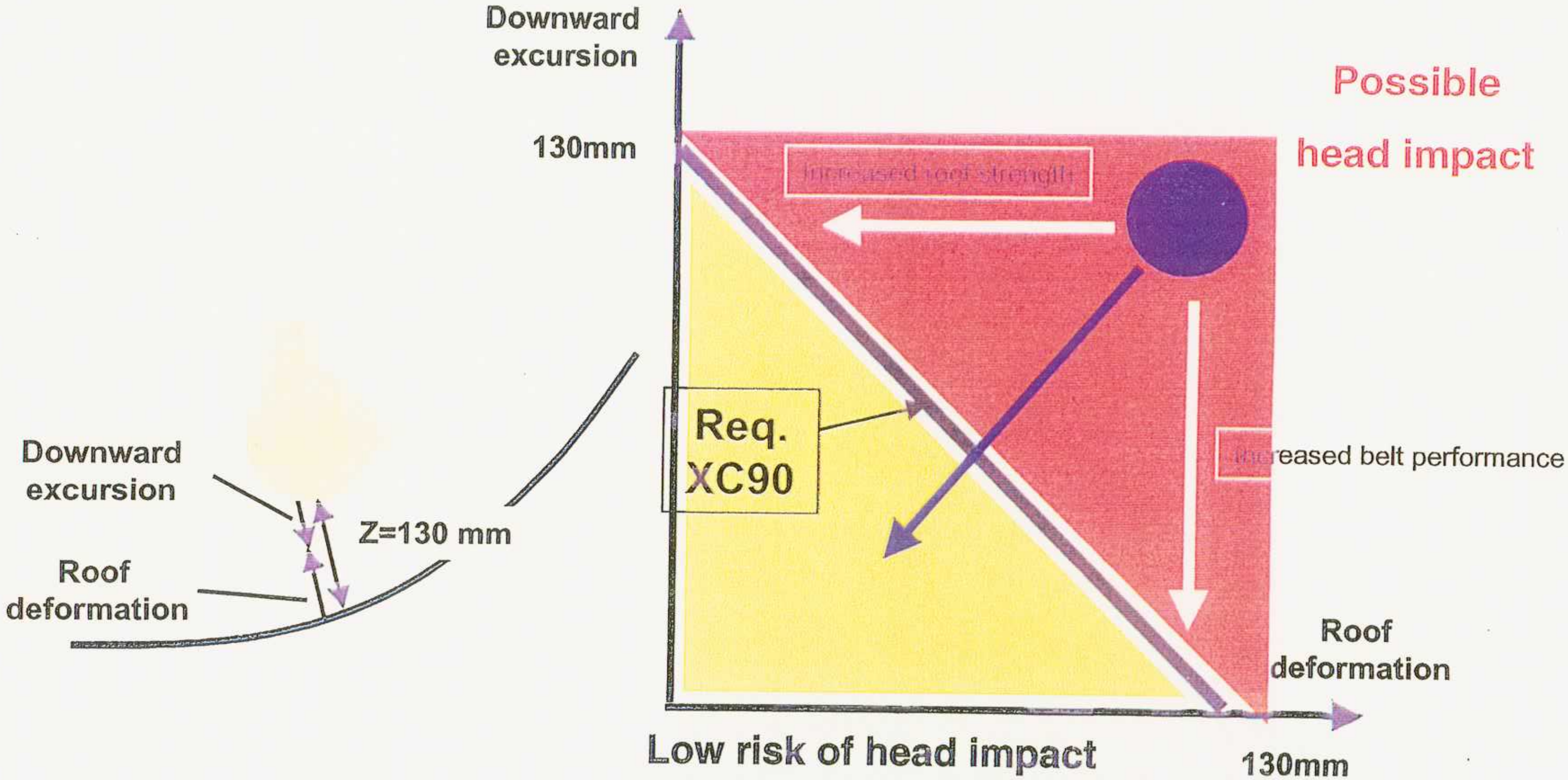
- Eliminate head impacts and partial ejection in rollover accidents

Basic Requirement:
No contact between head and roof

Occupant movement relative the ground



Rollover deformation schematic



Considered parameters in Requirements

Field accident research

- **Injury Mechanisms:**
  - Impact with body load (diving mechanism).
  - Friction impact (sliding contact with ground/roof).
  - Minor impact (minor body load).
  - Non-impact.
- **Roof deformation modes:**
  - T: Similar to FMVSS216/208 deformation
  - S: Shearing of roof and pillar sideways.
  - M: M-shaped roof in front view.
  - R: as T but on the whole vehicle width.
- **Rollover initiation types:**
  - Ramping down
  - Ramping up
  - Lateral deceleration
  - Collision
  - Pitch over

Further requirements on the rollover systems

Pretensioners:

- Maximum peak and remaining forces on lap belt.
- Retention performance belt system, drop test.

IC:

- Out Of Position test
- Ejection mitigation component test
- Bottoming out component test
- Several side impact complete vehicle tests including pole front and rear.

Interior panels:

- Component head impact testing beyond legal (FMVSS201) locations.
- Frontal (including moose), side and rear end complete vehicle tests.

Rescue:

- Test to cut pillars to lift off roof to rescue occupants from inside the vehicle.

Summary of test methods

- Development tests for retention system and roof characteristics:
  Drop tests with same energy level as FMVSS208.
- Occupant performance and vehicle performance:
  FMVSS208, SAE J857 (modified).
- Vehicle performance including activation of protection systems:
  FMVSS208 incl soil/curb tripped, SAE J857 (modified), TÜV screw rollover, ditch test.
- Vehicle performance, legal requirement:
  FMVSS216, static roof crush test.

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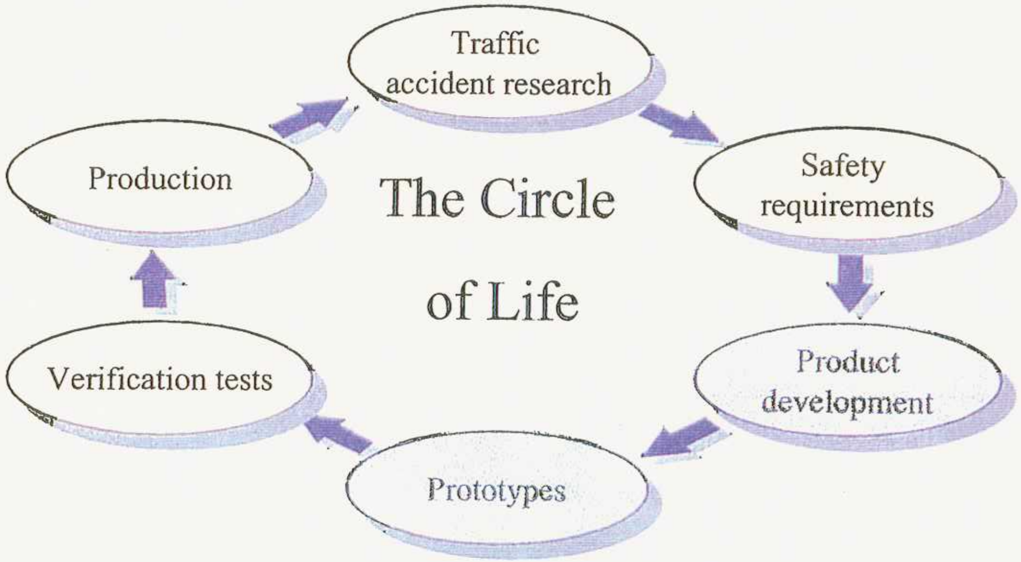


XC90: 3 legs to improve rollover performance in passive safety

Objective: To avoid head impact and partial ejection for belted occupants in rollover

- 1: Belt pretensioner

Objective: restrain the occupant and minimise diving

and

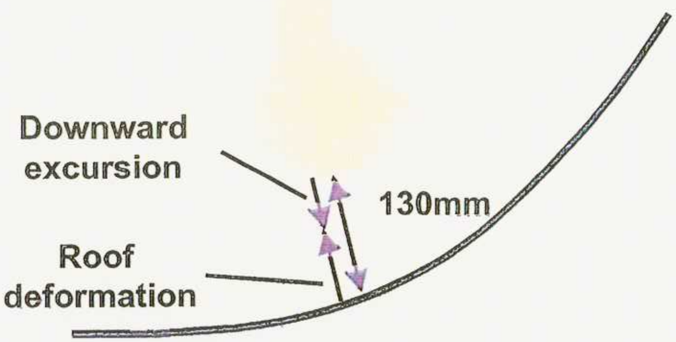
- 2: Strengthened upper body structure

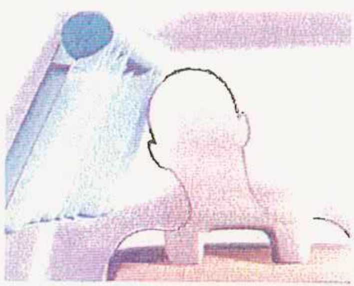
Objective: prevent the body structure to impact the occupant and partial ejection

and

- 3: Inflatable curtain and padding

Objective: prevent the occupant head to impact sideways and partial ejection





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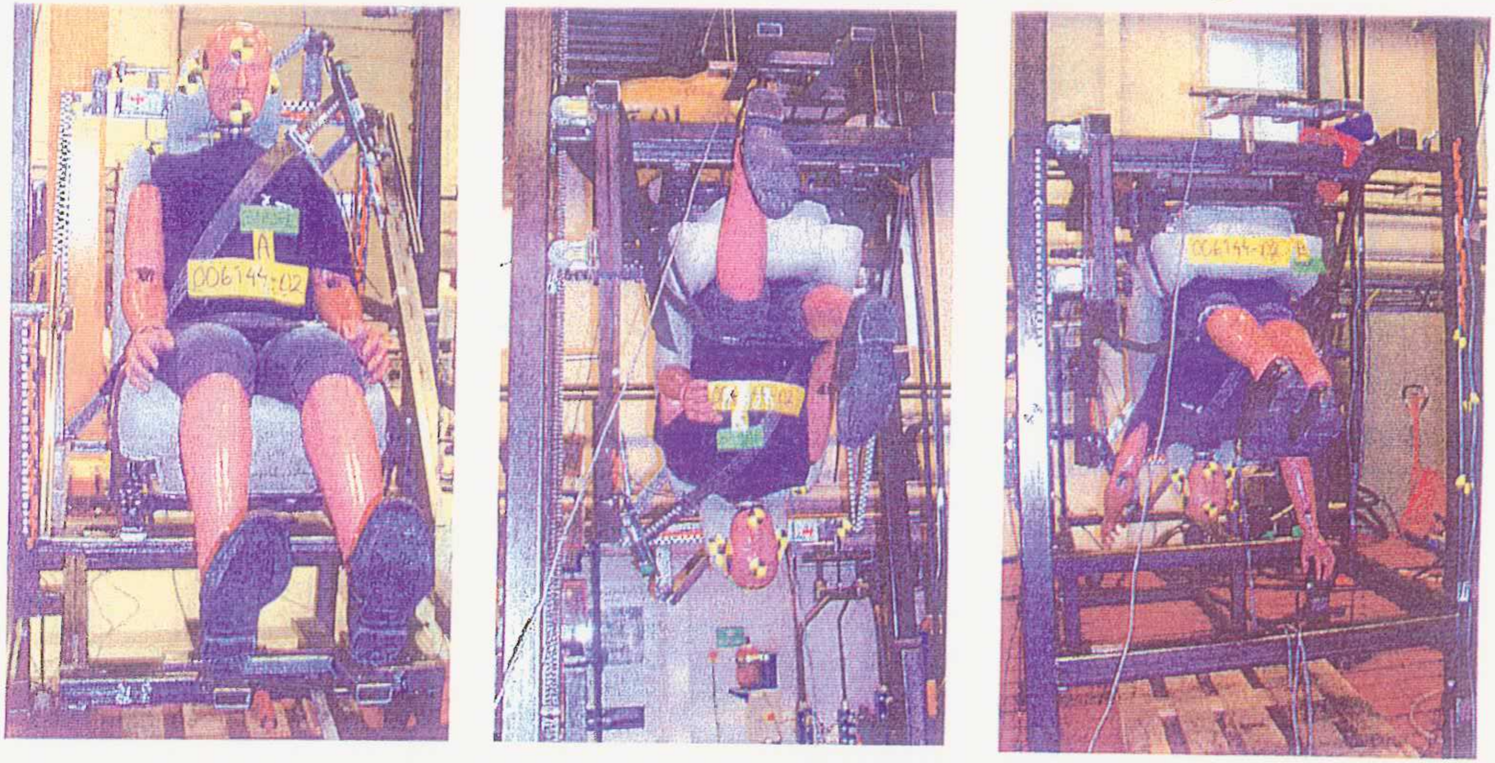
Component Tests Series, Retention Performance Belt System



Dynamic dummy movement = 30-40 mm

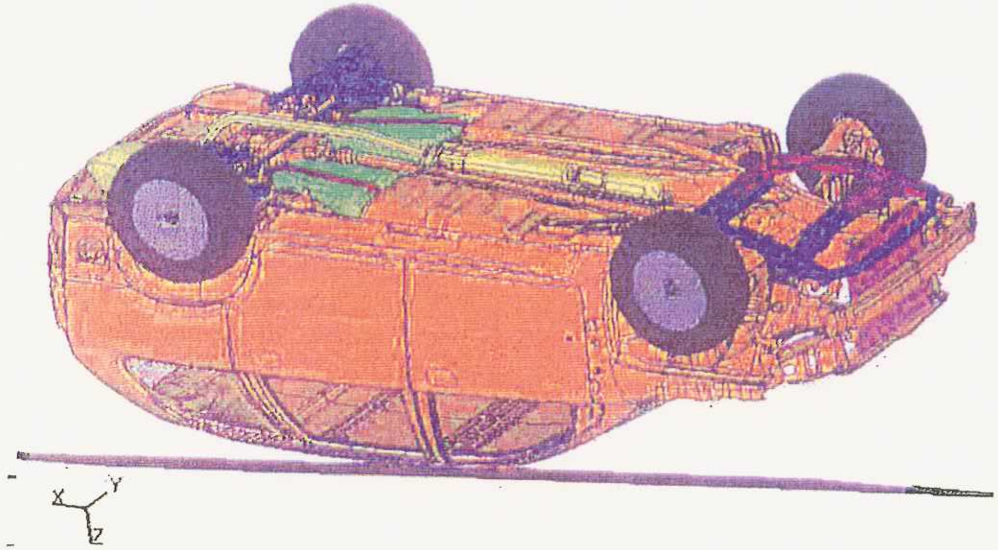
Basic Rollover Sensor Function

- Sensor activation is based on calculation from angle / angular velocity / vertical and lateral acc.
- Activation angle is 10-50 deg.
- Bosch MM2

Occupant position at activation of seat belt pretension.

- Based on test experience the occupant pelvic will be around the normal seating position at activation

Drop-Test XC90



Dynamic deformation = 90 mm

Drop height 300 mm. Drop angle 5/25 deg.
CAE and tests used for development

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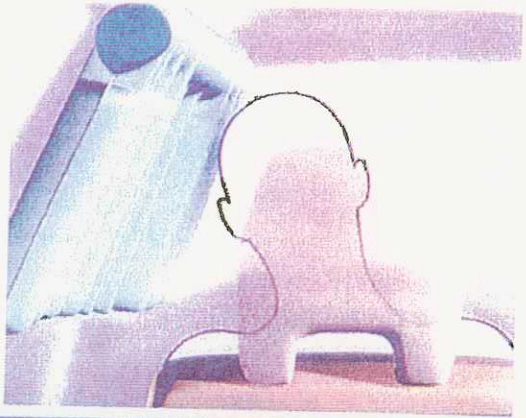
Main design objective

- Eliminate head impacts and partial ejection in rollover accidents

- Impact in one direction covered!

- **Impacts sideways**
- **Partial ejection**



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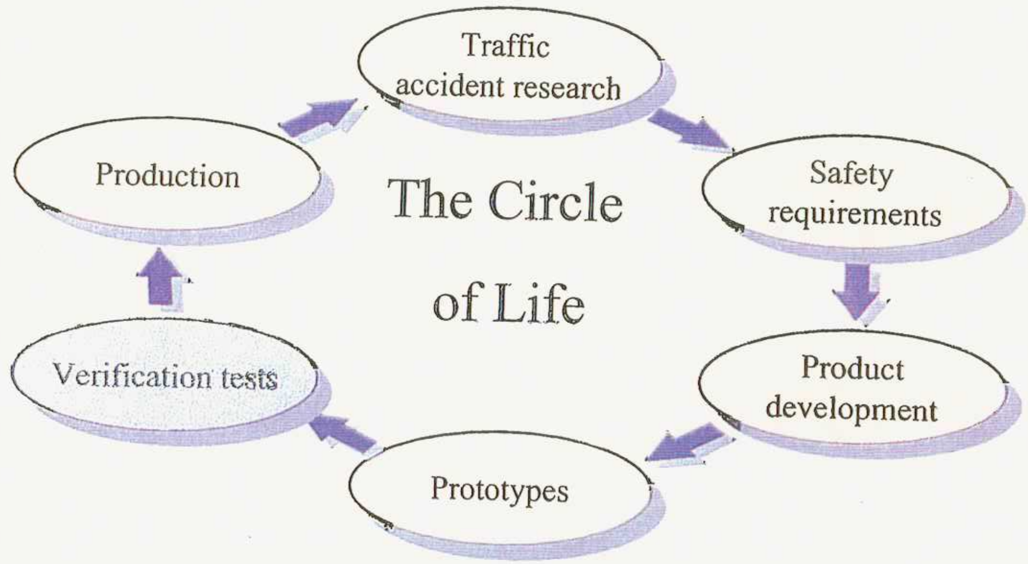

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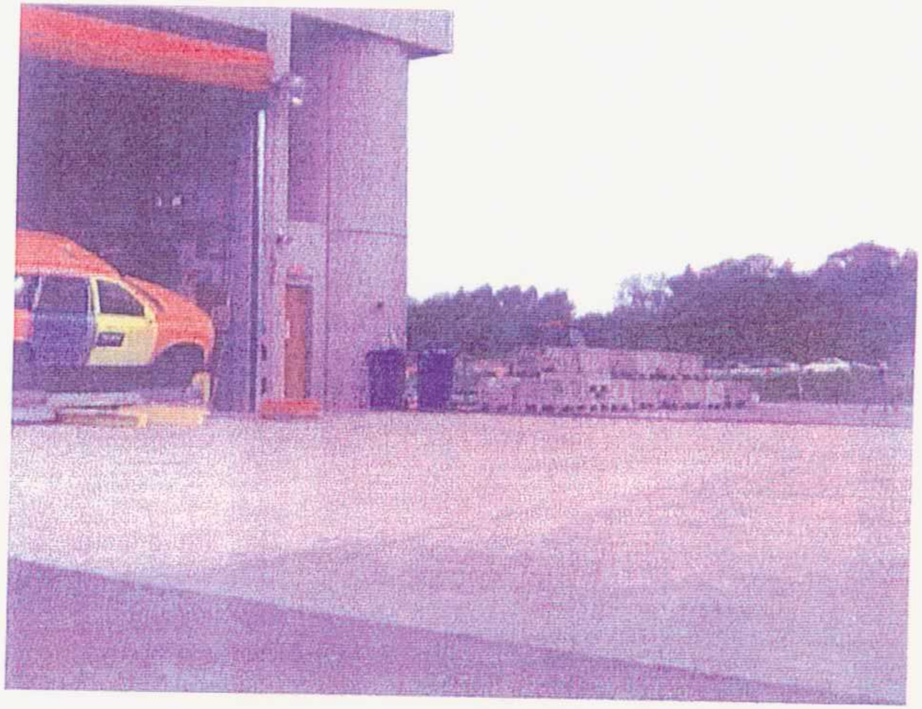

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Summary XC90 Passive Safety Rollover

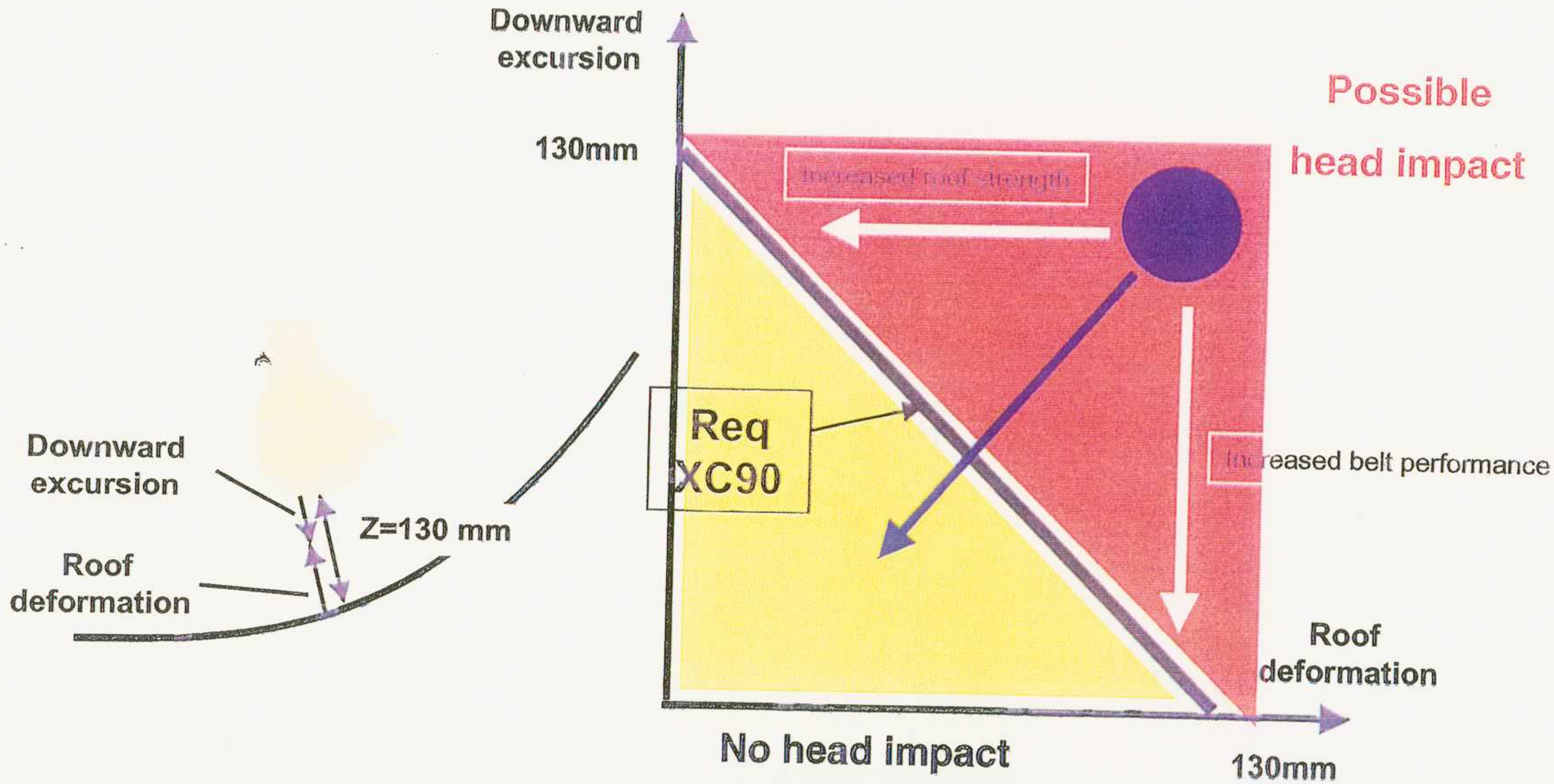
Fact

- Field data with belted occupants shows that the majority of injuries in rollover accidents are related to the head and spine caused by impacts and partial ejection

Main design objective

- Eliminate head impacts and partial ejection in rollover accidents

Rollover deformation schematic



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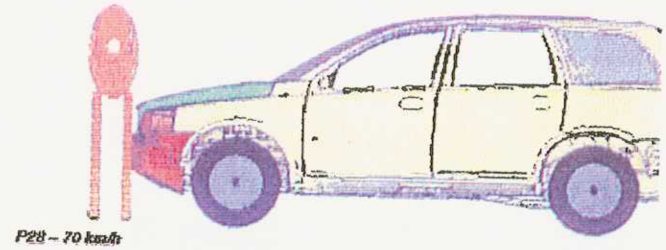
Solutions for XC90

Combination of all 3

- Belt pretensioner
- and Improved structural performance

  This also applies to side impact, offset crash and moose collisions
- and the Inflatable Curtain



Additional conclusions

- The pretensioner does give effect if used in combination with improved structural performance.
- An improved structural performance gives effect only in combination with a pretensioner.

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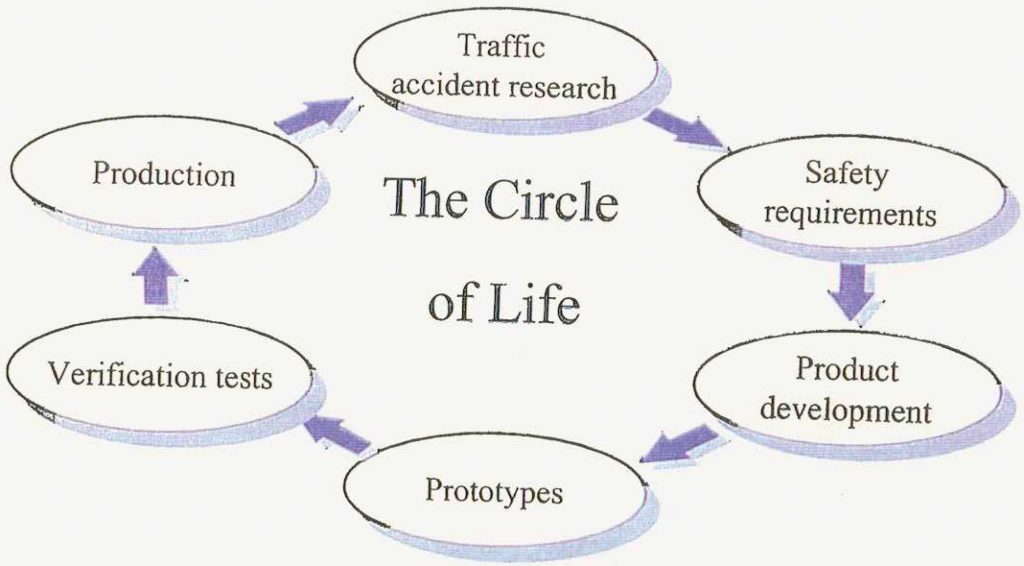

XC90 Safety Challenge

Focused areas when creating a Volvo SUV, based on field accident research:

- **Rollover**
  - Prevention
  - *Protection*
- **Compatibility**
  - Must cover all crash situations including.
  - SUV vs. other Cars
- **Third row seat safety**
  - Rear, Side and Rollover

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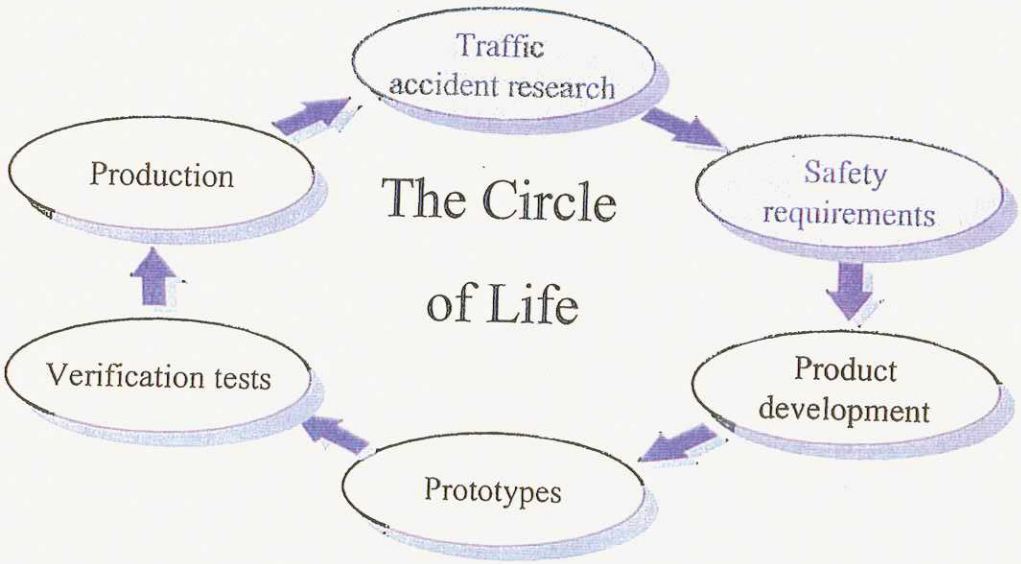
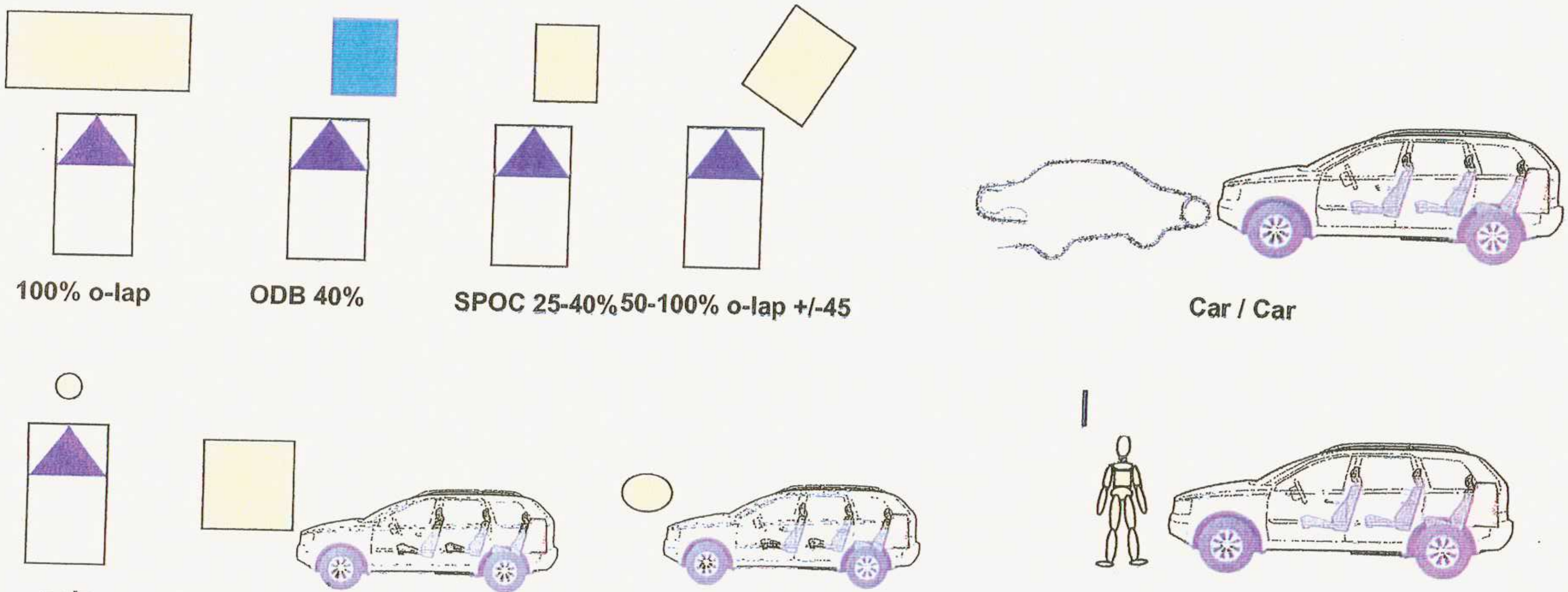


XC90 Safety Targets for front

Requirements for robust design

Self protection

Protection of collision partners



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SUV XC90 Compatibility

Challenge: Less aggressive SUV!

Key parameters:

- Geometry
- Stiffness
- Weight

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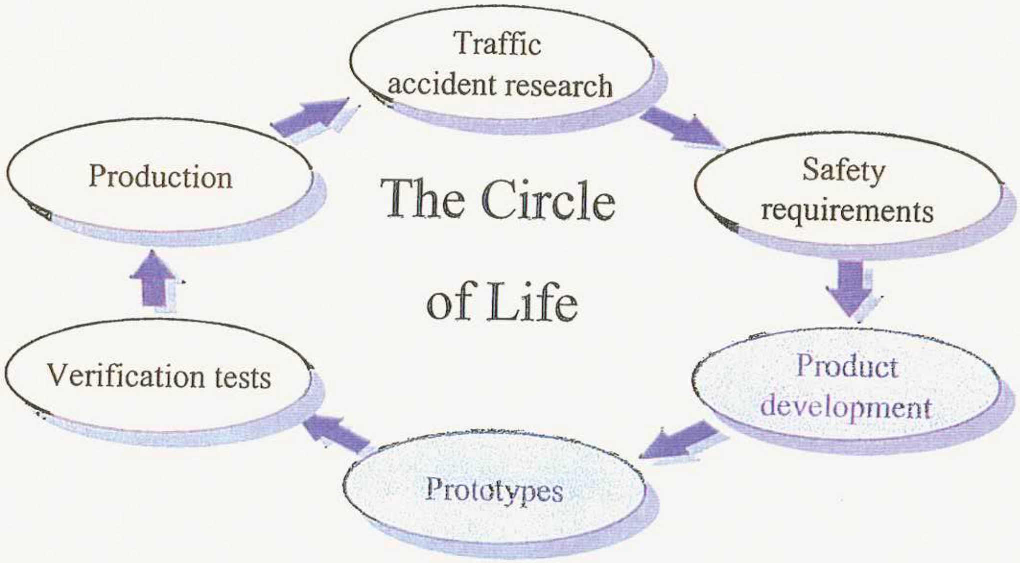

SUV Compatibility

XC90 compatibility strategy and design

- **Geometry**
  - Load path spread in height and width
  - Load path well connected
  - Unibody design, no frame.

- **Stiffness**
  - Additional load path instead of increased forcel level in single member.

- **Weight**
  - XC90 is heavier than a "normal" car but it is a light SUV

XC90 Front Structure

XC90 Safety Product Development
Slide 39

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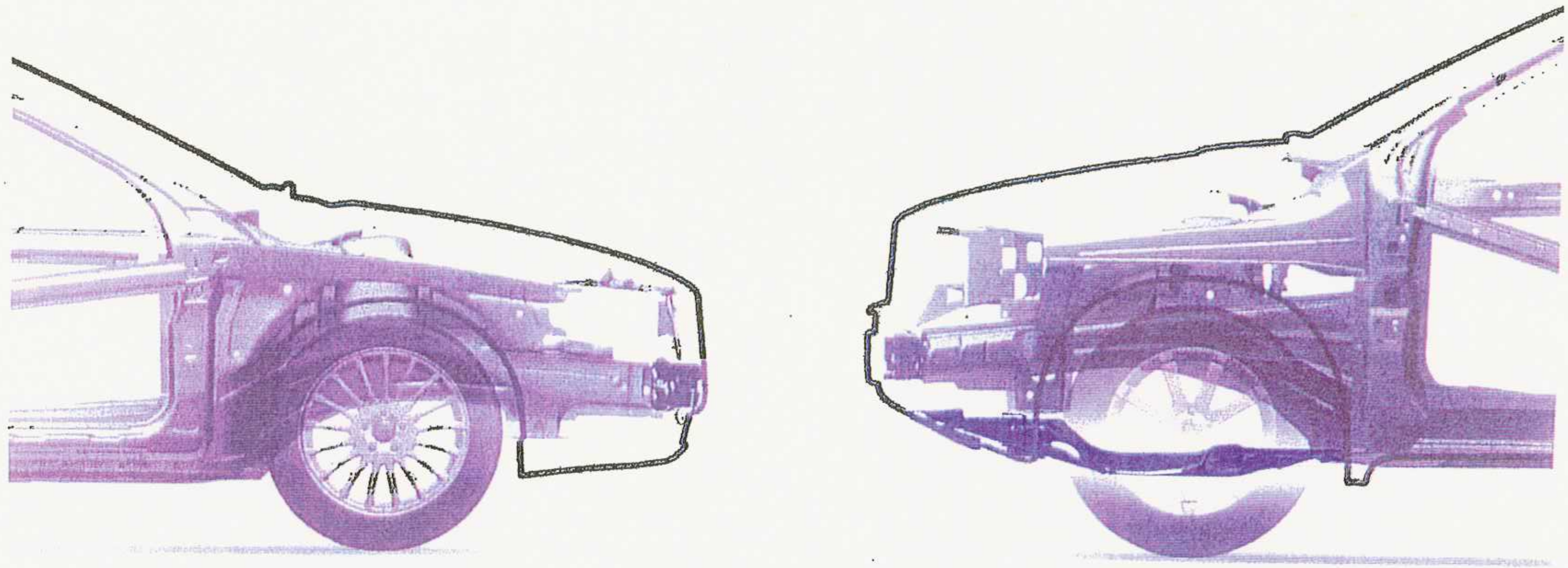
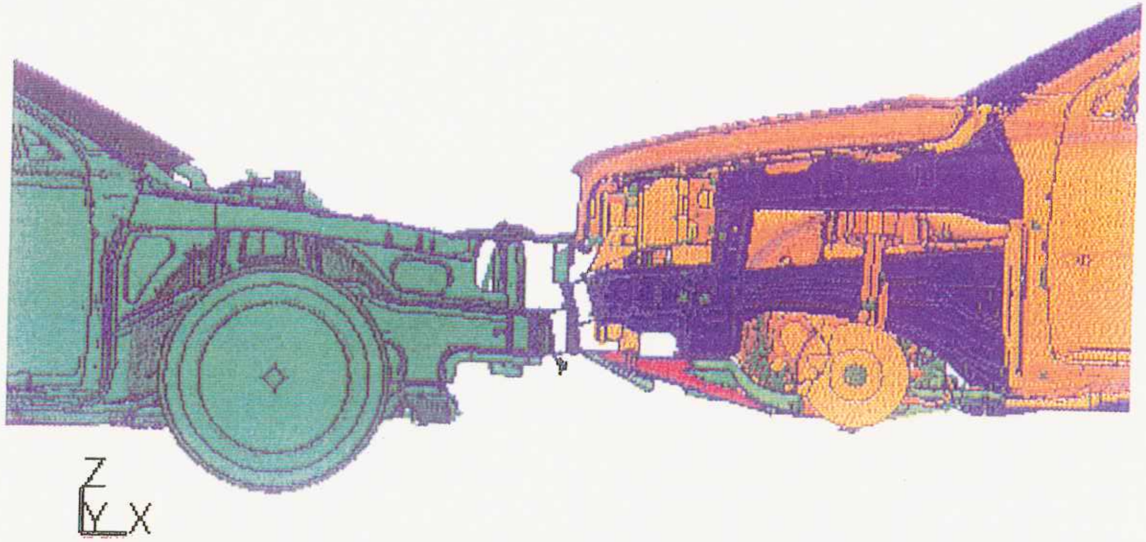
XC90 Compatibility



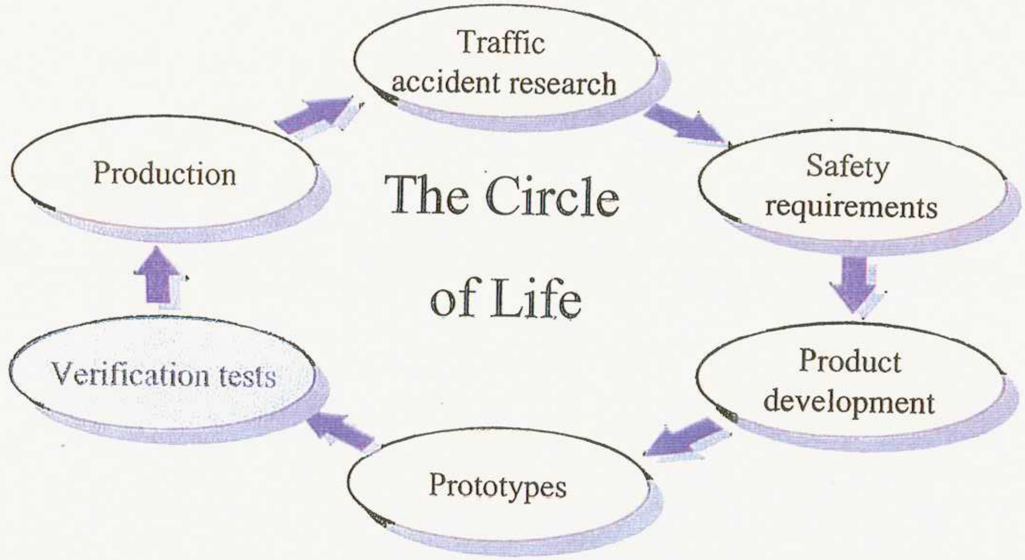
Car to car compatibility

- S60-XC90 full frontal CAE



Volvo Safety Work

Continuously improving real life safety



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XC90 Compatibility

XC90 Safety Product Development
Slide 43

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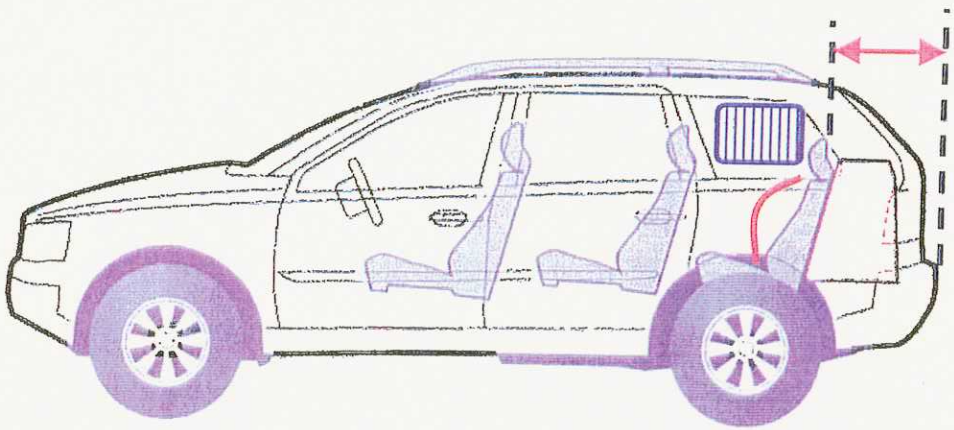
XC90 Safety Challenge

Focused areas when creating a Volvo SUV, based on field accident research:

- Rollover
  - Prevention
  - *Protection*
- Compatibility
  - Must cover all crash situations including.
  - SUV vs. other Cars
- Third row seat safety
  - Rear, Side and Rollover

XC90, Third Row Seat Safety

Challenge: Provide the same protection for third row seat occupants as other seating positions in the car!



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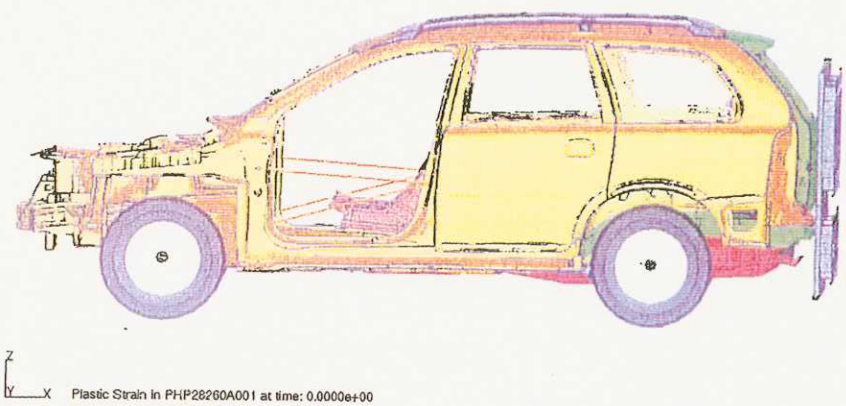
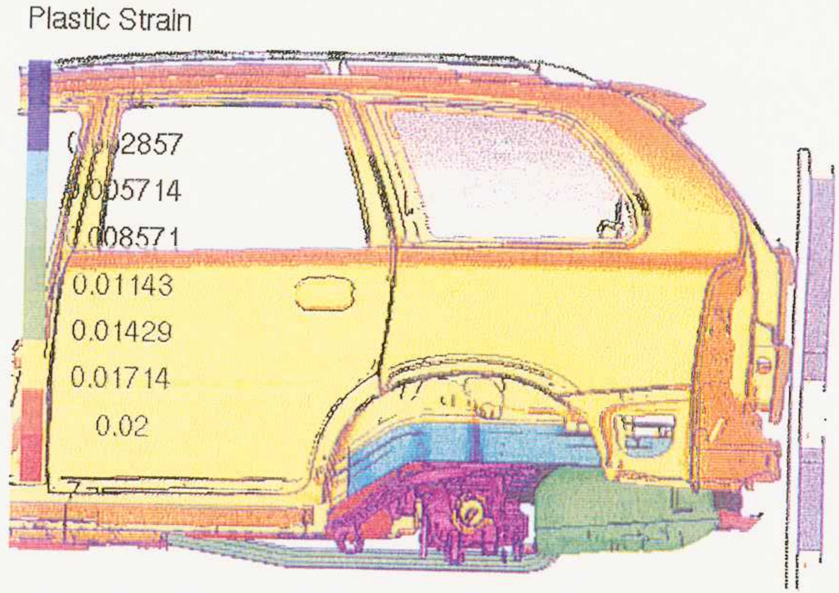
XC90, Third Row Seat Safety

- Front
  - Restraints with 3-p seatbelt with pretensioner
- Rear
  - Rigid seat with good head restraints
  - Deformation zone in rear impact
- Side and Rollover
  - 3-p seatbelt with pretensioner
  - Structure integrity
  - Inflatable curtain

XC90, Third Row Seat Safety

- Rear impact CAE





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Safety Product Development - XC90

- Rollover
  - Prevention
  - Protection
- Compatibility
  - Must cover all crash situations including.
  - SUV vs. other Cars
- Third row seat safety
  - Rear, Side and Rollover

Safety Product Development - XC90

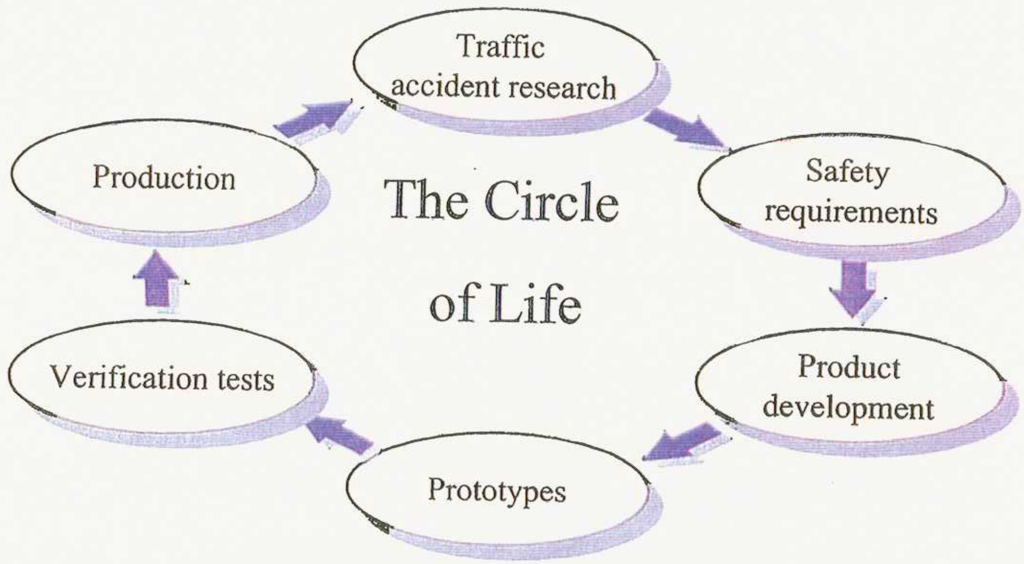
XC90 fulfil the Target:

Make a safe car for the occupants and the traffic environment

- Real life safety!

Volvo Safety Work

Continuously improving real life safety



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Appendix H

International Herald Tribune
May 14, 2005

Ford and Volvo clash over automobile safety

Dispute centers on role crushed roofs play in nearly 40,000 rollover accidents

By Danny Hakim and Jeremy W. Peters

DETROIT: Three years after buying Volvo in 1999, Ford told Volvo executives that their view on one of the most contentious areas of automotive safety was out of step with Ford's and had to change, according to documents that have emerged in recent rollover cases.

The dispute between Volvo, the Swedish automaker with a longstanding reputation for promoting safety, and its new corporate parent centered on the role that crushed vehicle roofs play in nearly 40,000 deaths and serious injuries from rollover accidents each year in the United States.

U.S. regulators are considering the first changes to roof regulations since they were created in the 1970s. They have found that roofs crumple to varying degrees in more than a quarter of those accidents.

But there is a bitter debate over the extent to which crushed roofs cause injuries. For decades, American automakers have argued that injuries or deaths from rollovers almost always occur in the moments just before a roof crushes, when an occupant of a vehicle is thrown into the roof not when roofs collapse on people's heads.

"There is no data out there to suggest people are injured by a roof collapsing," said Susan Cischke, Ford's vice president for environmental and safety engineering.

But Volvo, cheered on by safety advocates who vigorously dispute Detroit's view, has a long history of making roof strength a priority, going back to 1967 when it began reinforcing the roof support pillars of its 140 Series sedan. The company aggressively promoted roof safety in a series of advertisements that began in the 1970s, with one asking, "Are you in the market for a hardtop?" in which seven 144-Series sedans were stacked on top of each other.

The previously hidden corporate battle inside Ford's sprawling global empire came to a head in an e-mail message dated Nov. 23, 2002, in which Priya Prasad, a top Ford safety engineer, told a top Volvo safety engineer, Ingrid Skogsmo, that it was "absolutely necessary to close the technical differences" between the two companies.

"U.S. does not currently believe in roof crush as the major contributor to head/neck injuries in rollovers," he wrote, adding, "does Volvo have any scientific study to show otherwise?"

"This issue has dragged on very long, is very litigation oriented in U.S. (close to 110 cases pending) and the topmost management in the company is impatient," Prasad wrote, explaining that Ford's second highest-ranking executive at the time, Nicholas Scheele, wanted to resolve the disagreement "immediately."

The e-mail message, and one written three weeks later, in which Prasad laid out new talking points for Volvo and its other subsidiaries, are under court seal. Three people on the plaintiff's side of separate cases read or copied portions of the e-mails and provided them to The New York Times. They spoke under condition of anonymity because of the court seal. Ford officials acknowledged the existence of the documents but did not describe their contents. '

'Ford and Volvo do share the same views regarding roof strength and we have not disagreed," Cischke said. "Where there have been some confusion is how we talk about things."

Ford executives, the e-mail messages suggest, were concerned that Volvo's view on roof strength would be used against Ford in rollover cases, a potentially expensive concern that turned out to be prescient. Plaintiff's lawyers are increasingly pitting the views of the parent company and its subsidiary against each other in court.

Warren Platt, a top outside counsel for Ford, said that "if you put all of the auto companies on a continuum, Volvo has had more belief that stronger roofs were going to make some difference than other companies have had." "I don't know that there was really any data to support that, and I don't know that Volvo has any safety data that it prevented any one injury."

Ford executives, according to Cischke, were concerned that Volvo was overemphasizing the role roof strength played in rollover safety. Ford officials also cited a 1999 Volvo study that said that the amount of roof crumpling could not be used in and of itself to predict what injuries might occur.

"We value the Volvo brand very much and would never compromise their ability to demonstrate safety leadership," Cischke said.

Prasad's e-mail messages were written as Volvo was introducing its first sport utility vehicle, the XC-90, selling it to consumers as "a different SUV" with crucial safety innovations to prevent and mitigate rollovers, including side airbags and improved seatbelts that cinch up during accidents.

One of the important features of the XC-90 is a roof reinforced with high-strength boron steel that "exceeds the legal requirements in the U.S.A. by more than 100 percent," according to a promotional video.

Internal Volvo documents describe the reinforced roof as a crucial component of the company's rollover protection strategy. But in an e-mail message dated Dec. 13, 2002, that Prasad sent to senior Ford executives, he laid out talking points for Ford and all of its subsidiaries that said Ford studies showed "no direct causal correlation between roof strength" and neck injuries when people were wearing seatbelts.

Prasad also raised concerns about material on Volvo's Web site, suggesting it clashed with Ford's view. References to the XC-90's reinforced roof are no longer on Volvo's American Web site. Cischke said Prasad's memorandum was a normal "position paper" the company prepares on every significant safety issue.

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Ford, Volvo Clash on Roof Design

Auto regulators take internal files off the Web that depict a conflict over the safety feature.

By Myron Levin
Times Staff Writer

Federal auto safety regulators have taken the unusual step of removing documents on vehicle roof design from a government website at the request of Ford Motor Co. The material includes internal reports from Ford and its Volvo subsidiary that suggest the Swedish automaker views sturdy roofs as an important safety feature, a stance at odds with that of its parent company.

The National Highway Traffic Safety Administration on Friday removed the documents from a website of public comments on proposed changes in the federal standard for roof strength in passenger vehicles. Ford requested the material be removed, saying that a court order in a wrongful death case in Florida barred their release and that the disclosure would cause "irreparable" harm by revealing trade secrets.

An NHTSA spokesman said the agency would review Ford's confidentiality claim and decide what to do with the papers.

The action comes amid a highly charged debate over NHTSA's effort to craft a tougher vehicle roof strength standard, a move opposed by Ford and other major automakers who say roof strength has little effect on occupant injuries in rollover accidents.

The episode highlights a sensitive issue for Ford, a difference in design approach between Ford and the Swedish automaker that Ford acquired in 1999.

Ford spokeswoman Kathleen Vokes said Ford and Volvo "are both safety pioneers" that incorporated new safety features in their sport utility vehicles. She said research by both companies had shown "no direct causal correlation between roof strength and injury severity."

Roof collapse in vehicle rollovers may cause or contribute to as many as 6,900 serious to fatal injuries per year, NHTSA estimates. Safety advocates say the current roof crush standard, adopted in 1971, was too weak then and is grossly inadequate now given the popularity of top-heavy pickups and SUVs.

NHTSA recently sent a draft of a proposed new roof standard to the Office of Management and Budget, which reviews major federal regulations. The proposal has not been made public.

The Ford and Volvo documents had been posted for about 24 hours on the NHTSA site when Ford requested their removal.

The documents were submitted to NHTSA by Sean Kane, a Massachusetts-based safety consultant who often works with plaintiffs in automotive liability cases. Kane said in March that he and others obtained copies of the papers from public court files in Duval County, Fla., where they were exhibits in a wrongful death case involving a Ford Explorer.

A Jacksonville jury on March 18 ordered Ford to pay damages of $10.2 million to the husband of Claire Duncan, 26, who died after her 2000 Ford Explorer rolled and the roof collapsed. The Duncan family lawyers sought to prove with the documents that Ford skimped on safety and that its public position on roof strength was undercut by Volvo's.

Ford had produced the documents to the Duncan lawyers under a protective order that barred them from publicly releasing the documents. But the papers were stored in court files after the case ended. Realizing that people were copying the documents, Ford filed a motion April 22 to enforce the protective order.

By then, court clerks had made copies for Kane and others, including the Detroit News, which publicized some of the documents in an article in late March.

The documents include test data suggesting that roofs on Ford Explorers were made progressively weaker during the 1990s to the point where they were barely more robust than required by the federal standard. The Explorer roofs have a "less than desirable safety margin," said a Ford engineer in an e-mail in October 1999.

The Volvo documents reflect its concern about increasing roof strength for the new Volvo XC90 SUV, along with improving seat belts to hold passengers firmly in place in a rollover. The documents discussed the development of more advanced tests to see how roofs actually perform in rollovers.

"Improvements in this area will increase the passengers' rollover protection," one Volvo report said.

The roof of the Volvo SUV is more than twice as strong as required by the federal standard, the Swedish company has previously said.

Ford told NHTSA in its letter Friday that the documents could expose trade secrets, such as "the strategies by which new technological advancements are introduced."

NHTSA spokesman Rae Tyson said removal of the material might be only temporary.

"There were some documents that were placed in the public docket, which is a privilege or right that anyone has," Tyson said. In response to Ford's request, "we have removed the documents from the public file while Ford makes its claim for confidentiality, which we'll review and then make a decision."

Randy Barnhart, a Denver lawyer who has battled Ford in roof crush cases, said the company had acted too late. "The problem is, the genie is out of the bottle," Barnhart said. "Volvo's philosophy, which is entirely contrary to its parent Ford, is now well-known to the public."

Automakers have long contended that roof strength is of little consequence, because vehicle occupants typically strike the roof when a vehicle flips over. According to this argument, an injury will result from the force of a body pressing down on the head and neck, whether or not the vehicle's roof holds up.

The cornerstone of the industry's argument is research sponsored by General Motors Corp. in which test dummies were just as likely to strike their heads and necks in rollovers of cars with reinforced roofs as in cars with standard roofs.

However, critics said the data actually showed that the force of the head and neck impacts was less severe in cars with reinforced roofs than in conventional roofs that collapsed.