October 28, 2014

Mr. David J. Friedman, Deputy Administrator
National Highway Traffic Safety Administration
U.S. Department of Transportation
1200 New Jersey Avenue, SE West Building
Washington, DC 20590

RE: Petition to Improve Federal Motor Vehicle Safety Standards (FMVSS) 213, 207 & 301.

Dear Mr. Friedman:

My name is Kenneth J. Saczalski and I have been performing engineering research studies and consulting in the area of transportation occupant safety for more than 40 years. This includes service as a technical advisor on vehicle safety matters to two US Secretaries of Transportation while I was a member of the National Motor Vehicle Safety Advisory Council during the 1970's. A copy of my CV, with citations to several of my co-authored publications related to transportation safety research findings, and failure analysis of structural systems, is attached to this letter.

During the past two decades, my research has uncovered what I, and my colleagues, consider to be a serious problem related to a notable increase in the fatal and serious injury sustained by rear seated occupants, especially infants and children, when subjected to rear impact accidents. Our research deals primarily with multi-variable experimental studies correlated and combined with analysis of actual accident situations. The primary findings of our experimental and case studies are consistent with findings from independent statistical studies performed by other researchers using appropriate size data bases regarding child injury and fatalities in rear impacts.

This past year I, and my co-authors, have published and presented some of our more recent findings. These publications were presented at the 2014 American Academy of Forensic Sciences meeting in Seattle this past February[1], and the 2014 FISITA World Automotive Congress held in Maastrict, Netherlands, in June of this year[2]. I am attaching for your review and information a copy of the respective papers and the slides from the Power Point Presentations given at those 2 meetings. Briefly summarized, our experimental and case studies have found that, among other factors, front seat strength and rearward deformation of the front seat occupant into the rear seated child's occupant space are main factors in the cause of fatal and/or serious injury increases to rear seated children. Also, our research has found that violation of the child occupant volume from the rear, due to ease of intrusion from poorly designed vehicle rear structures, provides an added dangerous injury contributing factor caused by pushing the child forward into the rearward deforming front seat system. In addition, our review of FARS data have noted that the fatalities in the infant age group (i.e. newborn to 12 month old), during the time span of 2001 to 2011, have nearly doubled in

[1] K. Saczalski, M. Pozzi, J. Burton, T. Saczalski, P. Baray, "Experimental Study of Seat back Recliner Sudden Failure & Effect on Rear Child Injury in Rear Impact", AAFS 66th Annual Meeting, Seattle, WA, Feb., 2014.
[2] K. Saczalski, M. Pozzi, J. Burton, T. Saczalski, "Experimental & Field Accident Analysis Study of Factors Effecting Child Occupant Injury Risk & Safety in Rear Impacts', FISITA paper F2014-AST-013, 2014.

comparison to the earlier time span of 1990 to 2000. Similar statistical findings, relating to child fatalities and seat deformation, were found by other researchers, such as Norma F. Hubele[3], Ph.D. (Statistical Consultant, Refrac Systems, Chandler, Arizona) and Jermakian, et al., from the Childrens Hospital of Philadelphia (2008)[4]. The results and findings from these statistical studies are cited in our attached 2014 papers and are briefly summarized below.

In the study by Dr. Hubele it was found that *"while rear impacts account for only about 4% of all occupant fatalities in the U.S., the children in the (NHTSA) recommended rear seat area account for 11% of all child fatalities"*. These findings are consistent with the 1997 findings by IIHS that indicated rear seated children were 61% more at risk of fatalities in rear impacts than in any other crash vector[5]. The 1997 IIHS study pointed out that *"The one crash circumstance in which rear seats placed children at increased risk of death was when vehicles were struck in the rear."* The IIHS statistics were published very soon after the NHTSA campaign to 'put kids in the rear seat to avoid airbags', and showed that there was already clear proof of a significant problem with rear seated occupant protection. With regard to the FARS data in our study, and that of Dr. Hubele, there is no specific reliable national data base to verify the role of the front seat strength issue in the child deaths; however, as noted above, our multi-variable experimental testing, and case study correlations, have provided added valid scientific information to enhance understanding of the statistical results. For instance, our multi-variable controlled experimental findings have clearly shown that the front seatback strength and excessive rearward deformation are primary rear occupant injury related factors, along with other lesser, but important, factors as described in our 2014 FISITA and AAFS papers. Also, the more recent statistical study by Jermakian, et al., using a statistically significant data base (larger than that available in the national data bases alone) clearly identifies front seat deformation as an important key factor associated with injury increases to rear seated children in rear impacts (as similarly shown by our case studies and multi-variable test results, which have been published in many venues over the past years).

The results of our findings, and the consistency with the findings of the statistical studies cited above, should be sufficient to show the importance of the need to improve the rear impact safety problem facing both the front and the rear seated occupants. In essence, the rear impact problem is significant and it should be raised to a national safety priority level.

These issues are not just recent findings. Twenty five years ago, I petitioned the NHTSA in April of 1989 to examine the performance requirements of FMVSS 207 because of my concerns related to deficiencies in the 207 standard at that time, and the need to address occupant injury risks for both front and rear seated occupants. In addition, in November of 1989 I indicated to the NHTSA that, rather than a quasi-static minimum seat strength requirement, I preferred a more realistic dynamic evaluation with a full vehicle interior (similar to the test situation of the newer FMVSS 301 where a deformable moving barrier, traveling at 80 kph, impacts into the rear of a stationary complete vehicle with front seated

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[3] Personal Communication between Dr. Hubele and Dr. Saczalski in January of 2014.

[4] J. Jermakian, K. Arbogast, K. Durbin, M. Kallin, "Injury Risk for Children in Rear Impacts: Role of the Front Seat Occupant", Presented at the 57th AAAM Annual Conference, October 2008.

[5] E. Braver, Whitfield, Ferguson, "Risk of Death Among Child Passengers in Front and Rear Seating Positions", SAE paper No. SAE 973298, 1997.

surrogates). Note that my petition covered issues which had been addressed by earlier proposed NHTSA rulemaking in 1974.

As a result of my 1989 petition the NHTSA did begin to study the seat rear-impact safety performance issue in about 1990. Unfortunately, about 10 years ago in 2004, the NHTSA Chief Counsel and Acting Administrator, Jacqueline S. Glassman, decided to terminate the NHTSA study and, strangely, this termination occurred during the time that I was testifying in a trial that involved a front seat failure in a Chrysler minivan where an 8 month old infant, Joshua Flax, was fatally injured when the front seat collapsed rear and the 90kg front adult impacted the head of the infant during a rather low speed velocity change of about 27.5 kph (i.e. just above school zone speed). During my testimony I discussed a vehicle-to-vehicle test that I ran showing the dangers of the weaker OEM seat in a side-by-side comparison with an alternate, and more reliable, commercially available stronger belt-integrated-seat (BIS) offered by Chrysler in another vehicle (i.e. Chrysler Sebring Convertibles starting in 1996). In spite of the 207 petition termination by the NHTSA, which was noted by the Chrysler defense attorneys during trial, the Jury had the opportunity to see the data and videos from the test that I ran and the Jury awarded over 100 million dollars to the family of the infant. I am attaching a CD with a video composite of the Flax case crash test and data.

Because of the extensive amount of findings generated from the years of research, tests and accident case analysis performed by myself, and my colleagues, in cases like the Flax case, I am "once again" petitioning the NHTSA to now consider my 2014 suggestions, given below, for improvements to FMVSS 213, 207 and 301. This request is being made because my colleagues and I believe that more than a few dozen lives of front and rear seat occupants (especially infants and children) who are subjected to rear impacts can be saved each year by implementing these following suggestions. In addition, the numbers of those seriously injured with brain damage, paralysis, rear seat entrapment in fires, or otherwise injured due to loss of control, slack seat belts, etc., will also be reduced.

Specifically, with regard to the 213, I believe it is absolutely necessary that the FMVSS 213 be upgraded to include a rear impact phase of at least the level of the ECE Regulation 44 "rear impact criteria". Also, I feel that the rear-impact speed requirement of 25 kph in the ECE-44 should be increased up to 40 kph in the suggested U.S. version. This is only logical since human tolerance to rear impact has been proven since the 1950's to be approximately double the tolerance to frontal impact, but only if crashworthy seats and head restraints are provided which insure adequate restraint and protection to both front and rear seat occupants. This was proven by dynamic testing by UCLA, the Experimental Safety Vehicle and Research Safety Vehicle programs and early NCAP rear impact tests, among many others.

With regard to the 207 standard, our studies have shown that it is necessary that the quasi-static seat strength testing be conducted to "ultimate strength levels" that establish the seat's capacity to withstand predictable occupant rear crash loads as well as to resist collapse into the survival space of other occupants. This needs to be conducted with repeat testing that examines potential strength variations and possible failures associated with adjustable seat components, such as seat cushion height adjusters (i.e. "high and low" height position adjustment linkage sudden separations, as an example), recliners (i.e. gear teeth disengagement failures, as another example) and track position adjuster sudden release.

The ultimate loading and repeat testing with adjuster normal use and angular load variations are necessary to evaluate the "reliability" of a seats load carrying capability, and to also demonstrate that the important front occupant load resistance support levels can be reliably achieved without experiencing sudden load collapse from seat component failures like the results caused from "recliner gear-teeth slipping". These types of component and seat support "sudden load drop-off" failures were noted in my 2014 co-authored papers cited above. These types of "sudden load drop-off", or "collapse" failures, were also noted by a NHTSA researcher, Louis Molino in 1998[6] when he found gear-teeth failures like those found by myself, and my colleagues during our analysis of child fatal cases where some of the collapsing seats in our studies were identical to those tested by Molino. In essence, to be of some value, the 207 should be modified so as to "not allow" "sudden load collapse", or drop-off, of any structural support component where the occupant support loading drops "suddenly" by 400 pounds, or greater, within a short span of rearward deformation, as shown by some of our test results given in the 2014 publications.

Also, during these 207 tests the seat loading should be applied by a more realistic "torso-body-block" device, like that used in our tests since the early 1990's, which is designed to replicate the upper body weight of a 95th percentile male torso so as to more realistically load the seat cushion and seat back like a human subject. The "torso-body-block" load device was publicly reported on by Saczalski at the 1995 SAE TopTech on "Seat Design for Automotive Safety". That presentation was voted "Best Presentation" by the audience, which was comprised mostly of automotive seat design engineers[7]. In addition to the repeatability and reliability issues, the 207 should also be amended to require that the mechanical torque resistance of the seat be measured from the pivot intersection of the seat back structure and the seat cushion frame (not the "H" point) up to the load application line of the torso-body-block (i.e. about 30 cm) and the torque should reliably reach greater than 20,000 inch-lbs.

Finally, in a manner analogous to the surrogate injury risk measures and evaluations made in full vehicle frontal impact tests in the FMVSS 208 compliance, it is also absolutely necessary for the benefit of rear seated child safety in rear impacts that a similar testing be made for evaluation of child safety in rear impacts. This can be accomplished easily by implementing the more recent newer version of the 301 (i.e. fuel system rear impact integrity) standard, and modifying this requirement so that the right front seat is occupied by a instrumented 95th percentile male surrogate (in light the increasing size of the U.S. population) and that the seat behind should contain a 12 month instrumented CRABI surrogate seated in an appropriate 213 compliance tested "forward facing" child seat. The requirements for this improved 301 test (which is consistent with my suggestion in 1989 regarding my preference for full vehicle interior dynamic testing) should require that both of the right side surrogates should meet their respective NHTSA injury reference levels for head, neck, chest and extremities. In addition, the right front seat should be initially positioned ¾ back from full front on the track and the seat back should not experience any component failures. Ideally, the seat back should

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[6] L. Molino, "Determination of Moment-Deflection Characteristics of Automobile Seat Backs", NHTSA Office of Crashworthiness Standards Report, November 23, 1998.

[7] K. Saczalski, "Evaluation of Seat Strength and Energy Absorbing Characteristics Related to Occupant and Vehicle Impact Characteristics", Presented at the SAE TopTech on Seat Design for Automotive Safety, Marina Del Ray, CA, August, 1995

not rotate rearward more than 25 degrees from the initial design orientation of about 20 +/- 4 degrees from vertical. This is similar to the requirements of manufacturers, as noted on page 22 in the 1997 NHTSA sponsored seat study conducted by EASi and Johnson Controls[8]. In addition, this dynamic full vehicle test criterion should evaluate the potential danger of penetration of rear cargo components, like several 20 kg simulated luggage cases stored in the trunk area, which could shove the rear-seated child forward into a yielding front seat if rear seatback failure occurs. In essence, the safety of the rear child should be evaluated whether the child is injured due to the front seat collapse and/or the child occupant compartment intrusion from the rear. My co-authors and I have discussed some cases involving the rear occupant space violation issue in our recent 2014 publications.

The comments and requests made in this petition are based on not only hundreds of field investigations involving a wide variety of vehicle types, occupant loading and rear impact configurations, conducted by my colleagues and myself since the 1990's, but are also based on analysis including numerous NHTSA rear crash tests with instrumented front and rear seated dummies dating back to the 1970's. Specifically, my colleagues and I have run over one hundred dynamic rear impact crash tests, plus over 100 quasi-static seat tests, during our evaluation of numerous actual cases involving serious to fatal injury of rear seated children and front adults. The crash tests have included both full vehicle testing and sled-body-buck testing. The vast majority of the crash tests have included "side-by-side" (SBS) comparisons of occupant safety performance measures resulting from tests using the weaker, less-reliable, seat systems versus the stronger and more safety reliable seats like the belt-integrated (BIS) types. These tests have evaluated head restraint effectiveness, vehicle-anchored seat belt slackening, and relative protection of front and rear seat occupants in various seat designs in crashes with changes of velocity of 8 to more than 30 mph. Some videos and data from an example of our SBS seat crash comparison tests, using 95th percentile H-III's seated in dual recliner front seats in front of child surrogates, are included on the CD with the Flax test data.

The safety value of BIS designs, as shown in our studies, was also clearly recognized by NHTSA funded researchers in the 1990's, like the EASi and Johnson Controls studies cited above. These studies focused on an "Advanced Safety Seat" (which was similar to the Johnson Controls BIS design that has been used since 1996 on the Sebring convertible) that indicated a notable reduction in harm to vehicle occupants compared to conventional seats. Statistical studies by Garthe and Mango have also confirmed the value of the BIS designs[9]. It is puzzling to myself and my colleagues why such a valuable improvement in vehicle occupant protection, which has been proven to be lightweight, technologically and economically feasible in the U.S. for over 25 years, has not been adopted.

One other note or point of information; there have been on occasion articles published in recent years by researchers representing other points of view for the defense of weaker and/or less-reliable seat safety systems. These publications, sometimes authored by researchers who at one time or another had truly contributed some valid transportation research findings in the past, are now being offered as "allegedly scientific" research that in reality are no more than

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[8] V. Gupta, R. Menon, J. Gupta, A. Mani, I. Shanmugavelu, "Advanced Integrated Structural Seat", NHTSA Contract No. DTNH22-92-D-07323, Task-11, February 1997.

[9] E. Garthe, N. Mango, "Standard & Integrated Restraint First Row Seat Performance In Rear Impact Crashes", NHTSA VSR/ESV Conference, Washington, DC, June, 2011.

attempts to inaccurately skew or distort the findings of the many safer systems that have been demonstrated and proven, by myself and my colleagues, through our case analysis studies and our experimental side-by-side test evaluations of seat safety systems. Some of these inaccurate, misleading studies have been submitted to NHTSA as supposed 'proof' of how existing inadequate seat, head restraint and belt designs are performing in crash tests and real world crashes, and we (my colleagues and myself) recognize that these types of misleading submissions can result in confusion and delays in needed safety regulatory action. However, we hope that our input will help to correct this delaying situation.

In addition, it should be pointed out that some of the defenses of failed seats, head restraints and vehicle-anchored seat belts are in strong contradiction with the auto industry's own warnings and instructions published in vehicle owner's manuals to not recline seatbacks or adjust seat tracks while a vehicle is in motion, because such seat movement will decrease seat belt effectiveness, increase injury risk and can lead to loss of control. If such predictable hazards are known as a result of voluntary seat movement, then they certainly exist for involuntary seat movement at substantially greater force levels during a collision.

Fortunately, our technical review of these contradictory published materials has shown that these types of articles contain many significant technical errors (whether on purpose or by design is for others to decide) and as a result these articles arrive at incorrect conclusions that try to disparage our scientifically valid safety findings. In certain instances these types of inaccurate articles have been precluded by the Courts from being used as evidence during trials or legal hearings related to safety system performance issues. Also, these types of articles often suggest various obscure reasons for not using the safer seat systems that we have demonstrated are superior to the weaker and/or less reliable designs. Ultimately, we have responded to these types of misleading claims by publishing rebuttal articles, with accurate and scientifically valid supporting data, in various peer reviewed technical venues such as the FISITA[10] and AAFS[11]. Copies of some of these materials are included in the CD.

Finally, as in my letter to NHTSA of 25 years ago, both my colleagues and I would, once again, be most happy to provide you or your staff with more detailed information if so desired (assuming of course that the request is not an unreasonably costly endeavor to my colleagues or myself). Your help in correcting this rear impact national safety matter involving needed protection for child victims, and others, would be greatly appreciated. In order to assist your staff I am attaching a CD with several of the references cited herein.

Yours truly,

Kenneth J. Saczalski, Ph.D.

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[10] K. Saczalski, M. Pozzi, J. Burton, T. Saczalski "Multi-Variable Experimental Matched-Pair Comparison of Rear Impact Occupant Protection Performance of Strong Belt-Integrated Vehicle Seats versus Weaker Non-Belt-Integrated Types", FISITA 2010 World Automotive Congress Paper F2010-C-112, 2010.

[11] K. Saczalski, M. Pozzi, J. Burton, "Strong versus Weak Seats: Analysis of "Matched Rear" Impact Tests for Head & Neck Injury Risk Evaluations with Normal Out-of-Position Adults", Presentation at the AAFS 60th Annual Meeting, Washington DC, 2008.

APPENDIX TO SACZALSKI NHTSA LETTER OF OCTOBER 28, 2014
List of Reference Materials Contained on CD Attached to the Letter

1. Copy of Paper: Saczalski, et al. "Experimental Study of Seat back Recliner Sudden Failure & Effect on Rear Child Injury in Rear Impact", AAFS 66th Annual Meeting, Seattle, WA, February., 2014.
2. PDF Copy of Power Point Presentation: Saczalski, et al. "Experimental Study of Seat back Recliner Sudden Failure & Effect on Rear Child Injury in Rear Impact", AAFS 66th Annual Meeting, Seattle, WA, Feb., 2014.
3. Copy of Paper: "Experimental & Field Accident Analysis Study of Factors Effecting Child Occupant Injury Risk & Safety in Rear Impacts', FISITA paper F2014-AST-013, 2014.
4. PDF Copy of Power Point Presentation: "Experimental & Field Accident Analysis Study of Factors Effecting Child Occupant Injury Risk & Safety in Rear Impacts', FISITA paper F2014-AST-013, 2014.
5. Copy of Paper: J. Jermakian, et al., "Injury Risk for Children in Rear Impacts: Role of the Front Seat Occupant", Presented at the 57th AAAM Annual Conference, Oct. 2008.
6. Copy of Paper: E. Braver, Whitfield, Ferguson, "Risk of Death Among Child Passengers in Front and Rear Seating Positions", SAE paper No. SAE 973298, 1997.
7. Copy of Paper: L. Molino, "Determination of Moment-Deflection Characteristics of Automobile Seat Backs", NHTSA Office of Crashworthiness Standards Rpt, Nov. 23, 1998.
8. Copy of Paper: V. Gupta, et al., "Advanced Integrated Structural Seat", NHTSA Contract No. DTNH22-92-D-07323, Task-11, February 1997.
9. Copy of Paper: E. Garthe and N Mango, "Standard & Integrated Restraint First Row Seat Performance In Rear Impact Crashes", NHTSA VSR/ESV Conf., Wash., DC, June, 2011.
10. PDF Copy of Paper: Saczalski, et al., "Multi-Variable Experimental Matched-Pair Comparison of Rear Impact Occupant Protection Performance of Strong Belt-Integrated Vehicle Seats versus Weaker Non-Belt-Integrated Types", FISITA 2010 World Automotive Congress Paper F2010-C-112, Budapest, Hungry, June 2010.
11. PDF Copy of Power Point: Saczalski, et al. "Strong versus Weak Seats: Analysis of "Matched Rear" Impact Tests for Head & Neck Injury Risk Evaluations with Normal Out-of-Position Adults", Presented at AAFS 60th Annual Meeting, Washington DC, 2008.
12. Video of Saczalski Crash Test from Flax Case and PDF Copy of Power Point Data.
13. Videos and Data for 40kph delta velocity seat test comparisons of Dual Recliner vs BIS: 95th in Front Seats & child surrogates located behind in Forward Facing Child Seats (see FISITA 2014 paper tests 3CS-3 driver side dual recliner & 3CS-4 right front BIS side)