September 28, 2015

Administrator
National Highway Traffic Safety Administration
U.S. Department of Transportation
1200 New Jersey Avenue S.E.
West Building
Washington, DC 20590

Re: PETITION to Amend 49 CFR 571.207, FMVSS 207-Seating Systems

Dear Sir or Madame:

Alan Cantor of ARCCA submitted a petition to the NHTSA in 1989 recommending improved seating to protect occupants during rear impacts. The NHTSA accepted the petition, held it for a number of years, and then eventually did nothing to change the standard.

Since 1989, hardly a day passes that we are not faced with an issue related to seat failure in a rear-end crash and the resultant serious injury that such a failure causes. As automotive seating and restraint experts here at ARCCA, we have been involved in hundreds of seat back failure litigation cases, the vast majority of which have settled prior to trial. As part of our work on these cases, we have had the opportunity to review seat strength data from various auto makers, and we have been involved in the conduct of a variety of both static and dynamic tests on the failing seats as well as on seats that can withstand the types of forces typically seen in today's passenger vehicles that are involved in rear-end crashes. In addition, we have seen both the published and non-published research and data from many others, including most vehicle manufacturers. What is clear from all of this is that automotive seats are more than just "chairs" to allow people to comfortably drive cars or for passengers to be transported in luxury: seats are also safety devices that provide restraint and, in a rear-end crash, the seatback should afford the same kind of protection to the user that a seat belt provides in a frontal impact.

In its current form, unfortunately, FMVSS 207 is nothing more than a ***static*** standard for the ***empty*** seat structure, without any consideration at all to what happens to the user during a rear-end crash. In essence, FMVSS 207 requires the seatback to withstand a rearward moment value of only 3,300 inch-pounds. This absolutely minimal requirement is barely adequate to accommodate the normal wear and tear on the seat from regular driving, and does not address the seat strength required in even insignificant rear-end crashes. To put this into perspective, we have tested lawn chairs and cardboard

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seats, as ridiculous as that sounds, which have met or exceeded the 3,300 inch-pound requirement. Mathematically, a seat built to just 3,300 inch-pounds will fail rearward during a 2-5 mph rear-end collision depending on the weight of the occupant. Furthermore, the only dynamic test called for in FMVSS 207 is an acceleration test of 20 G, and that again is only concerned with components of the unoccupied seat not releasing under that acceleration level.

Since 1989 when ARCCA last petitioned the NHTSA regarding the FMVSS standard, three critical factors have occurred:

1. The NHTSA and the auto industry have undertaken an extensive education campaign to instruct parents to place children in rear seating positions behind the front seats. This step was taken due to the introduction of front passenger airbags and the risk they pose to children. The NHTSA's rationale was that the rear seat is deemed to be the safest location for children during crashes due to the potentially injurious hazards to children caused by deploying airbags. However, seats designed with insufficient rearward seatback strength essentially force parents to unknowingly place children behind a seat whose seatback can collapse rearward during a collision and cause extensive harm to the child in an otherwise protectable collision. Furthermore, there is no warning, for example, to "Place the child behind the unoccupied seat, if possible" or to "Place the child behind the lightest weight front occupant, if possible" (since the propensity of a seat to fail in a given rear-end collision is directly proportional to the weight of the occupant.)

2. Consumers are now able to evaluate the safety of cars through a star rating system based on a variety of key safety protection metrics. Unfortunately, rear impact protection is not one of them. Consumers still have no way of determining whether the car they are purchasing contains a safe seat or a dangerous seat, one that would protect them and their families in a rear-end collision, or one that would cause significant harm to them or their families. The reason for this is that there is no testing protocol utilized to evaluate the safety of seats during significant rear-end collisions.

3. In 1989, many of the automotive seats sold were of the type that would yield or fully collapse backwards during even relatively benign collisions and prove catastrophic at higher level collisions. Today, a number of manufacturers have developed stronger seats while others still have the older style of weak and collapsing seats in their vehicles, or while others have a mix within their own products based on trim choice. Thus, the best way to describe today's seat performance is to call them random and inconsistent, sometimes even within the same manufacturer.

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When dealing with the issue of seat failure and collapse in a litigation setting in cases investigated by ARCCA, the auto manufacturers maintain that the seats they install in their vehicles are designed to "yield" in rear impacts and thus provide whiplash protection (AIS1 and AIS2 injuries) to the occupant in the front seat. However, the current data shows that such minor AIS1 and AIS2 injuries can be avoided with a good head restraint design in an upright seat, while excessive yielding introduces the potential for serious to catastrophic injuries. Let's look at yielding a bit closer: when a metal structure is loaded beyond its designed strength point, it naturally yields, thus any seat will "yield" when presented with a high enough load. The question is what strength should the yield point of the seat be set to and how should the seat react throughout the foreseeable loading regime? The answer is to pick a desired performance level and set the strength high enough to protect all occupants in foreseeable crashes at and below that performance level. The current standard does not do that.

Our testing and evaluation of seats has shown that no seat on the market just simply meets the minimum rearward strength level called out in FMVSS 207 (3,300 inch-pounds). In fact, some of the weakest and worst (most likely to fail) seats on the market often test out at approximately 2-1/2 times (~8,000 inch-pounds) the compliance level, while some of the stronger seats test out at over 10 times the standard (~35,000 inch pounds). Let's use the following example to put this in perspective: assume there are two occupants in the vehicle, a driver weighing 200 pounds with a child sitting in the left rear seat, directly behind the driver when the vehicle is impacted from behind and experiences a crash equivalent to the crash test that is routinely performed for fuel tank integrity (FMVSS 301contains a test to ensure that there will be no excessive fuel leakage, but does not address what happens to the seats and occupants inside the vehicle). Let's assume that the occupant space experiences an acceleration of approximately 15G sustained (20 G peak) which is typical in FMVSS 301 testing. Such a hypothetical crash would produce a moment into the driver's seat back of between 25,000 and 29,000 inch-pounds (based on standard crash mathematics). Clearly the strength of the 8,000 inch-pound seat would be well below the strength needed to withstand this moment and complete collapse of the seatback will result. With the complete collapse, catastrophic injury would likely occur when the driver slams into the back seat area and/or into the child behind them. The outcome of this hypothetical crash with the 35,000 inch pound driver's seat would be non-lethal for both occupants, since the stronger driver's seat would have sufficient strength to hold up to the crash, prevent ramping, restrain the occupant, and prevent contact between the front and rear occupant.

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In addition to the risk to children in the back seat, such seat failures in rear-end crashes also create the following risks:

1. Seat back failure causes loss of seat belt restraint to the occupant in a multiple collision crash. Note that most owner's manuals warn not to have a seat reclined while the car is in motion because this will affect seat belt protection, yet failure of a front seat essentially places the seat in a reclined position;

2. Seat back failure of the driver's seat will result in loss of control of the vehicle since a driver cannot operate a vehicle when the seatback is collapsed rearward and the driver is now looking up at the roof. This often becomes a problem when the car is still in motion after the rear-end impact and has led to otherwise avoidable additional impacts during a crash event;

3. Seat back failure often leads to ramping of the occupant seated in the failing seat. Ramping is a term of art used to describe the condition that permits the belted occupant to slide rearward up the failed seat back and essentially causes the occupant to slide backwards under and out of the seat belt. This has resulted in total or partial ejection of occupants from the vehicle, and has also resulted in the occupants striking the seat, person, or structure behind them. The types of injuries sustained in these incidents are generally to the central nervous system (spinal cord and/or brain). What compounds the ramping issue is that the NHTSA currently has no requirement to inhibit ramping, which can be done through judicious selection of seat design, seat belt components/design, and/or seat belt geometry. Some manufacturers have designed such features into their vehicles, while others have not.

It is important to note that even without federal guidance and/or requirements, a number of manufacturers have addressed the problem of insufficient rearward seat strength on their own to varying degrees. The problem is that the inadequate standards allow some of the manufacturers to still provide seats with dangerous and inadequate strength. As a result of that, the motoring public has no way of knowing what type of seat they are getting and, therefore, no knowledge of how it will perform in a rear-end crash. It is precisely because of these types of potentially dangerous inconsistencies and to maintain a level playing field amongst competing manufacturers that the outdated FMVSS 207 standard needs to be revised and improved to reflect the reality of rear-end crashes. For these same reasons, a rear-end crash test should also be added to the New Car Assessment Program (NCAP) to provide consumers with the information they need to determine if the vehicle they are buying provides effective rear impact crash protection and to provide incentive to manufacturers to develop enhancements to rear impact crash protection.

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Recommendations:

As with the 1989 petition, our intent is to prevent ramping of the occupant into the rear seat as well as to protect both front and rear occupants by eliminating the hazard caused by a collapsing seat. The revised FMVSS 207 should address the following issues:

1. **Seat Strength** – Clearly, the physics of rear-end impacts dictate that occupants of different weights (or mass) will result in different loading of the seatback under the same rear-end crash conditions. Since weight and acceleration are directly proportional, increases in acceleration with the same weight occupant would provide comparable results to increasing the occupant weight given the same acceleration. Accordingly, we recommend both an FMVSS 207 dynamic test as well as an NCAP test. We recommend that the NHTSA either use the FMVSS 301 test that already exists (and add interior cameras) or conduct a sled test with parameters equivalent to the FMVSS 301 crash pulse. If the NHTSA chooses to use the sled test, then a test with a 20 G "peak" and the delta-V and time duration parameters equivalent to the FMVSS 301 crash pulse should be utilized. This will ensure that the test will closely replicate the loading conditions seen in the FMVSS 301 testing. This test should be coupled with an NCAP test so that the rear impact crash protection can be integrated into the star rating for the vehicle. Keeping with the NCAP practice of going beyond the standard, the NCAP test should be at 5 mph greater than the FMVSS 301 pulse. All tests should be with a Part 572, hybrid-III 50^{th} percentile male dummy on the seat. Thus, through equivalency, the NCAP test will represent the crash conditions of FMVSS 301 with a 95^{th} percentile dummy. It is recommended that the dynamic evaluation criteria for the seat include that the dynamic rearward deflection of the seatback should not exceed 15 degrees beyond the initial seatback angle and that there be no complete separation of any part of the seating system. This deflection can be easily assessed using a methodology similar to that employed in FMVSS 213-Child Restraint Systems, to evaluate the deflection of child safety seats during the testing specified in that standard. The complete separation criteria is similar to the seat belt anchorage criteria found in FMVSS 210.

2. **Structural Symmetry** – In order to provide effective protection under varying degrees of rear impact directions, strength of the seat structures should be designed symmetrically, so that support is provided equally to both sides of the seatback structure. Dynamically, this will minimize the potential of the seatback twisting excessively under load. Such twisting can introduce a rotation to the upper body of the occupant, thus facilitating rearward ramping and/or causing non-uniform loading and/or an out-of-position orientation during subsequent impacts. The solution is to require the seat to be capable of meeting the strength requirements in rear impacts of +/- 30 degrees from the longitudinal vector, similar to the frontal impact

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requirements of FMVSS 208, with no more than 10 degrees of differential rearward deflection between the left and right sides of the seatback.

3. **Ramping** – Ramping is the term of art referring to the rearward motion of a seat occupant along the excessively yielded, or collapsed, seatback. This motion causes the body to move away from the seat belt and reduces the restraining effect provided by the seat belt. In some cases, the rearward ramping of the occupant can result in the partial or even complete ejection of the occupant from the vehicle. Rearward ramping of the occupant due to excessively yielding, or collapse of the, seatback will also introduce impacts with rear seat structure and/or occupants in the rear seat. This requirement can be implemented by simply restoring the part of FMVSS 209, paragraph S4.1 (b), that was removed by the NHTSA, which required the lap belt portion of the seat belt to remain on the pelvis under all crash conditions. However, should the NHTSA desire to have an evaluation protocol then one can be readily implemented. Technology available to the auto industry for reducing or preventing rearward ramping allowed by an excessively yielded, or collapsed, seatback includes: use of a sliding/cinching latch plate to prevent excess shoulder belt webbing from transitioning to the lap belt portion and causing the lap belt to go slack; mounting both lap belt anchors to the seat, thus greatly improving seat belt geometry; deployment of seat belt pretensioners in rear impacts as well as other crash modes, such as frontal, side, and rollovers; and mounting the shoulder harness to the seat to stop ramping before it starts. These components will also help to maintain effective restraint after the rear impact when subsequent impacts and rollovers frequently occur. Some of these solutions, either singly or in combination, have already been implemented by a number of auto manufacturers, some of whom have actually incorporated all three solutions in their front seat belt systems.

4. **Rear Seats** – This petition to revise FMVSS 207 for the improvement of seating systems for rear impact occupant crash protection is not intended be limited to the front seats of vehicles. Here at ARCCA, we have had occasions to investigate crashes involving rear seat occupants in bucket seats. In those cases, we found that the second row bucket seats from minivans and similar vehicles had weaker seats in the rear then they had in the front. Consequently, these low strength second row seats introduced hazards not seen by the front seat occupants. Conversely, rear seats in sedans are virtually rigid given the support provided by the rear bulkheads, thus demonstrating that there is no true need for a ‘yielding’ design.

5. **Consumer Testing** – As noted above, we recommend that rear impact consumer testing be added as part of the New Car Assessment Program (NCAP) and that information be made publicly available to the consumers.

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Finally, our testing and research has shown that properly designed seats capable of meeting the proposed strength level provide effective occupant crash protection and have no detrimental effects on their occupants. We would be glad to share our test data with you.

Very truly yours,

Alan Cantor, Petitioner
ARCCA, Inc.
2288 Second Street Pike
Penns Park, Pennsylvania 18943
(215) 598-9750 ~ telephone

Louis D'Aulerio, Petitioner
ARCCA, Inc.
2288 Second Street Pike
Penns Park, Pennsylvania 18943
(215) 598-9750 ~ telephone

Mike Markushewski, Petitioner
ARCCA, Inc.
2288 Second Street Pike
Penns Park, Pennsylvania 18943
(215) 598-9750 ~ telephone

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Gary Whitman, Petitioner
ARCCA, Inc.
2288 Second Street Pike
Penns Park, Pennsylvania 18943
(215) 598-9750 ~ telephone

Larry Sicher, Petitioner
ARCCA, Inc.
2288 Second Street Pike
Penns Park, Pennsylvania 18943
(215) 598-9750 ~ telephone