DEVELOPMENT OF A REPRESENTATIVE SEAT ASSEMBLY FOR FMVSS NO. 213

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ABSTRACT

Federal Motor Vehicle Safety Standard (FMVSS) No. 213, "Child restraint systems," specifies performance requirements for child restraint systems (CRSs). The performance of a CRS is evaluated in a simulated frontal impact 48 km/h (30 mph) sled test. The National Highway Traffic Safety Administration (NHTSA) plans to update the FMVSS No. 213 seat assembly to better represent the rear seats of the current[1] vehicle fleet including the geometry, anchorage locations (seat belt, lower anchorages and tether anchorages) and seat foam of rear seats. Limited testing indicates that child restraints in the current market can meet the performance requirements of the current FMVSS No. 213 when evaluated using the updated seat assembly under consideration. Paired comparison analysis of performance measures obtained from CRSs in FMVSS No. 213 compliance tests and those in similar sled tests conducted with the updated seat assembly indicated no significant differences.

INTRODUCTION

Federal Motor Vehicle Safety Standard No. 213, "Child restraint systems," specifies performance requirements for child restraint systems. The performance of a child restraint system is evaluated in a dynamic frontal sled test that simulates a 30 mph change in velocity of a vehicle involved in a frontal crash. The FMVSS No. 213 seat assembly was originally based on the configuration and performance parameters of a 1974 Chevrolet Impala production front bench seat.

FMVSS No. 213 was upgraded on June 24, 2003[2] by, among other things, incorporating advanced child anthropomorphic test devices (ATDs), and by modifying some features of the standard seat assembly to make it more representative of rear seats of the vehicle fleet at that time.[3] Modifications to the seat assembly in 2003 included the seat bottom cushion angle, seat back cushion angle, spacing between the anchorages of the lap belts, and the seat back rigidity of the seat assembly. The 2003 upgrade of the seat assembly did not include modifications to the seat cushion, which was found to be soft and too thick in comparison to rear seat cushions in the vehicle fleet at the time.

This paper details the development of the latest potential updates to the FMVSS No. 213 seat assembly[4] including the assembly's geometry, anchorage locations (seat belt, lower anchorages and tether anchorages) and seat foam. This paper also presents results of paired sled tests with different CRSs to compare the performance of CRSs using the updated seat assembly and the current FMVSS No. 213 seat assembly.

STANDARD SEAT ASSEMBLY UPDATE

Vehicle Survey

The agency conducted a vehicle rear seat study[5] in which certain vehicles in the fleet were measured to compile data on the rear seat environment. Various measurements including seat back angle, seat back height, seat pan and seat back cushion thickness, seat pan width, and seat belt location as well as child restraint anchorages, were taken for 43 individual rear seat positions in 24 Model Year (MY) 2010 vehicles. The seat assemblies that are currently used to evaluate CRSs, including NHTSA's current FMVSS No. 213 seat assembly and the seat assembly from European tests, Economic Commission for Europe (ECE) R.44, were also measured as part of this study.

The rear seat study used a Seat Geometry Measuring Fixture (SGMF) to consistently measure the seat geometry and anchorage locations. The SGMF consisted of two wood blocks (600 mm x 88 mm x 38 mm) and a three-inch76 mm (3 inch) hinge (see Figure 1). To make the rear seat geometry measurements, the SGMF was positioned on the centerline of each rear seat position. Point A (see

[1] Based on a vehicle survey of using 24 Model Year 2010 vehicles.
[2] 68 FR 37620
[3] Some of the 2003 test bench upgrades were based on results of a 35 vehicle survey performed by U.S. Naval Air Warfare Center Aircraft Division at Patuxent River, Maryland (PAX). Docket No. NHTSA-2002-11707.
[4] Drawings of the latest updates to the seat assembly can be found in Docket No. NHTSA-2013-0055-0008 and NHTSA-20013-0055-0013.
[5] The vehicle survey was conducted by Alpha Technology Associate, Inc. The Vehicle Rear Seat Study – Technical Report can be found in docket No. NHTSA-2014-0012-0005.

Figure 1), which corresponds to the hinge location of the SGMF, was the reference point for all measurements.

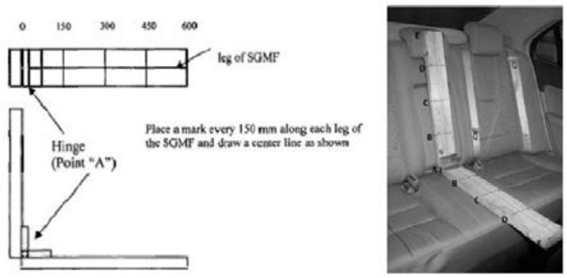

***Figure 1.* SGMF Sketch (left), SGMF Positioned on a Vehicle Rear Seat (right).**

Seat Geometry

<u>Seat Assembly Angles</u> The vehicle survey showed that the average seat back angle of the surveyed vehicles was 20 degrees from the vertical with a standard deviation of 4 degrees. The seat back angle ranged from a minimum of 9 degrees to a maximum of 28 degrees from the vertical. The current seat back angle of the FMVSS No. 213 seat assembly is 20 degrees. The updated seat assembly has a seat back angle of 20 degrees.

For the seat pan angle, the survey showed that the average angle was 13 degrees from the horizontal with a standard deviation of 4 degrees. The seat pan angle ranged from a minimum of 7 degrees to a maximum of 23 degrees. The current seat pan angle of the FMVSS No. 213 seat assembly is 15 degrees. The updated seat assembly has a seat pan angle of 15 degrees.

<u>Seat Back Height and Seat Pan Length</u> The survey showed that the average seat pan length of the surveyed vehicles was 406 mm (16 inches) with a standard deviation of 38 mm (1.5 inches). The seat pan length of the current FMVSS No. 213 seat assembly is 416 mm (16.3 inches). The average height of the seat back from the vehicles surveyed was 688 mm (27 inches) with a standard deviation of 76 mm (3 inches) when the head restraint was included, and 578 mm (22.7 inches) with a standard deviation of 60 mm (2.3 inches) when the head restraint was not included in the measurement. The seat back height of the current FMVSS No. 213 seat assembly is 517 mm (20.4 inches), and the seat back does not have a head restraint.

Table 1.
Standard Seat Assembly Geometry Comparison

		Vehicle Survey Average	Standard Deviation	FMVSS No. 213	ECE R. 44	Updated Seat Assembly
Seat Back Angle (degrees)		20	4	20	20	20
Seat Pan Angle (degrees)		13	4	15	15	15
Seat Pan Length (mm)		406	38	416	438	412
Seat Back Height (mm)	**With Head Restraint**	688	76	-	-	-
	Without Head Restraint	578	60	517	432	573

The updated seat assembly has a seat pan length of 412 mm (16.2 inches), which is within one standard deviation of the average seat pan length in the current vehicle fleet. The updated seat assembly, which has a seat back without a head restraint, has with a seat back height of 573 mm (22.5 inches). This is within one standard deviation of the average seat back height observed for the current fleet when the head restraint is not included.

Table 1 shows a summary of the standard seat assembly geometry comparisons.

<u>Seat Belt Anchorages</u> The updated seat assembly has only one seating position, which is designed to represent a generic outboard or center seating position. The data from the surveyed vehicles guided the location of the lap belt and shoulder belt anchorages. Also taken into consideration were the seat belt anchorage location requirements in FMVSS No. 210, "Seat belt assembly anchorages," the practicability of testing different types and sizes of CRSs, and potential variability in test results due to interference between the seat belt anchorages and the seat structure.

Table 2 shows the averages and standard deviations of the seat belt anchorage locations from the surveyed vehicles, and also the location of the seat belt anchorages in the updated seat assembly design as well as the current FMVSS No. 213 seat assembly.

Table 2. Belt Anchorage Measurements (mm)

		Surveyed Vehicles Average	Standard Deviation	FMVSS No. 213	ECE R. 44	Updated Seat Assembly
Shoulder Belt Location	**Aft**	350	118	350	216	393
	Lateral	247	57	247	302	244
	Vertical	581	72	690	500	634
Lap Belt Location	**Aft**	57	61	-	-	77
	Lateral	211	54	-	-	225
	Vertical	-44	82	-	-	-89
Distance Between Lap Belt	**Outboard**	450	36	427	-	449
	Center	356	60	400	-	-

Notes: Fore/Aft: Positive value mean they are rearward of point A (fore) and negative values mean they are forward of point A (aft). For vertical measurements positive means they are above point A and negative means they are below point A. Lateral measurements mean the distance from point A to either side of the anchor.

Figure 2 shows the side view of the updated seat assembly, the location of the lap belt anchorages, and the FMVSS No. 210 corridor.[6] Figure 2 also shows that the lap belt anchorage locations in the updated seat assembly are within the FMVSS No. 210 corridor.

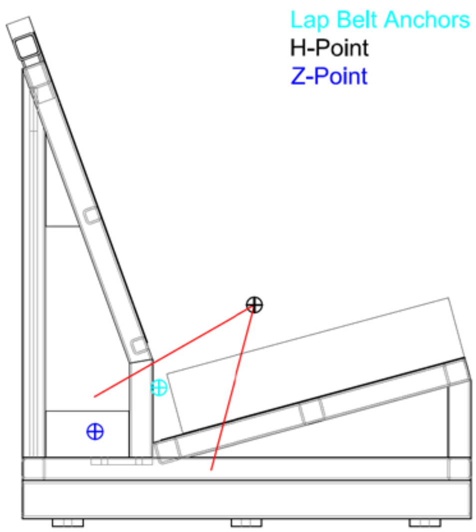

Figure 2. **Updated Seat Assembly Depicting the FMVSS No. 210 Corridor.**

The locations of the lap belt anchorages on the updated seat assembly were selected to be more rearward and lower than the average locations from the vehicles surveyed, while still being within one standard deviation of the average values found in the surveyed vehicles. The seat belt position was selected to avoid interaction of the belt and belt hardware with the seat cushion, which could introduce variability in the test results. The distance between lap belt anchorages is approximately equal to the average spacing found in the vehicles surveyed.

<u>LATCH Anchorages</u> Table 3 shows the average location of the lower anchorages and the tether anchorage in the 24 vehicles surveyed and the updated seat assembly. A negative vertical value indicates the anchorage is below Point A on the SGMF. The lower anchorages of the updated seat assembly have an 280 mm (11-inch) lateral spacing between them, as specified in FMVSS No. 225, "Child restraint anchorage systems," and the lower anchorage metal bar is 37 mm (1.45 inches) long.

[6] FMVSS No. 210 Section 4.3

Table 3.
Child Restraint Anchorage System Measurements from Point A of SGMF

		Average	Standard Deviation	Updated Seat Assembly
Lower Anchorages (mm)	**Aft**	100	21	58
	Lateral	137	29	140
	Vertical	-12	24	-38
Tether Anchorage Seat Back Position (mm)	**Aft**	280	88	330
	Lateral	0	44	0
	Vertical	140	281	133

The location of the lower anchorages selected for the updated seat assembly is more forward than the average location obtained from the current fleet in order to prevent interference with the seat back cushion, and to prevent some CRSs with rigid LATCH from adopting an incorrect installation angle. A location more forward than the average from the surveyed vehicles was selected for the lower anchorages to make it easier to install the CRSs on the seat assembly. While the updated location for the lower anchorages in the aft direction is not within one standard deviation of the average for the current vehicle fleet, the aft location of the lower anchorages on the updated seat assembly is likely to be representative of the average vehicle fleet that would comply with the proposed LATCH usability requirements[7] that limit the depth of the lower anchorages to be no more than 2 cm inside the seat bight.

Although tether anchorages can be located in a wide area specified by FMVSS No. 225, the surveyed vehicles showed that tether anchorages were mostly centered along the designated seating position (DSP) centerline and found in two main areas: the seat back and the package shelf. A seat back tether anchorage location within one standard deviation of the survey average was selected for the updated seat assembly, as shown in Table 3.

Seat Pan Cushion Characteristics[8] Since CRSs are tested on the FMVSS No. 213 standard seat in a dynamic sled test, the dynamic stiffness of the various seat cushions was quantified. The dynamic force-deflection (dynamic stiffness) of the seat cushion in rear seats of 14 MY 2006-2011 vehicles, the seat foams specified in ECE R.44 and New Programme for the Assessment of Child Restraint Systems (NPACS), and the seat cushion from the FMVSS No. 213 standard seat assembly were compared. The dynamic stiffness of the seat cushions and seat foams were determined using a pendulum impact device (PID), which consisted of an arm with a 152.4 mm (6 inches) diameter impactor weighing 7.8 kg (17.2 lb). The impactor was dropped at an average impact velocity of 3.4 m/s (7.6 mph) on the seat cushion. The PID was instrumented with a tri-axial accelerometer and an angular rate sensor to calculate the displacement as well as a uniaxial load cell to measure the force.

Figure 3 below shows the results from the PID test with the various foam selections. The force deflection curves show the ECE R.44 and NPACS foams to be stiffer than the vehicle fleet tested. The FMVSS No. 213 foam, tested on the standard seat assembly with a cover, is on the low end of the vehicle fleet rear seat stiffness.

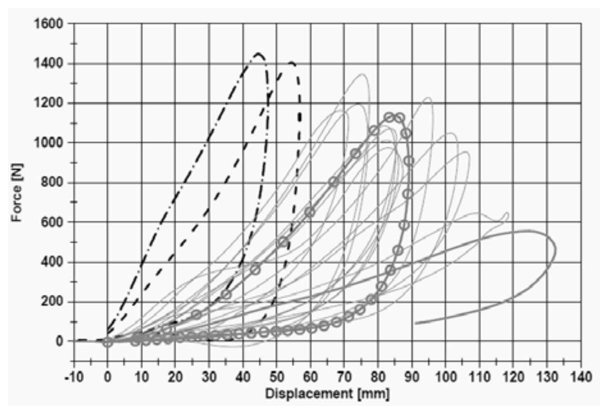

***Figure 3.* Dynamic Force-Displacement (stiffness) of ECE R.44 Seat Foam (black-dashed), NPACS seat foam (black-dashes and dots), FMVSS No. 213 Seat Cushion (dark grey solid), Seat Cushions from Vehicle Rear Seats (light grey solid), and the Updated NHTSA-Woodbridge Seat Cushion (solid with circles).**

The agency worked with The Woodbridge Group to develop a new seat cushion targeting average foam characteristics from the current vehicle fleet. This is shown and referred to as the NHTSA-Woodbridge seat cushion in Figure 3. Table 4 shows the dynamic stiffness characteristics of the developed seat foam

[7] 80 FR 3744
[8] Detailed information on the foam development can be found in the report "Evaluation of Seat Foams for the FMVSS No. 213 Test Bench," Docket No. NHTSA-2013-0055-0013.

based upon ASTM D3574[9] indentation force deflection (IFD) and compression force deflection (CFD) testing. The NHTSA-Woodbridge foam specifications are shown in Table 4:

Table 4.
Stiffness of the NHTSA-Woodbridge Seat Foam

Foam Characteristics	Foam Specifications
Density	47 kg/m^3 (2.9 lb/ft^3)
IFD (25% deflection)	237 Newton (N) (53.2 lb)
IFD (50% deflection)	440 Newton (N) (99 lb)
IFD (65% deflection)	724 Newton (N) (162.7 lb)
CFD (50% compression)	6.6 kPa (137.8 lb/ft^2)

Measurements that were obtained from the surveyed vehicles showed an average seat cushion thickness for rear seating positions of 90 mm (3.5 inches) with a standard deviation of 40 mm (1.5 inches), measured at the centerline of the seat pan. The NHTSA-Woodbridge foam is 101.6 mm (4 inches) thick, which is within one standard deviation.[10] A four-inch foam was also desirable to simplify procurement of the foam, as standard foam certifications, such as IFD, are provided for samples with a four-inch thickness.

The cushion assembly, which includes the foam wrapped and secured with cover, was based on the ECE R.44 test procedure and its recommendations on how to wrap the foam for testing. The ECE R.44 cover material is a sun shade cloth made of poly-acrylate fiber with a specific mass of 290 (g/m^2) and a lengthwise and breadthwise breaking strength of 120 kg (264.5 lb) and 80 kg (176.3 lb), respectively. The updated seat cushion assembly used a similar material to cover the foam. The cover was folded using a specified method similar to the ECE R.44 procedure and taped onto the underside of the metal mounting plate. Three-inch-wide preservation tape - was used to secure the cover to the plate. Figure 4 demonstrates the cushion assembly for the seat pan cushion.

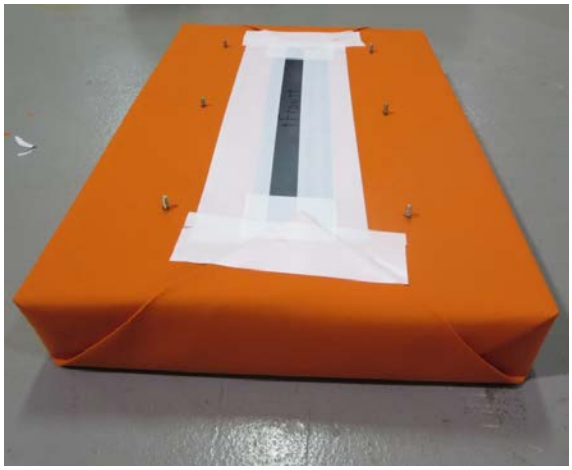

Figure 4. **Seat Pan Cushion Assembly.**

SLED TESTING

The updated seat assembly was used for a series of dynamic sled tests performed by the Transportation Research Center (TRC) Inc. and the data were used to evaluate different CRS models for comparison to compliance test results using the current FMVSS No. 213 seat assembly. A total of 12 sled tests were performed using 12 different CRS models. Details of the sled testing can be found in Appendix A, Table A1. The overall updated seat assembly with the cushions is shown in Figure 5.[11]

Figure 5. **Updated Seat Assembly.**

[9] American Society for Testing and Materials D3574-11 - Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams.

[10] The current FMVSS No. 213 seat assembly seat pan cushion has a thickness of 152.4 mm (6 inches).

[11] Described as Version 2 (V2) seat assembly in the referenced documentation including Docket No. NHTSA-2013-0055-0008.

Sled testing with the updated seat assembly was conducted using a sled pulse with a change in velocity per the FMVSS No. 213 specifications of 48, +0, -3.2 km/h (30, +0, -2 mph). To assess CRS performance, testing included the use of CRABI 12-month-old (CRABI 12MO), Hybrid III three-year-old (HIII 3YO), and Hybrid III six-year-old (HIII 6YO) ATDs.

The CRABI 12MO was utilized in the rear-facing (RF) configuration with infant and convertible CRSs. Instrumentation used in the CRABI 12MO included head accelerometers, upper and lower neck load cells, chest accelerometers, lumbar spine load cells, and pelvis accelerometers.

The HIII 3YO was tested in the forward-facing (FF) configuration with convertible CRSs. HIII 3YO ATD instrumentation included head accelerometers, upper and lower neck load cells, chest accelerometers, a chest rotary potentiometer, a lumbar spine load cell, and pelvis accelerometers.

The HIII 6YO was used in the FF configuration with convertible CRSs and belt positioning boosters (BPBs). The instrumentation used to evaluate the HIII 6YO included head accelerometers, upper and lower neck load cells, chest accelerometers, a chest rotary potentiometer, a lumbar spine load cell, pelvis accelerometers, and left and right femur load cells.

Data was collected for all of the aforementioned instrumentation; however, an analysis was only conducted on the data pertaining to the performance measures currently used in FMVSS No. 213: head injury criteria (HIC36), 3-millisecond (ms) clip chest acceleration, and occupant head and knee excursions. Additionally, occupant kinematics were noted and compared to responses on the standard FMVSS No. 213 seat assembly.

The CRSs were installed on the updated seat assembly using the lower anchorages only (LA Only), lower anchorages and top tether (LATCH), 3-point belt with top tether (SB3PT&T), or 3-point belt without top tether (SB3PT). This configuration differs from current compliance testing, as 3-point belts are only used for BPBs. For all of the configurations tested, the belts were tensioned as given in Table 5 using a three-prong belt tensioning gauge (Borroughs BT3329S).

For some CRSs, it was not possible to access the lower anchorages with the belt tensioning gauge, or the belt tension could not be accurately measured using the gauge. In such cases, adequate belt tension was determined by ensuring that the installed CRS could not be moved by more than one inch in any direction of its installed position when pulled at the belt path. The lateral alignment of the ATD and the CRS on the seat assembly was set using measurements from a digital measuring device (FARO arm).

Table 5.
Belt Tensioning Targets

Belt Type	Tension
Harness	8.9-13.3 N (2-3 lb)
Lower Anchorages	53.4-66.7 N (12-15 lb)
Tether Anchorage	44.5-53.4 N (10-12 lb)
Belts for CRSs	53.4-66.7 N (12-15 lb)
Belts for BPBs	8.9-13.3 N (2-3 lb)

For each test, the computed performance measures of HIC36 (1000), 3-ms clip chest acceleration (60 g), maximum seat back angle from vertical for rear-facing orientations (70 degrees), head excursion (720 mm with top tether, 813 mm without top tether), and knee excursions (915 mm) for forward-facing orientations were compared to the injury assessment reference value (IARV) limits specified in parentheses above. Excursion values were measured using 2D image analysis software. Results were categorized as “pass” if the performance measure was less than the corresponding IARV and as “fail” if it was greater than the IARV.

Results of the sled testing were:
- 14/14 passed HIC36
- 14/14 passed 3-ms clip chest acceleration

Rear-facing CRSs
- 7/7 passed seat back angle

Forward-facing CRSs
- 7/7 passed head excursion
- 7/7 passed knee excursion

Test results and performance measures for each test are provided in Appendix B, Table B1. For HIC36 values that are marked with an asterisk, the accelerometer data had to be truncated due to a data spike caused by the head striking the seat back. The truncation only removed the rebound phase, starting at approximately 175 milliseconds.

COMPARISON TO CURRENT FMVSS NO. 213 SEAT ASSEMBLY

Child restraint systems sold in the United States must meet performance requirements specified in FMVSS No. 213, including a sled test that simulates a 48 km/h (30 mph) frontal impact to which manufacturers must self-certify. NHTSA's enforcement testing verifies that manufacturers have met the necessary requirements.

Dynamic sled tests on the current FMVSS No. 213 seat assembly completed for enforcement were compared to similar tests on the updated seat assembly. Test results for the compliance tests are available in Appendix C, Table C1. Note that the Evenflo Tribute in rearward-facing and forward-facing modes was restrained by a two-point seat belt in the compliance testing, but it was restrained by a three-point belt during the updated seat assembly testing.

Paired T-tests were performed to evaluate whether the results of tests with the updated seat assembly were significantly different than the results of tests with the current FMVSS No. 213 seat assembly.

The FMVSS No. 213 performance measures for each CRS tested on the two seat assemblies are shown in Figures 6 through 13.

Rear-Facing CRSs: When test results from the two seat assemblies are compared, rear-facing CRSs (including infant seats and convertible seats) tested on the updated seat assembly and with the 12 MO CRABI dummy, showed an average HIC increase of 12% (ranging from -14% to 39%), an average chest acceleration decrease of 8% (ranging from -22% to 1%), and a 2% average reduction in seat back angle rotation (ranging from -23 to 25%). Paired T-tests indicated at a 95 percent confidence level that the HIC, chest acceleration, and seat back angle values in tests with the updated seat assembly were not significantly different from those with the current FMVSS No. 213 seat assembly.

Forward-Facing Convertible CRSs: Using similar analysis approach, forward-facing CRSs tested with the HIII-3YO dummy showed an average HIC decrease of 14% (ranging from -26% to -1%), an average chest acceleration decrease of 4% (ranging from -22% to 15%), an average head excursion decrease of 5% (ranging from -17% to 7%), and an average knee excursion decrease of 3% (ranging from -8% to 3%). Paired T-tests indicated at a 95 percent confidence level that the HIC, chest accelerations, and head and knee excursion values in tests with the updated seat assembly were not significantly different from those with the current FMVSS No. 213 seat assembly. A paired T-test comparison was not possible for tests with the forward facing convertible seats tested with the HIII-6YO, as only one paired test was available.

BPBs: Similarly**,** BPBs tested with the HIII-6YO dummy showed an average HIC reduction of 14% (ranging from -35% to 21%), an 8% average chest acceleration increase (ranging from -2% to 16%), a 12% average head excursion increase (ranging from 5% to 21%), and a 1% knee excursion decrease (ranging from -9% to 9%). Paired T-tests indicated at a 95 percent confidence level that the HIC, chest accelerations, and head and knee excursion values in tests with the updated seat assembly were not significantly different from those for the current FMVSS No. 213 seat assembly.

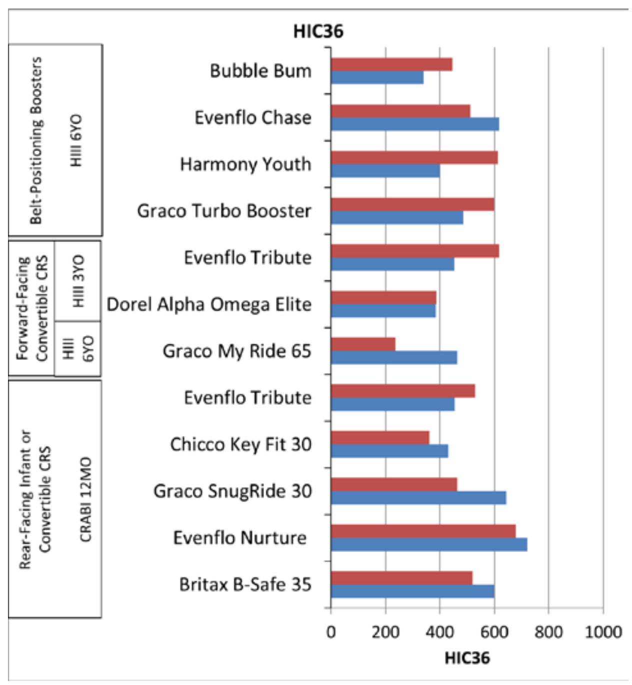

***Figure 6.* Comparison of HIC36 Response for Tests on Updated Seat Assembly (Blue) and Standard FMVSS No. 213 Seat Assembly (Red).**

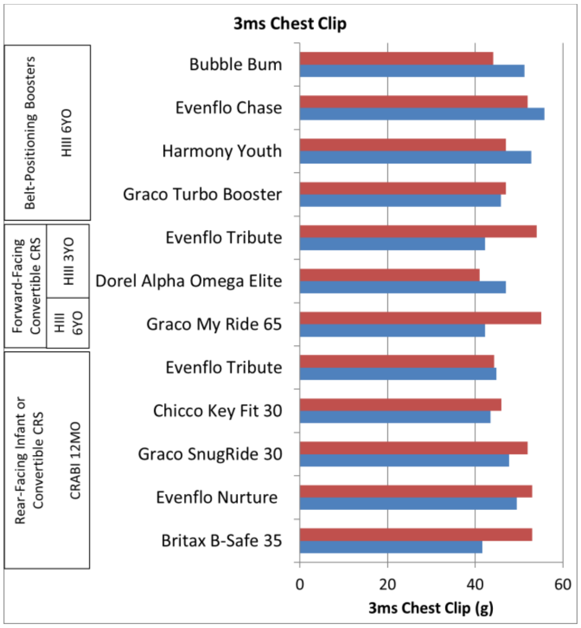

Figure 7. **Comparison of 3ms Chest Clip Response for Tests on Updated Seat Assembly (Blue) and Standard FMVSS No. 213 Seat Assembly (Red).**

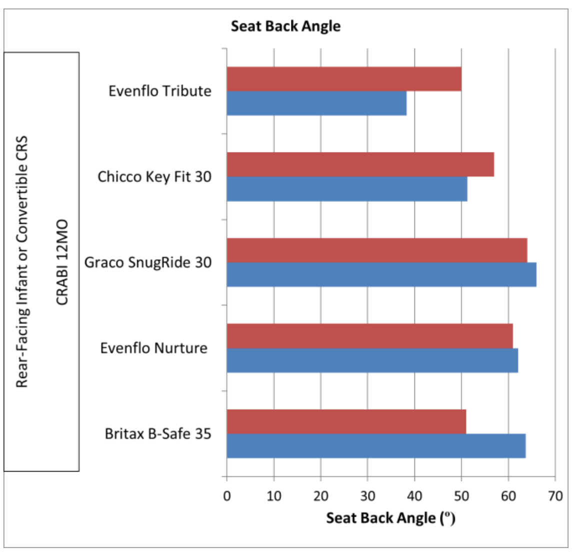

Figure 8. **Comparison of Seat Back Angle Response for Tests on Updated Seat Assembly (Blue) and Standard FMVSS No. 213 Seat Assembly (Red).**

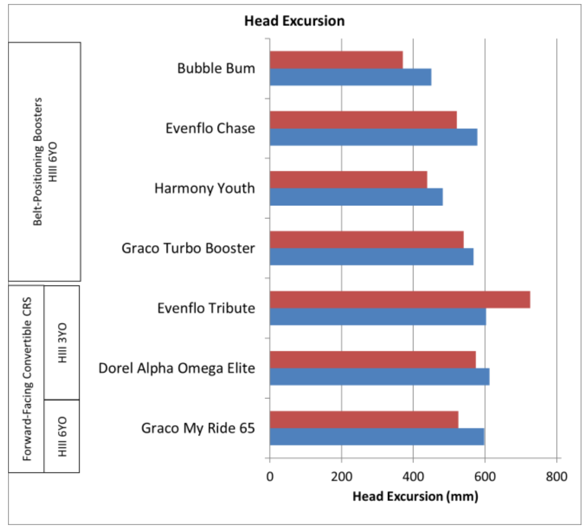

Figure 9. **Comparison of Head Excursion Response for Tests on Updated Seat Assembly (Blue) and Standard FMVSS No. 213 Seat Assembly (Red).**

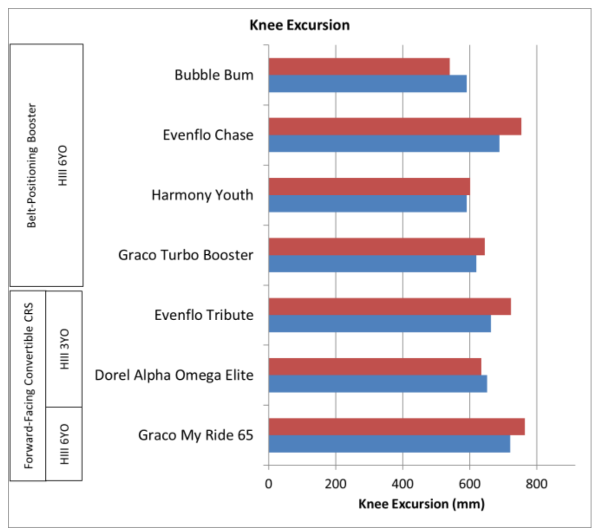

Figure 10. **Comparison of Knee Excursion Response for Tests on Updated Seat Assembly (Blue) and Standard FMVSS No. 213 Seat Assembly (Red).**

Occupant Kinematics: Overall, occupant kinematics between tests on the different seat assemblies were similar and had similar timing, with the forward-most position of the dummy occurring around 80 milliseconds.

Figure 11. **Comparison of CRABI 12 MO Kinematics in Rear-Facing Infant Seat.**

Figure 12. **Comparison of HIII 3YO Kinematics in Forward-Facing Convertible Seat.**

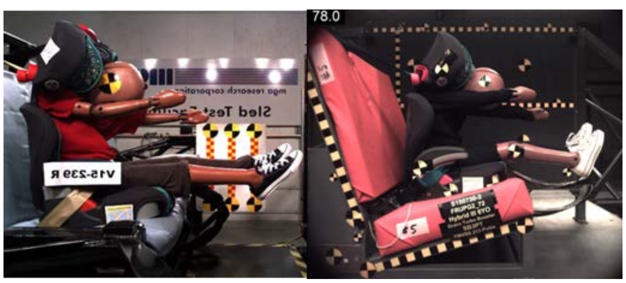

Figure 13. **Comparison of HIII 6YO Kinematics in BPB.**

CONCLUSIONS

A survey of vehicle rear seats guided the design of an updated seat assembly for FMVSS No. 213 to replicate rear seat geometry, which included the anchorage locations and tether locations of the vehicle fleet. One major change in the updated seat assembly is the seat foam, which is significantly stiffer and thinner than the current FMVSS No. 213 specified foam. This study suggests that CRSs in the current market can meet the performance requirements of FMVSS No. 213 when evaluated using the updated seat assembly.

REFERENCES

[1] 68 FR 37620

[2] Glass, W., "*Technical Report on the FMVSS 213 Crash Pulse and Test Bench Analysis*," April 2002, Docket No. NHTSA-2002-11707, Item No.009.

[3] Aram, M.L., Rockwell, T., "*Vehicle Rear Seat Study*," July 2012. Docket No. NHTSA-2014-0012

[4] 80 FR 3744

[5] Wietholter, K., Louden, A., Sullivan, L., & Burton, R. "*Evaluation of Seat Foams for the FMVSS No. 213 Test Bench*". June 2016. Washington, DC: National Highway Traffic Safety Administration. Docket No. NHTSA-2013-0055, Item No. 0013.\

Appendix A

Table A1.
Testing on Updated FMVSS No. 213 Seat Assembly

Vehicle Database Test No.	Test Date	VRTC Test No.	Side of Bench	CRS Model	ATD Type	CRS Orientation and Installation Method	Seat Foam #	Test Sled Pulse	Test Velocity (mph)
V09601	S150721-1	FRUPG2_56	Right	Graco My Ride 65	HIII 6YO	FF Convertible LATCH	WB Foam 5	FMVSS No. 213 Pulse	30
V09606	S150728-1	FRUPG2_65	Left	Chicco Key Fit 30	CRABI 12MO	RF Infant LA Only	WB Foam 4	FMVSS No. 213 Pulse	30
V09607	S150729-1	FRUPG2_67_68	Left	Graco SnugRide 30	CRABI 12MO	RF Infant LA Only	WB Foam 4	FMVSS No. 213 Pulse	30
			Right	Evenflo Chase	HIII 6YO	BPB SB3PT	WB Foam 5		
V09608	S150730-1	FRUPG2_69	Left	Britax B-Safe 35	CRABI 12MO	RF Infant LA Only	WB Foam 4	FMVSS No. 213 Pulse	30
V09609	S150730-2	FRUPG2_72	Right	Graco Turbo Booster	HIII 6YO	BPB SB3PT	WB Foam 5	FMVSS No. 213 Pulse	30
V09610	S150731-1	FRUPG2_73_74	Left	Evenflo Nurture	CRABI 12MO	RF Infant LA Only	WB Foam 4	FMVSS No. 213 Pulse	30
			Right	Harmony Youth	HIII 6YO	BPB SB3PT	WB Foam 5		
V09613	S150911-1	FRUPG2_79	Left	Evenflo Tribute	CRABI 12MO	RF Convertible SB3PT	WB Foam 4	FMVSS No. 213 Pulse	30
V09614	S150915-1	FRUPG2_82	Right	Bubble Bum	HIII 6YO	BPB SB3PT	WB Foam 5	FMVSS No. 213 Pulse	30
V09618	S150921-1	FRUPG2_89	Left	Dorel Alpha Omega Elite	HIII 3YO	FF Convertible LA Only	WB Foam 4	FMVSS No. 213 Pulse	30
V09620	S150923-1	FRUPG2_93	Left	Evenflo Tribute	HIII 3YO	FF Convertible SB3PT	WB Foam 4	FMVSS No. 213 Pulse	30

Appendix B

Table B1.
Updated Seat Assembly Test Data

Vehicle Database Test No.	Test Date	VRTC Test No.	Side of Bench	CRS Model	CRS Orientation	Installation Method	ATD Type	HIC 36	Chest Clip 3ms (g)	Max Seat Back Angle (°)	Head Excursion (mm)	Knee Excursion (mm)
V09601	S150721-1	FRUPG2_56	Right	Graco My Ride 65	FF Convertible	LATCH	HIII 6YO	463	42.3	N/A	598	721
V09606	S150728-1	FRUPG2_65	Left	Chicco Key Fit 30	RF Infant	LA Only	CRABI 12MO	431	43.6	51	N/A	N/A
V09607	S150729-1	FRUPG2_67_68	Left	Graco SnugRide 30	RF Infant	LA Only	CRABI 12MO	645	47.7	66	N/A	N/A
			Right	Evenflo Chase	BPB	SB3PT	HIII 6YO	617	55.8	N/A	579	689
V09608	S150730-1	FRUPG2_69	Left	Britax B-Safe 35	RF Infant	LA Only	CRABI 12MO	598	41.6	64	N/A	N/A
V09609	S150730-2	FRUPG2_72	Right	Graco Turbo Booster	BPB	SB3PT	HIII 6YO	485	45.9	N/A	568	620
V09610	S150731-1	FRUPG2_73_74	Right	Harmony Youth	BPB	SB3PT	HIII 6YO	399	52.8	N/A	483	591
V09612			Left	Evenflo Nurture	RF Infant	LA Only	CRABI 12MO	721	49.5	62	N/A	N/A
V09613	S150911-1	FRUPG2_79	Left	Evenflo Tribute	RF Convertible	SB3PT	CRABI 12MO	454	44.9	38	N/A	N/A
V09614	S150915-1	FRUPG2_82	Right	Bubble Bum	BPB	SB3PT	HIII 6YO	339*	51.2	N/A	450	591
V09618	S150921-1	FRUPG2_89	Left	Dorel Alpha Omega Elite	FF Convertible	LATCH	HIII 3YO	384	47.0	N/A	612	652
V09620	S150923-1	FRUPG2_93	Left	Evenflo Tribute	FF Convertible	SB3PT	HIII 3YO	453	42.3	N/A	603	664

Appendix C

Table C1.
Compliance Test Data

Highway Safety Number	Test Number	CRS Model	CRS Orientation	Installation Method	ATD Type	HIC 36	Chest Clip 3ms (g)	Max Seat Back Angle (°)	Head Excursion (mm)	Knee Excursion (mm)
644215	213-MGA-15-002	Britax B-Safe 35	RF Infant	LA Only	CRABI 12MO	520	53	51	N/A	N/A
644226	213-MGA-15-014	Evenflo Nurture	RF Infant	LA Only	CRABI 12MO	679	53	61	N/A	N/A
644261	213-MGA-15-050	Graco SnugRide Click Connect 30	RF Infant	LA Only	CRABI 12MO	463	52	64	N/A	N/A
644248	213-MGA-15-037	Chicco Key Fit 30	RF Infant	LA Only	CRABI 12MO	362	46	57	N/A	N/A
643833	213-MGA-14-053	Evenflo Tribute	RF Convertible	SB2PT	CRABI 12MO	529	44	50	N/A	N/A
643713	213-MGA-13-061	Graco My Ride 65	FF Convertible	LATCH	HIII 6YO	236	55	N/A	526	765
644281	213-MGA-15-074	Dorel Alpha Omega Elite	FF Convertible	LATCH	HIII 3YO	387	41	N/A	574	635
644229	213-MGA-15-016	Evenflo Tribute	FF Convertible	SB2PT	HIII 3YO	616	54	N/A	726	724
644266	213-MGA-15-056	Graco Turbo Booster	BPB	SB3PT	HIII 6YO	599	47	N/A	541	645
644246	213-MGA-15-035	Harmony Youth	BPB	SB3PT	HIII 6YO	614	47	N/A	439	602
644234	213-MGA-15-021	Evenflo Chase	BPB	SB3PT	HIII 6YO	510	52	N/A	521	754
642302	213-MGA-12-090	Bubble Bum	BPB	SB3PT	HIII 6YO	445	44	N/A	371	541