ADVOCATES
FOR HIGHWAY
AND AUTO SAFETY

# SUMMARY OF COMMENTS

**Roof Crush Resistance**
**Supplementallary Notice of Proposed Rulemaking**
**National Highway Traffic Safety Administration**
**March 27, 2008**

The National Highway Traffic Safety Administration (NHTSA) issued a supplementallary notice of proposed rulemaking (SNPRM) to consider major changes in how it intends to amend the roof crush resistance standard. Currently, the roof crush resistance standard requires testing on only one side of the vehicle roof. NHTSA proposed the same approach of a one-side test in its August 2005 notice of proposed rulemaking (NPRM). The NPRM did not take into account, however, the need for roof crush resistance (or roof strength) on both the driver and passenger sides of a vehicle as required by the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), P. L. 109-59 (Aug. 10, 2005).

Advocates' comments emphasized that the SNPRM had multiple procedural and substantive inadequacies. First, it is clear that NHTSA does not intend to adopt a dynamic rollover test procedure. In response to the 2005 NPRM, Advocates recommended that NHTSA adopt a dynamic roof strength test because the current static test, in which force is slowly applied to one side of the vehicle roof, is not representative of the forces that a vehicle experiences in a real-world rollover crash.

Since NHTSA has rejected a dynamic test and appears to be intent on amending the existing static compliance test, Advocates' recommended in its SNPRM comments that the agency adopt a requirement of four (4) times unladened vehicle weight for the amount of force applied to a roof (strength-to-weight ratio (SWR)), and that the test must be conducted on both the driver and the passenger sides of the roof. The comments pointed out that the agency's own, most recent tests of both sides of a group of passenger motor vehicles showed that it was not possible to predict how well a roof would resist intrusion on the second side in rollover crashes by conducting only a one-side test. Advocates' comments were considerably strengthened by a recent analysis of roof strength conducted by the Insurance Institute for Highway Safety (IIHS), which recommended that the agency choose at least a 3.5 SWR.

The comments also emphasized that the SNPRM was incomplete because the agency did not perform benefit-cost analyses of the different regulatory alternatives it was considering, despite the fact that NHTSA admitted that the basis for calculating costs and benefits had been substantially altered since the 2005 NPRM. NHTSA claimed that it was still considering how much more demanding it would make the existing test, and

whether it would require a roof crush resistance compliance test of only one side of a passenger vehicle or of both sides. However, the agency did not provide any benefit-cost analysis to support each of the several options it is considering and that are presented for public comment. The agency simply stated that whatever it chose as the new standard in a final rule would be accompanied by a supporting benefit-cost analysis.

Advocates also argued that the agency was underestimating the safety benefits of a much stronger regulation by severely limiting the number of occupants who could benefit from a more demanding compliance test. IIHS also argued in its recent roof crush resistance study, as well as in its docket comments, that NHTSA was clearly underestimating the benefits of much stronger roofs in preventing deaths and reducing the severity of injuries.

Finally, Advocates recommended that NHTSA should extend the deadline for issuance of a final rule since it has not provided sufficient information and supporting economic analysis for the alternative approaches proposed in the SNPRM. A documented factual basis for each alternative proposed by the agency is essential both for improving the roof crush resistance standard and to meet procedural requirements for providing the public with adequate information during rulemaking. For these reasons, Advocates urged the agency to choose a new completion date for the issuance of a final rule, which NHTSA is permitted to do under SAFETEA-LU. NHTSA should use the additional time to develop a more complete analysis of the proposed regulatory options and to perform benefit-cost analyses of each alternative that the agency needs to provide for public comment before a final rule is issued.

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Docket No. NHTSA-2008-0015
National Highway Traffic Safety Administration
U.S. Department of Transportation
West Bldg., Ground Floor, Rm. W12-140
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March 27, 2008

**Federal Motor Vehicle Safety Standards – Roof Crush Resistance**
**Supplemental Notice of Proposed Rulemaking, 73 FR 5484 (Jan. 30, 2008)**

## I. Introduction.

The National Highway Traffic Safety Administration (NHTSA) has published a supplemental notice of proposed rulemaking (SNPRM) proposing a revised roof crush resistance standard (Federal Motor Vehicle Safety Standard No. 216). 73 FR 5484 (Jan. 30, 2008); 49 CFR § 571. On August 23, 2005, NHTSA published a notice of proposed rulemaking (NPRM) while Congress was considering a mandate to the agency to upgrade the roof crush resistance standard. 70 FR 49223 (Aug. 23, 2005). Section 10301(a) of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (Pub. L. 109-59, Aug. 10, 2005) directed the Secretary to initiate a rulemaking proceeding "to establish performance criteria to upgrade Federal Motor Vehicle Safety Standard No. 216 relating to roof strength for driver and passenger sides[]" and to "issue a * * * final rule by July 1, 2008."[1] Codified at 49 U.S.C. § 30128(d).

The SNPRM, a quasi-static test of roof crush resistance, is essentially identical to the compliance protocol currently required in Standard No. 216 except for the current regulatory requirement of an intrusion limit and the substitution of a no head contract pass/fail criterion. Windshield glazing. as well as closing moveable glazing and locking doors, are required in conducting the roof crush resistance test. The SNPRM also adds a requirement to secure moveable and immoveable roof structures and to remove all "non-structural components," such as roof racks. 73 FR 5484, 5492-5493. In contrast to the 2005 NPRM for amending Standard No. 216 that proposed a test of only one side of a passenger vehicle roof at 2.5 times unladen vehicle weight, 70 FR 49223, the

[1] The preamble of the supplemental proposed rule does not cite this specific statutory mandate and only alludes to it in relation to the abbreviated public comment period that the agency claims was selected, in part, due to "the need to comply with a statutory deadline." 73 FR 5486.

supplemental proposal offers the potential adoption of a 2.5 times (2.5X), 3.0X, or 3.5X unladen vehicle weight platen force application near the front corners of the roofs of passenger vehicles less than 10,000 pounds gross vehicle weight rating (GVWR).[2] The agency is also considering whether an amended Standard No. 216 would require only a test of one side of a passenger vehicle roof (1-side test) or of both sides (2-sides test). The platen application would measure only peak forces, no intrusion limit would be specified in the amended standard, and a successful compliance test would hinge only on intrusion at the required platen force application without any roof component or portion of the platen contacting the head of a 50$^{th}$ percentile male anthropomorphic test device (ATD, test dummy). 73 FR 5491-5493.[3]

## II. The Supplemental Proposed Rule Will Not Adequately Protect Occupants In Rollover Crashes.

The proposed rule crush resistance rule as presented is seriously inadequate in several ways.

► The proposed compliance procedure is only a component test and cannot demonstrate actual roof crush resistance in rollover crashes.[4] Compliance with NHTSA's regulation as proposed would have no predictive value for determining what the actual impact response of a given passenger vehicle roof will be in rollover crashes of 2 quarter-turns or more.

►The agency has not shown the relationship between the quasi-static test metric at the 3 different proposed application forces (2.5X, 3.0X, 3.5X) to differences in real-world rollover occupant injury response.

► The proposed quasi-static test cannot show roof dynamic flexion or recoil and cannot show occupant excursion even when front seat occupants are belted. Both of these rollover dynamics can substantially reduce survival space and result in head and face roof impacts despite a given vehicle demonstrating Standard No. 216 compliance.

► The SNPRM quasi-static platen application procedure is not a real-world test because it directs manufacturers to close all moveable glazing, secure moveable or unmovable roof structures, and remove roof racks before testing for compliance. These actions increase the probability of compliance even though new vehicles will often be factory-

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[2] For all practical purposes, multiples of unladen vehicle weight and values for strength to weight ratio (SWR) are used interchangeably by NHTSA and in these comments, although technically the two metrics are not identical.

[3] Although the proposed text of the amended regulation contains alternatives for a 1-side or a 2-sides test, it still specifies a maximum force application of only 2.5 times unladen vehicle weight. Agency consideration of a 3.0X or 3.5X test is discussed only in the preamble of the SNPRM. 73 FR 5490.

[4] *See*, comments of DVExperts International Pty Ltd, March 4, 2008 (DVExperts), NHTSA-2008-0015-0010.1, at 4.

equipped with roof racks, other roof structures, and will be operated with opened moveable glazing. 73 FR 5492.

► A roof meeting the most stringent regulatory alternative proposed in the SNPRM does not ensure that a belted occupant will avoid serious head-face-neck injury. In fact, this is implied by the agency's own 2005 benefits analysis based solely on a 2.5X, 1-side test: the lives saved – 13 or 44, 70 FR 49225 – were only a small fraction of the population defined (596)[5] as even susceptible of benefiting from the proposed rule.[6]

► The upright, safety belt-retrained ATD – the Hybrid (H)III 50th percentile male test dummy – has no dynamic function or injury measurement for the proposed compliance test. Its use cannot show the dynamic response of safety belts to translational forces and occupant inversion that can result in occupant contact with an intruding roof even if the vehicle passes the quasi-static platen test using the dummy head contact/no-contact compliance test criterion.[7]

► Use of only a 50th percentile male ATD for the compliance test immediately denies equal safety protection to taller occupants.

► The proposed quasi-static compliance test disregards dramatic differences in occupant injury response and morbidity related to occupant age, and ignores the fact that older occupants are much more prone to death and injury in rollover crashes than younger occupants.

►The SNPRM offers several regulatory alternatives without support from a cost-benefit analysis projecting lives saved and injuries averted or reduced in severity for each regulatory combination of SWR with a 1-side or 2-sides test. The failure to supply a cost-benefit analysis for each regulatory alternative denies the public an opportunity to evaluate the agency's comparative estimates of costs and benefits before submitting comments supporting one or more of the regulatory alternatives of the SNPRM.

## III. The Proposed Quasi-Static Platen Test of Roof Crush Resistance Is Weak.

The SNPRM relies on the belief that roofs designed to meet a higher strength requirement in a quasi-static test of applied plate force are more resistant to crush and intrusion and will maintain sufficient occupant headroom and survival space during real-world rollovers. But no correlation of the proposed 2.5X SWR metric based solely on no head contact without an intrusion limit has been made with actual occupant fatality and

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[5] *FMCSS 216, Upgrade Roof Crush Resistance, Preliminary Regulatory Impact Analysis*, National Highway Traffic Safety Administration, August 2005 (2005 PRIA), at IV-7.

[6] The target population in the SNPRM has been further reduced to 476 belted, non-ejected occupants.

[7] *See*, M. Bidez, *et al.*, "Occupant Dynamics in Rollover Crashes: Influence of Roof Deformation and Seat Belt Performance on Probable Spinal Column Injury," *Annals of Biomedical Engineering*, 35:11 (Nov. 2007), 1973-1988.

injury data of passenger vehicles in rollover crashes.[8] NHTSA's proposed surrogate measure of adequate roof strength – contact or no contact with the head of a 50th percentile test dummy – proves nothing about how any vehicle complying with the proposed quasi-static platen test will actually resist roof deformation and intrusion during rollover crashes and cannot predict occupant injuries in rollover crashes.

NHTSA has not shown in the SNPRM that passenger vehicle roofs that resist intrusion at greater, specific SWR force applications in such a quasi-static test also result in fewer occupant severe injuries or deaths. One major deficiency in the recent roof intrusion study published by NHTSA[9] is the fact that intrusion cannot be correlated with specific injury predictions even for the very conservative benefits target population except at a gross level of analysis. The 2007 NHTA Vertical Roof Intrusion Study only shows that "coefficient estimates for intrusion were negative indicating that an increase in intrusion tended to be associated with an increase in the level of injury severity; the coefficient estimates for post-crash headroom were positive, indicating that an increase in headroom tended to be associated with a decrease in the level of injury severity."[10]

This implies that, in general, stronger, more intrusion-resistant passenger vehicle roofs providing more post-rollover survival space will protect more front-seat occupants from severe injuries and deaths. Yet, NHTSA has failed to provide any evidence in the SNPRM that a roof crush resistance standard based on the platen test can be correlated with substantial improvements in the real-world prevention of head, face, and neck injuries in rollover crashes.

This crucial point is emphasized in recent comments filed with the docket:

> The proposed standard raises the force level required to generate roof crush, *but it does not necessarily result in increased energy resistance or reduced roof crush in a rollover.* Individual vehicles with different peak loads can have similar energy resistance capabilities and therefore similar degrees of roof crush in a rollover, and, inversely, individual vehicles with identical peak loads can have dramatically different energy resistance capabilities and dramatically different degrees of roof crush. For this reason, simply requiring a minimum force level does not ensure that roofs will be able to resist a significant amount of energy in a rollover nor maintain the necessary structural integrity. Consideration for

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[8] "The energy absorbed by the roof may be more relevant to injury risk than the peak force it can withstand, or the roof's performance over a plate displacement other than 5 inches would better predict injury risk. M. Brumbelow, *et al.*, *Roof Strength and Injury Risk in Rollover Crashes*, Insurance Institute for Highway Safety, March 2008 (IIHS Roof Strength Study), at 5.

[9] *The Role of Vertical Roof Intrusion and Post-Crash Headroom In Predicting Roof Contact Injuries to the Head, Neck, or Face During FMVSS No. 216 Rollovers – An Updated Analysis*, DOT HS 810 847, October 2009 (2007 NHTSA Vertical Roof Intrusion Study).

[10] 2007 NHTSA Vertical Roof Intrusion Study at 11.

> structural energy management is critical if the Agency's goal is to reduce roof intrusion.[11]

The Insurance Institute for Highway Safety (IIHS) has recently published an important study supporting the concept that more highly crush resistant passenger roofs will provide enhanced protection of front seat occupants from head, face, and neck injuries if based on a more stringent quasi-static test. The IIHS Roof Strength Study indicates that vehicle roof energy management is a major parameter relating to occupant injury.[12] NHTSA needs to evaluate these findings in light of its demurral on using an intrusion limit and energy absorption criterion to adopt a roof crush resistance standard based on the platen test of Standard No. 216. The IIHS Roof Strength Study comprised 22,817 single-vehicle rollover crashes involving drivers suffering both incapacitating injuries and deaths in 11 sport utility vehicle (SUV) models in police-reported crashes in 12 states. These crashes were matched with roof strength results from using the quasi-static platen test in which 8 midsized SUVs' roofs were crushed at 2, 5, and 10 inches of platen displacement. The highest SWR achieved by any of the study vehicles undergoing the platen test was 3.16. The study performed logistic regression analyses of the 12 states' single-vehicle rollover crashes, controlling for the state in which the crashes occurred, Static Stability Factor (SSF), and driver age. The results of the analyses found that lower incapacitating and fatal injury rates were associated not only with higher values of peak force and SWR, but also for energy absorption.

These findings support the need for NHTSA to adopt several, interacting metrics to a roof crush resistance compliance test that relies on a quasi-static platen test of intrusion. Using only a SWR multiple, such as 2.5X, 3.0X, *etc.*, without an intrusion limit, no energy management requirement, and only a head no-contact/contact (pass/fail) criterion cannot provide sufficient assurance that a complying vehicle will provide substantially enhanced roof crush resistance, which, in turn, will produce lower rates of severe injury and death in rollover crashes. The IIHS Roof Strength Study found consistent trends in odds ratios for reduced risk of fatal or incapacitating driver injuries that were correlated with reduced platen displacement, higher SWRs, and higher energy absorption.[13]

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[11] DVExperts at 5 (emphasis supplied). In its 2005 proposed rule, NHTSA specifically asked for comments on an energy absorption criterion added to the requirements of Standard No. 216 because two commenters argued that a peak force requirement alone is insufficient to prevent roof collapse after initial peak force is attained. The agency stated that it would have to conduct additional analysis to evaluate energy absorption to establish test parameters. 70 FR 49236. However, two and one-half years have elapsed since the agency asked for further comments on an energy management criterion for the standard, and there is no indication that the agency has conducted the additional analysis necessary to test vehicles for roof energy management in rollover crashes.

[12] IIHS Roof Strength Study at 5.

[13] *Id.* at 10.

Using the logistic regression models of driver fatality risk to calculate the odds ratio for a full 1-unit increase in peak force, SWR, and energy absorption, the study found that the lowest driver fatality risk was associated with a 2-inch peak force platen displacement, 2 inches SWR, and 2 inches energy absorption.[14] Overall, the logistic regression analyses found that rollover injury risks were significantly lower for vehicles with stronger roofs regardless of which strength assessment was used. However, the IIHS Roof Strength Study could not determine whether any one metric is more predictive of injury outcomes than others.[15] This implies that NHTSA should act prudently and adopt several different metrics to ensure that the quasi-static platen test results in substantial safety benefits in injury prevention.

In order to be cautious in using a non-dynamic, surrogate measure of real-world vehicle roof responses to rollover impact forces, NHTSA should seriously consider establishing multiple measures for conducting a quasi-static platen compliance test if the agency continues to insist that it cannot adopt a dynamic compliance test. Given the agency's continued insistence on the quasi-static compliance test, Advocates supports the following as the main features of the test protocol, including the minimum number of metrics and their values:

- A SWR of no less than 4.0X[16]
- An intrusion limit of no more than 2 inches with maintenance of force level instead of simply achieving peak force.[17]
- A residual headroom limit of no less than 2 inches from the top of the head of a 50$^{th}$ percentile male ATD.[18]

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[14] *Id.* at 11. The finding in the IIHS Roof Strength Study that occupant injury is strongly related to a higher SWR and the amount of intrusion is consistent with Advocates' prior comments that responded to the 2005 proposed rule. Advocates supported a SWR of at least 3.0X and, preferably, 3.5X and the restoration of an intrusion limit of a maximum of 3 inches, the platen test conducted without the windshield and with retracted side glazing. *See*, comments of Advocates for Highway and Auto Safety dated Aug. 23, 2005 (Advocates' 2005 Comments), to Docket No. NHTSA-2005-22143-0136, at 4-5, 13.

[15] *Id.* at 13.

[16] A SWR of at least 4.0X is recommended by DVExperts. Advocates supported a SWR of at least 3.0X and desirably 3.5X in its comments filed in response to the 2005 proposed rule, but this stance was based on the agency eliminating reliance on the windshield and closed side glazing for the quasi-static compliance test. Since FMCSA appears to be resolute in allowing both to be used in complying with an amended Standard No. 216, Advocates has increased its recommended minimum SWR to at least 4.0X. *See*, Advocates' 2005 Comments at 15-16.

[17] DVExperts cites the roof crush resistance achievement of the Volvo XC90. Volvo requires that a minimum force level of 3.5X SWR be reached within 2 inches of platen displacement, but then maintained to within 7.9 inches, followed by a force level of 4.3X SWR maintained within 11.8 inches of platen displacement. DVExperts at 3-5. Volvo's test requirements result in a roof in a rollover crash that progressively becomes stronger as the forces of a rollover test roof crush resistance.

[18] Advocates continues to support the use of a 95$^{th}$ percentile male ATD in the test protocol if NHTSA continues to insist on the use of a dummy in the platen test. However, the use of the ATD has no

- Moveable side glazing should be retracted or otherwise positioned to open side portals.[19]

Surprisingly, NHTSA takes no action in the SNPRM to factor in the amount of intrusion that should be permitted in a quasi-static platen test apart from an ATD head no-contact requirement, despite the fact that its own 2007 Vertical Roof Intrusion Study found "a statistically significant relationship between intrusion and injury for belted occupants * * *" and that, "together with other factors * * * will likely lead to slightly higher benefits than was estimated in the NPRM." 73 FR 5490. When this finding is framed by the more specific finding of the IIHS Roof Strength Study linking the level of force applied to a vehicle roof with the amount of intrusion for the extent and severity of occupant injury, NHTSA must appreciate that a revised roof crush resistance standard must incorporate an intrusion limit to accompany a SWR force level in the final rule. The agency cannot simply disregard its own finding that "a statistically significant relationship between intrusion and injury" has been determined through its own further investigation by offering a roof crush resistance regulation that has no specific intrusion limit other than avoidance of ATD head contact. This would be a capricious choice that is contrary to the evidence in the rulemaking record provided by NHTSA itself, IIHS, and DVExperts that a specific intrusion limit figure is necessary to produce injury prevention benefits.

## IV. Without Requirements for an Intrusion Limit, Minimum Residual Headroom Space, and Sustained Force, the Proposed Quasi-Static Platen Test Can Be Easily "Gamed" By Manufacturers.

Requirements that limit maximum intrusion, specify a minimum residual headroom space, and use sustained force and energy absorption as components of a strengthened quasi-static roof crush resistance test can substantially reduce the ability of manufacturers to manipulate other features of roof and roof support design that will translate into passing the compliance test. These measures will not nullify the ability of manufacturers to "game" a quasi-static compliance test of roof components, as recognized by other commenters to the docket, but the use of more, specific test metrics for determining compliance will limit the ability of manufacturers to introduce compensatory design features to pass the platen test.[20] The simpler NHTSA renders the compliance test requirements, the easier it is for manufacturers to compensate for weak forward roof crush resistance by artful choices of other design changes. Test manipulation is strongly facilitated by NHTSA's binary compliance criterion of dummy

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relationship to any injury measure. For all practical purposes, the ATD used in the proposed platen test is a manikin. *See*, Advocates' 2005 Comments at 12; DVExperts at 6.

[19] Advocates urges the agency to reconsider barring the use of windshields in conducting the platen test.

[20] "There are ways to 'trick' the quasi-static simple test and achieve artificially high loads, by incorporating a strong B-pillar, for example, meanwhile ignoring the critical areas that bear loads in real world rollovers such as the A-pillar and windscreen header." DV Experts at 4.

head contact/no-contact while dispensing with a platen intrusion limit. The use of the HIII head for the criterion is gratuitous since the ATD has no injury response measurements even if head contact occurs. Even if the ATD had injury response measurement corridors, such as measurement of neck axial compression, flexion, or shear, complying with the quasi-static test shows nothing about how an occupant would actually respond in a real-world rollover crash because occupant kinematics in a rollover are categorically different from the static, belted ATD seated in an upright position used for such a binary compliance decision.[21]

If the agency chooses a quasi-static test at 2.5X, 3.0X, 3.5X, or some other SWR figure, the test should specify (a) a maximum intrusion limit of no more than 2 inches and (b) that limit must be reached at a distance no less than 2 inches from a 50$^{th}$ percentile ATD head, although Advocates urges the agency to require a greater residual head space that will respond to the safety needs of the 95$^{th}$ percentile of front seat male occupants. However, a choice of a lower SWR will substantially counter the benefits of a stringent intrusion limit and residual headroom requirement. NHTSA's crash data investigation showed that 9 percent of occupants with post-crash headroom above the tops of their heads nevertheless still experienced roof contact injuries to the head, neck, or face, while 34 percent suffered such injuries when headroom was below the tops of their heads. 70 FR 49237. This clearly shows that increasing residual headroom will commensurately increase benefits because of lower rates of head, face, and neck injuries, especially in connection with a more demanding SWR than 2.5X.

Removing an intrusion limit and substituting a binary criterion of head contact/no contact will allow manufacturers to design to maximum intrusion that falls just short of head contact, a design choice that can allow considerable intrusion reducing the margin of safety for preventing severe head, face, and neck injuries in actual rollovers. In real-world rollovers, manufacturers of low roofline vehicles can pass a head non-contact regulatory compliance platen test with only a small margin that will disappear in real-world rollovers due to excursion even of belted occupants, transient roof dynamic flexion and recoil, and roof structural failures that cannot be replicated in a quasi-static test. Measurable residual headroom found post-crash does not ensure that roof contact and consequent head, face, and neck injuries even to belted occupants did not occur.

A regulation based solely on a simplistic "no contact" compliance criterion cannot reach the agency's goal of "quantifiable benefits of limiting headroom reduction," and it allows manufacturers to manipulate the test for compliance that will continue to result in unacceptable occupant head, face, and neck injuries in rollovers. A no head contact criterion with no intrusion limit and no required minimum residual space above the heads of occupants simply indulges manufacturers to continue to produce compliant, low roofline vehicles with little margin before head contact, margins that easily will be exceeded in real-world rollover crashes with a high risk of severe injury.

[21] *See,* DVExperts at 6.

Failure to specify an intrusion limit, which should be considerably less than 5 inches, and basing the test on peak force resistance rather than *sustained* resistance has no real-world correlation with multiple quarter-turn rollover crashes. A roof that might sustain, say, a 2.5X SWR load in the first impact of each side might subsequently fail in the second set of impacts in vehicles that suffer multiple full rolls. NHTSA tested several passenger vehicles with an inverted drop test and concluded that the quasi-static test of Standard No. 216 was as accurate in reproducing roof deformation as a drop test in producing deformation similar to real-world crashes. 70 FR 49231. All of these vehicles presumably complied with existing Standard No. 216, including the 5-inch intrusion limit. Yet, NHTSA also found a high percentage of vehicles that complied with the quasi-static test requirements of No. 216 but also suffered roof intrusion beyond 5 inches in real-world rollover crashes. Specifically, the agency found that 32 percent of cars and 49 percent of light trucks under 6,000 pounds exceeded 5.9 inches of vertical roof intrusion, and 55 percent of light trucks with a GVWR greater than 6,000 pounds and less than 10,000 pounds suffered vertical roof intrusion exceeding 5.9 inches. *Id.* at 49236.

This shows that, in fact, complying with a quasi-static test that claims to reproduce real-world deformation does not predict whether any given complying vehicle will nevertheless suffer roof intrusion exceeding the limits of such a standard. The agency's subsequent review of heavier passenger cars near or above 3,333 pounds GVWR, *id.* at 49237, found that several of these withstood 1.5X vehicle weight in the platen test. But this compliance result clearly has no predictive value for whether any of these vehicles would not suffer severe roof crush in real-world rollover crashes, including crashes that resulted in greater than 5 inches of vertical intrusion. NHTSA cannot substantially improve roof strength while also dramatically reducing occupant deaths and injuries based solely on a higher SWR value and an ATD no-contact compliance criterion.

## V. SAFETEA-LU Requires NHTSA to Upgrade Passenger Vehicle Roof Strength In Standard No. 216 for Both Driver and Passenger Sides.

NHTSA is required by law to upgrade "roof strength for [both the] driver and passenger sides." SAFETEA-LU, Sec. 10301(a), codified at 49 U.S.C. § 30128(d). In order to accomplish this, the agency must require a compliance procedure that demonstrates the strength of both sides of a passenger vehicle roof. This makes eminent sense because NHTSA cannot predict which side of a rolling vehicle will receive the first impact, and because vehicles in multiple quarter-turn rolls can suffer impacts to both sides of the roof. As a result, Congress understood that the agency must ensure that both sides of a passenger vehicle roof are strengthened in any upgrade of Standard No. 216, and a 2-sides test is the only realistic means for ensuring this goal of enhancing real-world occupant protection in rollovers.

It is clear from the agency's tabulated results of 1-side and 2-sides testing in the SNPRM, 73 FR 5486-5487, Tables 2 and 3, that compliance with the quasi-static test at the adopted force level for 1-side cannot determine whether the vehicle would comply with a sequential test of the 2nd side if tested with the platen. Even the agency's summary

analysis of tests conducted for the 2005 proposed rule showed that first side test results cannot be used to predict second side test results using the platen test. In testing the second side of a Crown Victoria, local peak force was reduced 17 percent between 50-90 mm of crush in contrast with the first side test. 70 FR 49239. But a platen test of both sides of a Land Rover Freelander produced an increase in force during the second side test over that of the first side starting at approximately 40 mm of plate movement. As contrasted with the Lincoln LS test, local peak force was increased by 20 percent on the second side for the Freelander, whereas the Lincoln LS suffered a decrease in force beginning at 40 mm of platen intrusion, resulting in a 20 percent decrease in peak force for the second side. *Id.* As a consequence, NHSTA concluded that "some vehicles may have weakened or strengthened far side roof structures as a result of a near side impact." 70 FR 49239. NHTSA found similar disparities in the test results for 1-side and 2-sides tabulated in SNPRM, showing that 1-side peak force roof responses cannot be relied on to gauge second side responses, especially in light of the fact that increases, rather than decreases, in peak force in the second side tests were the exception rather than the rule. *See*, Table 3, 73 FR 5487.

Although NHTSA asserts in the SNPRM that it is actively considering whether to adopt a 1-side or a 2-sides compliance test, *e.g., id.* at 5490, the agency is arguably less able to relate the results of a 1-side test to real-world roof crush resistance in rollovers and occupant injury responses than even the use of a quasi-static 2-sides test. The statutory mandate cannot be satisfied with a 1-side platen test.

## VI. The Proposed Platen Test Impedes Development of Other, Crucial Safety Performance Features for Reducing Injury in Rollover Crashes.

Contrary to NHTSA's assertion that the SNPRM is "part of a comprehensive plan for reducing the serious risk of rollover crashes," 73 FR 5484, NHTSA's refusal to consider a dynamic test for determining roof crush resistance to intrusion in rollover crashes denies the agency the advantages of determining other key safety design and performance features of passenger motor vehicles in rollovers. Instead, the agency has chosen to perpetuate an outdated, simplistic method of applying localized force to the corners of an upright passenger vehicle roof near the A-pillars as a surrogate for the dynamic forces acting on vehicle roofs in real-world rollovers.

Perpetuating this anachronistic approach evades a systems engineering response to rollover crash occupant safety, an approach that would rely on a dynamic test protocol that simultaneously demonstrates occupant kinematics and injury responses in actual rollover crashes. The proposed platen test cannot show the effects of actual rollover crashes on vehicle safety systems, including door latch/lock and hinge strength to resist failure leading to ejection and restraint system effectiveness in sustained rollover events to maintain occupant containment and to reduce occupant excursion.[22] Restraint system performance, door component retention effectiveness, and occupant injury mechanisms

[22] These important benefits of a dynamic roof crush resistance standard are also emphasized in the comments of DVExperts at 2.

in rollover crashes shown in compliance tests of a dynamic roof crush resistance standard would be immensely valuable in helping the agency to accelerate the adoption of more effective crashworthiness standards governing the safety performance of these vehicle systems. Instead, NHTSA has chosen a roof crush resistance test approach that cannot provide any information in these areas and therefore delays the development of standards based on dynamic tests in these areas. In fact, choosing a quasi-static platen test undermines the agency separately establishing both active and passive restraint system and seating system standards for rollover protection on the basis of dynamic testing.

The proposal to continue the use of the quasi-static platen test stands in stark contrast to the evolution of other major safety standards from quasi-static to fully dynamic compliance tests, including Standards Nos. 201, 208, and 214. This is recognized in comments filed with the docket: "Each of the other mandated crashworthiness standards rely on a systems approach to crashworthiness. A dynamic test is necessary to evaluate the performance of the rollover protection system, which is made up of the restraints, airbags, glazing, and roof strength."[23] The agency has previously documented the increases in benefits of lives saved and injuries reduced as a consequence of more stringent, effective vehicle design factors and safety performance resulting from dynamic testing, yet it has paradoxically ignored its own record showing the benefits of dynamic testing in the SNPRM.

## VII. A Strong, Effective Roof Crush Resistance Standard Can Achieve Benefits Substantially Greater Than Previously Estimated By NHTSA.

Although NHTSA contends that its revised estimate of the number of head injuries prevented by stronger roofs and the impact of electronic stability control (ESC) in reducing rollover crashes will erode benefits of a strengthened roof crush resistance standard,[24] the benefits analysis provided by the agency in the 2005 proposed rule artificially restricted potential benefits of reduced head, face, and neck injury to only belted, non-ejected front seat occupants.[25] The agency's target population for an amended Standard No. 214 is produced by its statistical approach to avoiding confounders in determining potential benefits and its compliance with the Office of Management and Budget's proscription on double-counting benefits for any proposed rule.[26]

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[23] *Id.* at 4.

[24] NHTSA projected in its 2007 final rule on ESC benefits of between 4,200 and 5,500 deaths prevented annually when full fleet implementation of ESC (beginning with Model Year 2012) occurs. 72 FR 17236 (April 6, 2006). Of the approximately 10,800 annual rollover crash fatalities, this means that ESC will not prevent as many as 60 percent of rollover fatalities. Even if many of those dying in rollover fatalities suffer fatal injuries because of ejection or because of trauma suffered to other body regions than the head, face, and neck, a strong roof crush resistance standard can ensure that many additional lives can be saved in rollover crashes that cannot be prevented by ESC alone.

[25] In contrast, the IIHS Roof Strength Study did not find that belt use was confounding the results of its final regression model. Preliminary models for drivers with reported belt use estimated roof strength effects nearly identical to the effects estimated for all drivers. *Id.* at 12.

[26] *See*, 2007 NHTSA Vertical Roof Intrusion Study at 3.

This method of isolating the purported target population for the benefits of a stronger roof crush resistance standard is largely an artifact of the agency's statistical analysis[27] and thereby substantially underestimates potential benefits of a stronger Standard No. 216. Furthermore, even NHTSA has recognized that it has a very limited set of cases – 32 crashes – from which to infer benefits,[28] some of the relevant cases within the sample lacked data elements, and certain individual cases were assigned very large sample weights. As a result, NHTSA admits that "the characteristics of this limited sample may not accurately represent the full benefits from the proposed roof crush resistance upgrade." 70 FR 49242.

The agency's analysis in the 2005 NPRM pointed out that about 64 percent of the 10,000 occupants fatally injured in rollovers each year are killed when they are either partially or completely ejected during the rollover. This means that about 6,400 fatally injured occupants die from ejection. NHTSA further states that about 53 percent of these fatally injured individuals are completely ejected, and 72 percent of these are unbelted. 72 FR 49227. This amounts to about 3,480 fatally injured occupants who are only partially ejected.

These partially ejected occupants, as well as occupants who are unbelted but who remain within the occupant compartment, might benefit from a stronger roof crush resistance rule even though they do not fall within the agency's artificially restricted potential benefits population of only front-seat occupants who are belted and not ejected at the time of rollover crashes. It is likely that non-ejected, unbelted occupants could suffer fewer severe and fatal head, face, and neck injuries by preserving more rollover survival space gained by highly crush resistant roofs that reduce the chances of impacting rigid roof structures such as headers, rails, and sunroof frames, as well as with the roof proper apart from these framing structures. This inference appears to have at least partial support in the agency's concession that "seriously and fatally injured occupants who had a non-MAIS roof contact injury may also derive some benefit from decreased roof intrusion." *Id.* at 49229.

This inference that many occupants not part of NHTSA's benefits target population may avoid severe injury or death from roof crush in rollovers is also supported by IIHS in its recent Status Report[29] and the IIHS Roof Strength Study that properly point out that real-world benefits can accrue to occupants who are not part of the agency's benefits target population because other crashworthiness system features can have increased effectiveness in tandem with much stronger roofs.[30] Some of the occupants

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[27] *Id.*

[28] The IIHS Roof Strength Study emphasizes that the agency's benefits estimates are based on only 32 National Accident Sampling System/Crashworthiness Data System (NASS/CDS) rollover crashes. *Id.* at 2.

[29] *Status Report*, IIHS, 43:2, March 15, 2008.

[30] IIHS Roof Strength Study at 13.

excluded from NHTSA's benefits target population[31] could nevertheless avoid death in rollover crashes if roofs were appropriately strengthened. In contrast to the agency's very low benefits estimates, the IIHS Roof Strength Study found that after controlling for major confounders, even amending Standard No. 216 to increase the SWR to 2.5X could save 108 lives of the 668 front outboard seat occupants who were killed in single-vehicle rollovers in 2006, and that increasing the SWR to 3.16X could have saved 212 lives.[32]

The increase to 3.16X SWR from 2.5X SWR is less than one full unit, yet the number of lives saved is almost double the number of a standard indexed to 2.5X SWR. Advocates believes that further increases in lives saved by each half-unit SWR increase in roof strength would rise at some unknown but nevertheless exponential rate. Adding a stringent maximum intrusion limit, such as 2 inches, and a minimum residual headroom space as compliance requirements would probably increase these gains by substantial amount while probably also increasing the exponent for each half-unit step in SWR magnifying the number of lives saved. These gains could move upward at even at greater rate given the additional strength supplied by windshield retention when a high SWR with stringent limits on intrusion and residual headroom space interact to ensure higher rates of windshield retention and resistance to cracking.[33] Even introducing fleet-wide effects of ESC benefits in preventing rollover fatalities, estimated at about 60 percent effectiveness for passenger vehicles, cannot reduce real-world benefits to only the untenably small numbers estimated in the 2005 proposed rule.

NHTSA also cannot reduce benefits in any final rule based on the exaggerated figures provided by the Alliance of Automobile Manufacturers (Alliance) for the weight and cost of complying with 2.5X, 3.0X, or 3.5X roof crush resistance standard. The Alliance estimates that it would cost an additional $130 for a large SUV to comply with a 3.5X alternative and that, based on NHTSA's cost studies, "total costs could be 50 percent higher." 73 FR 5488. Similarly, the Alliance estimates that the additional weight of the extra countermeasure design changes to meet a 3.5X SWR standard could be as much as 540 pounds. These inflated estimates are consistent with past Alliance claims that, in each instance, are intended to dissuade NHTSA from adopting a substantially stronger or a more demanding standard in a key crashworthiness safety area. Even NHTSA's own study of the comparative costs and weight needed to upgrade a Ford Explorer to the roof crush resistance level of a Volvo XC-90 SUV "would increase material and tooling costs by [only] $81 and weight by [only] 15 kilograms (33 pounds)." *Id.* at 5489. These

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[31] NHTSA concluded from the evaluation of only 32 crashes in the NASS/CDS that, after excluding convertibles as a class, no benefits of more crush-resistant passenger vehicle roofs would accrue to occupants in one quarter-turn passenger vehicle rollovers, fixed object roof impacts, ejected occupants, unbelted occupants, rear seated occupants, and occupants with no coded roof intrusion over their seating positions. PRIA, Sec. IV; IIHS Roof Strength Study at 2.

[32] IIHS Roof Strength Study at 11.

[33] *See, id.* at 13.

figures are cited and supported by comments already submitted to the docket.[34] The Alliance cost and weight figures for substantial strengthening of passenger motor vehicles to better resist roof crush have no credibility, and NHTSA should continue to reject them.

## VIII. The SNPRM Is Procedurally and Substantively Inadequate.

### A. The SNPRM Has No Supporting Cost-Benefit Analysis to Justify a Final Rule.

The SNPRM has no cost-benefit analysis of the various combinations of test requirements (1-side at 2.5X, 2-sides at 3.0X, *etc.*) suggested by NHTSA as potential regulatory outcomes. The failure to provide the costs and safety benefits of different alternative combinations of SWR with 1-side or 2-sides testing denies the public an opportunity to evaluate NHTSA's justification for a final rule choosing one of these alternatives to amend Standard No. 216. Without the ability to review and critique alternative costs and benefits for different regulatory alternatives, the public is unable to show that a more demanding SWR (that is, a peak force requirement greater than 2.5X) on both sides of a vehicle roof is needed to appropriately reduce occupant deaths and injuries or to challenge an agency cost-benefit analysis that NHTSA believes supports its regulatory choice.

NHTSA states that a number of major factors will substantially change both benefits and costs of a final rule. 73 FR 5488. Among these are major revisions to the benefits population that is the target of the SNPRM because the agency has modified its analysis of the cause of death in rollover crashes, resulting in a reduction by one-third the number of annual fatalities attributable to head injury that were estimated in the 2005 Preliminary Regulatory Impact Analysis. *Id.* at 5485. Moreover, NHTSA states that the installation of ESC on new passenger motor vehicles as a result of the April 2007 ESC final rule, 72 FR 17236 (April 2007), "will significantly reduce both the target population and the safety benefits associated with FMVSS No. 216." 73 FR 5488. Further, the agency forecasts increased costs if a 2-sides regulation were adopted. However, figures for the costs and benefits of these major impacts on various regulatory alternatives are not provided for public review and comment. Instead, NHTSA asserts that "regardless of which alternative is adopted in the final rule, the agency will ensure that the final rule is cost beneficial * * *." *Id.* at 5490. This conclusory assertion does not fulfill the agency's obligation to present the public with the regulatory alternatives it is considering.

### B. The SNPRM Is Not a Proposed Rule.

The SNPRM is incomplete and does not fulfill the requirements for a proposed rule. Without a cost-benefit analysis, without proposing a specific regulatory alternative for comment, and without an assessment of how the rule can be improved at a minimum with the addition of a specific intrusion limit figure and, desirably, with an energy absorption criterion, the supplementary proposal is only equivalent to an advance notice of proposed rulemaking seeking initial data, views, and arguments for various

[34] DVExperts at 2-3.

combinations of prescriptive requirements for a range of regulatory alternatives. NHTSA cannot move from this notice to a final rule without proposing a specific regulation and without a cost-benefit analysis of all regulatory alternatives, especially in light of major changes in costs and benefits that the agency anticipates because of the new considerations indicated in the foregoing paragraphs of Section VIII of these comments. That cost-benefit analysis must include an assessment of each regulatory alternative, including the alternative proposed by NHTSA for amending Standard No. 216. The cost-benefit analysis must also comprise an assessment of the injury prevention benefits of an energy management criterion, a maximum residual headroom limit, and the addition of a specific vertical intrusion limit to a SWR value governing an amended standard.

The SNPRM regulatory alternatives comprise several different possible combinations of SWR with a 1-side or 2-sides platen test, with a simple no head contact criterion. These are the principal components of a prospective final rule. It is clear that the agency cannot proceed to a final rule on the basis of this SNPRM given its own finding in its recent 2007 NHTSA Vertical Roof Intrusion Study, as buttressed by the more detailed findings of the IIHS Roof Strength Study, that the number of fatalities and the extent of severe injuries are directly linked to the interaction of roof crush resistance with the amount of intrusion.

**C. NHTSA Has Authority to Establish a New Deadline for Issuing a Final Rule.**

Contrary to NHTSA's claim that it has to accelerate its rulemaking action to meet a statutory deadline by dispensing with a new assessment of costs and benefits for this SNPRM, SAFETEA-LU provides an opportunity for the Secretary to inform Congress that the enacted regulatory deadline cannot be met and to select a new deadline.[35] There are major unresolved issues and a lack of an adequate cost-benefit analysis impacting the supplementary proposed rule. There is no need or justification for NHTSA to short-circuit the rulemaking process by requesting comments without a complete cost-benefit analysis showing the impacts of different regulatory alternatives, including alternatives that must include evaluation of the benefits of an intrusion limit. The SNPRM openly compromises the public in responding to a specific proposed regulation with required supporting materials justifying the agency's choice. It is indefensible for the agency to issue a final rule without any justification in the SNPRM why, at a minimum, the agency needs to forego an adequate cost-benefit analysis of the regulatory alternatives it is considering, in light of the explicit discretion that Congress provided for NHTSA to set new rulemaking deadlines. It is too important to a major opportunity to advance public safety to rush the adoption of a rule that clearly is not ready, especially when Congress

[35] SAFETEA-LU specifically provides the Secretary and NHTSA with discretion on meeting statutory deadlines for regulatory action:

> (e) DEADLINES.—If the Secretary determines that the deadline for a final rule under this section cannot be met, the Secretary shall—
>
> (1) notify the Senate Committee on Commerce, Science, and Transportation and the House of Representatives Committee on Energy and Commerce and explain why that deadline cannot be met; and
>
> (2) establish a new deadline.

SAFETEA-LU, § 10301(a), codified at 49 U.S.C. § 30128(e).

has provided the agency ample flexibility in giving full consideration to all options for improving rollover safety by requiring stronger roofs.

## IX. Conclusion.

The proposed rule as modified by the SNPRM is still inherently deficient at several major junctures. NHTSA is prepared to adopt a compliance test that, even if indexed to a higher SWR, is arguably weaker than the current standard because it lacks a maximum intrusion limit. The benefits of the agency adopting a much more demanding SWR figure, such as at least 4.0X, accompanied by a stringent intrusion limit of 2 inches and a minimum residual headroom limit of 2 inches, would result in many more lives saved each year even despite the growing contribution of ESC to reducing rollover crashes.

In part, those annual lives saved from reduced head, face, and neck trauma would be further augmented by lives saved from reduced occupant ejections because much stronger roofs would produce less portal deformation leading to loss of glazing and door component retention failures that result in open ejection paths. NHTSA may not be able to count these benefits in its artificially constrained cost-benefit analysis, but these benefits are real and they would be produced as corollary benefits from a much stronger roof crush resistance standard, even one based on a quasi-static roof component test. It is hard to understand why NHTSA, while continuing to demur on the adoption of a dynamic roof crush resistance standard, would pass up an opportunity not only to save many more lives from reduced head, face, and neck trauma due to weak roofs in rollover crashes, but also to gain the additional lives saved from reduced ejections. The agency can acknowledge that ejection benefits would be forthcoming just from a stronger roof crush resistance regulation even if it also had to state that such benefits could not be quantified in this rulemaking action.

A much stronger roof strength standard would also increase the effectiveness of upper interior air bags and curtains because front pillars, headers, and side rails would resist deformation far better and thereby increase the lifesaving benefits of these upper interior passive restraint systems.[36] This is particularly true if the agency also moves forward with upper interior head impact protection systems that are required to have sustained inflation throughout the protracted amount of time that a rollover crash can consume before the vehicle comes to a stop.[37] A weak roof strength standard undermines future agency efforts to combine different strategic responses to occupant compartment safety that provide the safety management synergism that a well-reasoned, systems engineering approach can provide. Even the IIHS Roof Strength Study and DVExperts

[36] "As the number of vehicles with side curtain airbags increase, the likelihood of ejection through the side windows should decrease. However, weak roofs could compromise the protection afforded by these airbags if they allow the roof rails to shift laterally and expose occupants to contacts with the ground." IIHS Roof Strength Study at 13.

[37] DVExperts emphasizes this at 2, 8.

appreciate the effect of a much stronger roof crush resistance standard on other, mutually dependent and interacting safety systems within the occupant compartment. NHTSA should not forswear these prospective benefits, much less undermine its future rulemaking actions in these other crashworthiness design and performance areas, by refusing to adopt a much more demanding roof crush resistance standard along the lines suggested by Advocates in the foregoing comments.

Advocates also wants to emphasize here that NHTSA apparently regards any quasi-static test method for determining roof crush resistance to be essentially occupant age-neutral in its effects, despite its own 2007 NHTSA Vertical Roof Intrusion Study finding a statistically significant correlation of roof crush with front seat occupant age.[38] Unfortunately, that unstated assumption clearly is not the case. The IIHS study also found strong correlations of significant injury risk increases – 12 to 13 percent – for each 10-year increase in driver age.[39] To date, NHTSA has offered a proposed roof crush resistance regulatory proposal that disregards the substantial greater propensity to injury of older vs. younger vehicle occupants, despite the fact that the 8 adjusted models of its 2007 Vertical Roof Intrusion study found that occupant age was one of the 4 statistically significant variables.[40] Given the rapid "squaring" of the demographic pyramid in the U.S., with disproportionately large increases each year in both the number and percentage of older passenger vehicle occupants, NHTSA has an obligation to err on the side of caution by adopting a standard that will afford substantially increased protection to older front-seat occupants who are more prone to severe injuries and death in rollover crashes where roof crush is the main cause of head, face, and neck trauma. The SNPRM foists starkly inequitable safety impacts on older Americans. If the agency does not adopt a standard that affords substantial protection to older vehicle occupants in rollover crashes involving roof crush, the agency will be imposing substantially more severe injuries and societal costs on a rapidly aging U.S. vehicle occupant population.

NHTSA cannot issue a final rule based on the SNPRM. The SNPRM is essentially procedural window-dressing without advancing a specific, substantive regulatory proposal for public review and comment. The proposal is incomplete without a specific assessment of injury and fatality prevention from the various regulatory alternatives on which the agency requests comments, without the consideration of a specific roof vertical intrusion limit and energy absorption criterion, and without an assessment of the different costs and benefits of these alternatives.[41] The agency cannot issue a final rule without prior notice and comment that provides the public an opportunity to assess NHTSA's cost-benefit analysis and its injury and fatality claims for different regulatory alternatives taking these considerations into account. A final rule issued on the basis of the SNPRM and the existing rulemaking record would be subject to

[38] 2007 NHTSA Vertical Roof Intrusion Study at 16.

[39] IIHS Roof Strength Study at 14.

[40] 2007 NHTSA Vertical Roof Intrusion Study at 16.

challenge. NHTSA should instead avail itself of the explicit statutory permission granted the agency to establish a later date for completing roof crush resistance rulemaking in order to provide a more reasonable and effective regulatory proposal with ample opportunity for public comments on the merits.

Respectfully submitted,
**ORIGINAL SIGNED**
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