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Comparing the CRABI-12 And CRABI-18 for Infant Child Restraint System Evaluation

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16. Abstract A preliminary study was performed to consider how evaluation of rear-facing-only child restraints might differ if the CRABI 18 month old crash test dummy was used instead of the CRABI 12 month old. In comparison to child anthropometry data, the CRABI-18 does a better job in representing the dimensions of children over 1 year old. Nineteen rear-facing-only child restraint systems (CRS) were measured, and both test dummies were installed in the CRSs for static evaluation. The CRABI-12 fit well in all the CRSs. Nine child restraints were too narrow for the CRABI-18 shoulders (including 7 CRSs for use with children at or over 18 kg [30 lb]), and 12 child restraints did not allow the recommended 25 mm head clearance. In dynamic FMVSS No. 213 testing with 3 CRSs (Graco Snuggly30, Chicco KeyFit, and Evenflo Embrace), the measured response of both test dummies was similar; both met all FMVSS No. 213 requirements.					
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Introduction

In the United States, the minimum best practice for transporting infants in passenger vehicles requires children to face the rear of the vehicle while seated in harnessed child restraint systems (CRS) until they are both at least 1 year old and 9 kg (20 lb) body mass. Promising injury data from other countries where children remain rear-facing longer have promoted extended rear-facing use in the United States. Swedish data showing benefit for children rear-facing through age 4, with rear-facing restraints reducing AIS2+ injury by 90 percent compared with unrestrained children (Jakobsson, Wiberg, Isaksson-Hellman, & Gustafsson, 2007; Isaksson-Hellman, Jakobsson, Gustafsson, & Norin, 1997). U.S. crash data show that children up to 2 years old are 5.53 times safer in a rear-facing restraint than in a forward-facing restraints in side impacts and 1.23 times safer in frontal impacts (Henery et al., 2007). In early 2011, NHTSA and the American Academy of Pediatrics (AAP, 2011) modified their best practice recommendations to encourage infants to ride in rear-facing child restraints as long as possible. AAP has articulated a new goal of keeping children rear-facing up to age 2 when the child can be properly accommodated in a rear-facing restraint.

Over the past decade, rates of obesity and high body-mass index (BMI) among children in the United States have increased and mean that a greater proportion of children are heavier for their age/height. The goal of keeping all children rear-facing longer, possibly until age 2, means that child restraints should aim for accommodating children rear-facing to over 14 kg (32 lb). Traditionally, rear-facing only CRSs for infants have accommodated children up to 10 kg (22 lb). Parents were then advised to switch to a convertible child restraint used rear-facing. While the rear-facing convertibles usually have higher seatbacks and larger occupant spaces to accommodate larger children, rear-facing-only CRSs often have smaller overall dimensions and may fit more easily in smaller vehicles.

In response to the AAP recommendation to keep children rear-facing longer, CRS manufacturers have designed rear-facing CRSs that accommodate heavier children. The first rear-facing convertible CRSs were developed for use by children up to 13.6, 16, or 18 kg (30, 35, or 40 lb). Then rear-facing-only CRSs were also developed that accommodated children up to 13.6 and 16 kg (30 and 35 lb). The rear-facing-only CRSs usually have a shell with a handle that can be used to carry the infant, plus a base left in the vehicle for easier and quicker installation.

Although the development of these CRSs has had the positive outcome of allowing more children to remain rear-facing longer, there have also been some unintended issues with their development. As the child restraints accommodate larger children, the CRS become larger and require more open rear-seat volume in the vehicle to allow for proper installation and use. They have also become heavier, which can make installation more

challenging. Additionally, once children are above the age of 6 months, the combined mass of the infant seat and the child often make carrying the child in the CRS with a handle difficult or impractical, especially with the rear-facing only child restraints accommodating children up to 18 kg (35 lb). Finally, the occupant mass limit for the product is displayed on the label, but the best practice recommendation in the National Child Passenger Safety Certification Training Program (NHTSA, 2010) that the top of the child's head be at least 25 mm (1 in) below the top of the CRS shell is not required on the label, although it is often in the owner's manual. Some children outgrow rear-facing only seats by height before reaching the maximum rated mass. If the child restraint is designed to be strong enough to restrain the higher mass occupant, but does not account for the larger dimensions, misuse may occur with the child's head becoming too close to or extending past the top edge of the child restraint.

The FMVSS No. 213 family of anthropomorphic test devices (ATD) generally represents an average height and weight for a designated age. Currently the CRABI 12-month old (CRABI-12) ATD is used to represent a larger infant and the next-larger-sized ATD is the Hybrid III 3-year-old (HIII-3YO). CRS manufacturers also use the ATDs as a representation of typical anthropometry for size. There are concerns that neither the CRABI-12 nor the HIII-3YO are good representations of the 12- to 24-month-old child who has high weight for height/age. The CRABI 18-month old (CRABI-18) is another available ATD that has not been incorporated into Federal regulation.

Table 1 compares selected anthropometry for the three ATDs and 95th percentile 1 and 2-year-olds in the United States. The UMTRI anthropometry data provides more detailed measures, but was collected over 30 years ago. The current CDC data only provides height and weight. These data show that the CRABI-12 is smaller on every dimension than the 95th percentile 1-year-old child data from the United States. The CRABI-18 comes closer to the 95th percentile marks but is still low on some metrics. The HIII-3YO is larger than both the 95th percentile 1-year-old and 2-year-old on every dimension.

Table 1. Comparison of Selected Anthropometry Measures for Children and ATDs

	CRABI 12	95% 1YO UMTRI	95% 1YO CDC	CRABI 18	95% 2YO UMTRI	95% 2YO CDC	HHH 3YO
Mass (kg)	10.1	11.7	12.4	11.2	13.2	14.5	16.1
Standing Height (mm)	742	790	806	818	883	930	945
Seated Height (mm)	470	512	--	500	549	--	546
Shoulder Breadth (mm)	208	232	--	224	239	--	244
Hip Breadth (mm)	165	184	--	175	191	--	208

This study compares the CRABI-12 and CRABI-18 ATDs for suitability in evaluating rear-facing only CRS. Both ATDs were used to assess how the current range of commercial child restraints accommodates the two ATDs. Three models of rear-facing only CRS were then tested to compare the CRABI-12 and CRABI-18 ATDs responses under dynamic FMVSS No. 213 test conditions.

Static Evaluation

Methods

Nineteen rear-facing infant only child restraints were measured and evaluated by visiting local retailers and conducting in-store data collection. The seats measured are listed in Table 2. The Combi Shuttle 35 was measured twice using two different specimens but both yielded similar results. This model is listed twice in the table, to show the small differences but only counted once in the analysis. A set of simple physical dimensions was collected for each seat including: seatback height, seat pan length, harness slot heights, crotch slot locations, interior widths and exterior width. A tool made of two pieces of Plexiglass connected by a hinge, shown in Figure 1, was developed to make the measurement more repeatable and the definition of the bight of the seated area less subjective. Then the CRABI-12 and CRABI-18 were seated in each product. The distance between the top of the ATD's head and the top of the CRS shell was measured and any fit issues encountered while seating the ATDs were documented. A complete list of measures is shown in Table 3.

Table 2. Rear-Facing CRS Measured

<i>Manufacturer</i>	<i>Model</i>
BabyTrend	FlexLock
Britax	B-Safe 30
Britax	Chaperone
Chicco	KeyFit
Chicco	KeyFit 30
Combi	Shuttle 35
Cosco	Comfy Carry
Cosco	Comfy Carry Elite
Evenflo	Discovery
Evenflo	Embrace 35
First Years	Via
Graco	Snugride
Graco	Snugride 30
Graco	Snugride 35
Graco	Snugride CC 40
Peg Perego	Primo Viaggio
Safety 1st	onBoard 35
Safety 1st	onBoard 35 Air
Summer	Infant Prodigy



Figure 1. An infant CRS with the measurement tool.

Table 3. Information Collected

Infant seat model name
Manufacturer
Model number
Date of manufacture
Height range
Weight range
Number of shoulder slots
Number of crotch slots
Seatback height (cm)
Seat length (cm)
Slot heights (cm)
Crotch strap from bight (cm)
Seat interior width at bight (cm)
Seat interior width at harness slots (cm)
Seat interior width at crotch straps slots (cm)
Max exterior width location (cm)
Max exterior width (cm)
Top head to top shell with each ATD (cm)

Results

The full compiled results table and the photos of each product measured are provided in Appendix A. The CRABI-12 fit well in all 19 child restraints while 9 of the 19 child restraints fit the CRABI-18 tightly at the shoulder. Of the 9 CRSs with tight shoulder fit, 7 of them were rated for use with children up to or over 18 kg (30 lb). The top of the CRABI-12 ATD's head fell 25 mm or more below the top of the CRS shell in all child restraints, meeting the best practice fit guidelines, while 12 of the 19 seats tested did not allow a 25 mm head clearance for the CRABI-18. Of the 12 child restraints not allowing a 25 mm head clearance for the CRABI-18, 7 were rated for occupants who weigh 18 kg (30 lb) or more. Examples of contrasting fit with the two ATDs are shown in Figure 2. In one CRS the highest harness routing slots were higher than the shoulder height of the CRABI-18 ATD and the top of the head is not 25 mm below the top edge of the back support shell. This suggests potential for misuse, as the shoulder harness should be placed at or below the child's shoulders when rear-facing, to prevent the child from sliding up along the back and exposing the head to interior contact when in a frontal crash.

In one CRS rated for children up to 18 kg (40 lb), the CRABI-18 could not sit fully into the child restraint with the back of the ATD in full contact with the CRS back support surface. This was due to a relatively stiff head support feature that formed a raised surface on the upper part of the CRS seatback and was well aligned to support the CRABI-12 head but contacted the CRABI-18 ATD below the shoulder. When the CRABI-18 was seated in this CRS, either the shoulders were propped forward off of the seatback surface or the ATD's pelvis had to be pulled forward in the seat to drop the height of the ATD's shoulders below the head support.



Figure 2. A single CRS model that provides good fit with the CRABI-12 (left) and tight fit with reduced head-to-CRS shell clearance with the CRABI-18 (right).

Dynamic Evaluation

Methods

Six, FMVSS No. 213-type frontal impact tests were conducted using three models of commercial CRS: Graco SnugRide30, Chicco KeyFit, and Evenflo Embrace 35. Each model was run once with the CRABI-12 and again with the CRABI-18 using a new seat for each run. Each seat was set up per manufacturers' instructions and all seat adjustments for harness routing and recline were held constant between tests of the same model CRS. All signals were processed per SAE J211 and standard algorithms were used to calculate HIC36 and 3-ms-clip chest accelerations. High-speed digital video was recorded at 1,000 frames per second and analyzed to quantify CRS motion. Figure 3 shows pre-test photos with both ATDs.



Figure 3. Pre-test photos of the Graco SnugRide 30 with the CRABI-12 (top) and CRABI-18 (bottom)

Results

Table 4 lists the relevant response criteria for the test series. None of the CRS sustained any structure damage and all child restraints met the dynamic requirements of FMVSS No. 213. Figure 4 shows the initial position and maximum forward rotation video frame for each test, indicating the motion of the head relative to the CRS shell. The acceleration response of the two ATDs was very similar, as shown by the close agreement of the resultant head and chest acceleration histories shown in Figures 5 to 7.

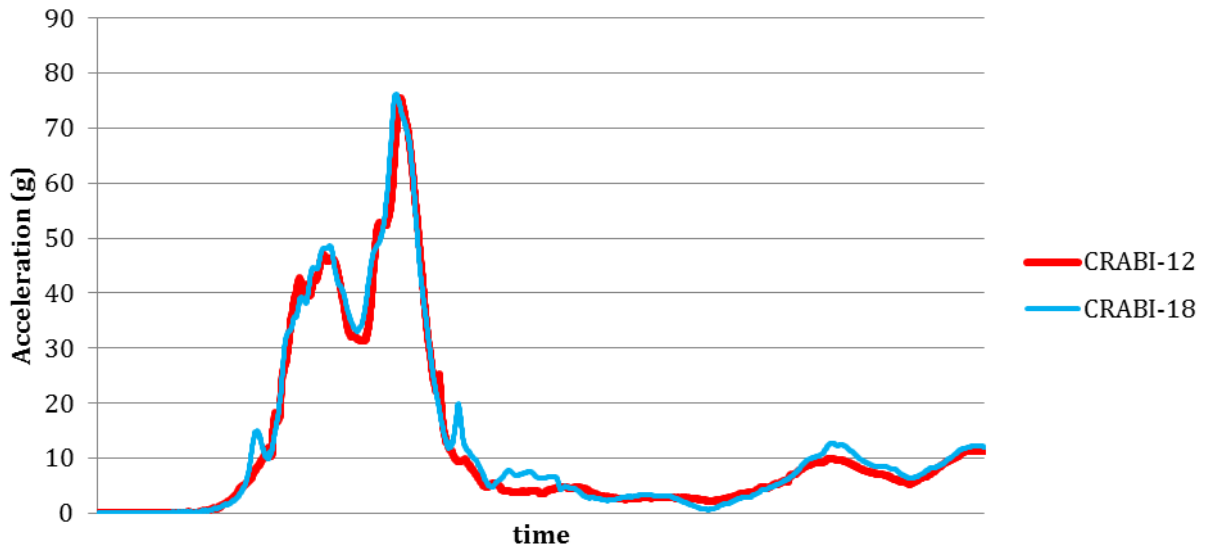
Table 4. Key FMVSS No. 213 Criteria for Test Series

Test ID	Seat/ATD	HIC-36 (213 limit 1000)	3-ms Chest Clip (g) (213 limit 60 g)	Pre-test Angle (deg)	Max Rotation (deg) (213 limit 70 deg)
NT1303	Embrace - 12	482	45	35	59
NT1306	Embrace - 18	517	45	35	60
NT1302	KeyFit - 12	350	52	41	59
NT1305	KeyFit - 18	487	47	39	56
NT1301	Snugride - 12	596	50	34	59
NT1302	Snugride - 18	658	54	35	59



Figure 4. Time-zero and maximum rotation video frames for each test conducted with the CRABI-18.

SnugRide Head Resultant Acceleration



SnugRide Chest Resultant Acceleration

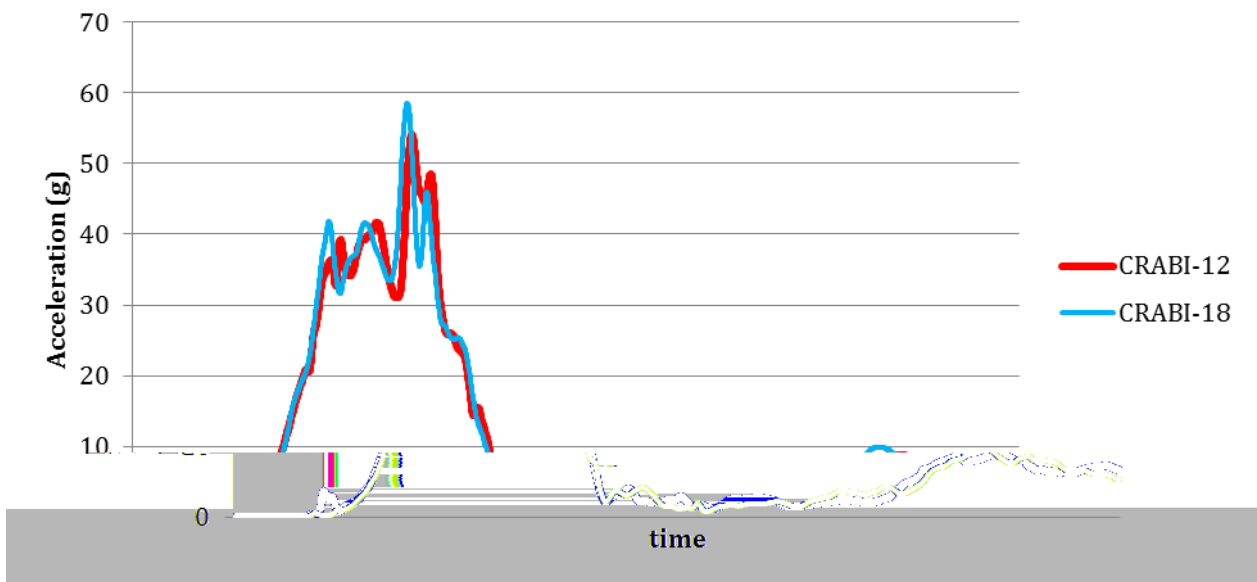
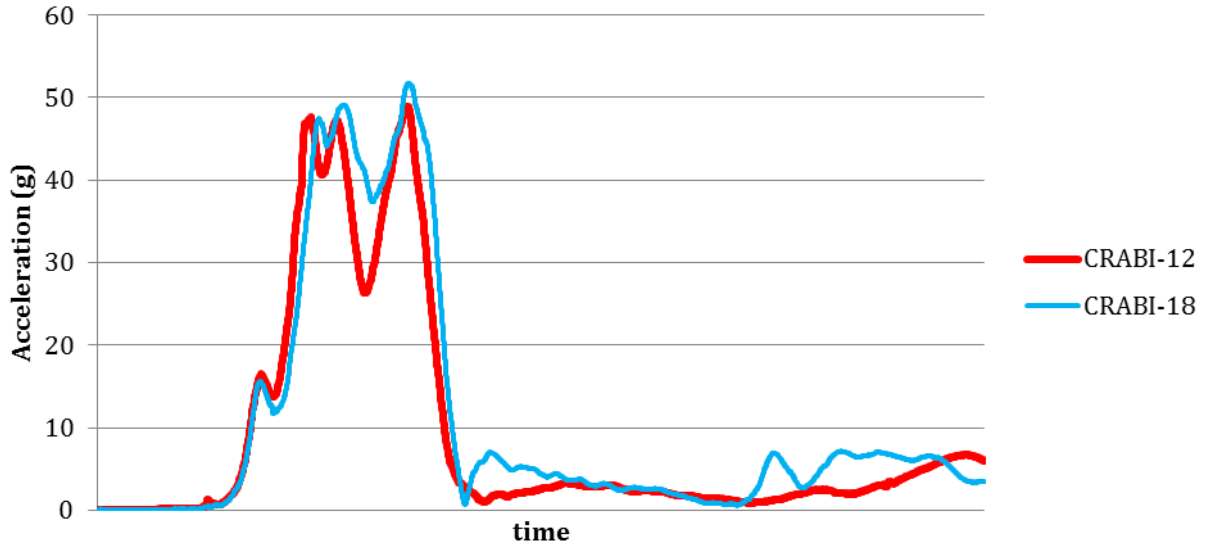


Figure 5. Comparison of head and chest resultant acceleration histories for the Graco SnugRide 30 with both ATDs.

KeyFit Head Resultant Acceleration



KeyFit Chest Resultant Acceleration

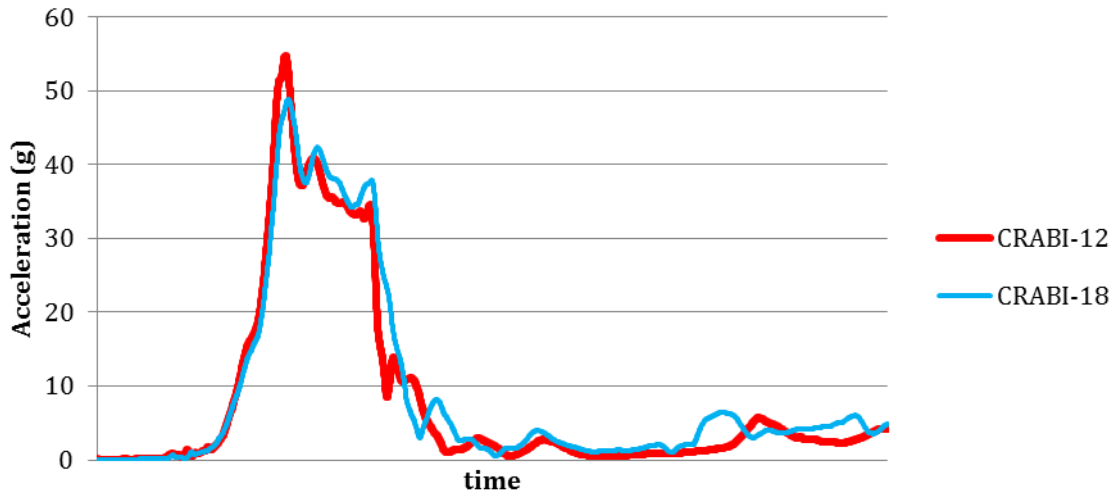
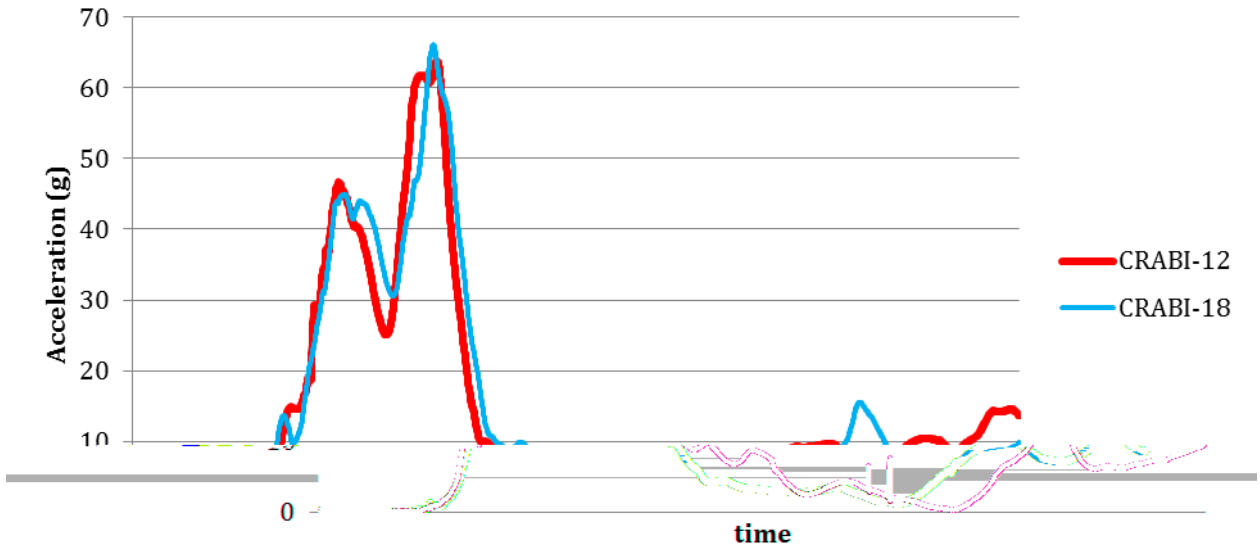


Figure 6. Comparison of head and chest resultant acceleration histories for the Chicco KeyFit with both ATDs.

Embrace Head Resultant Acceleration



Embrace Chest Resultant Acceleration

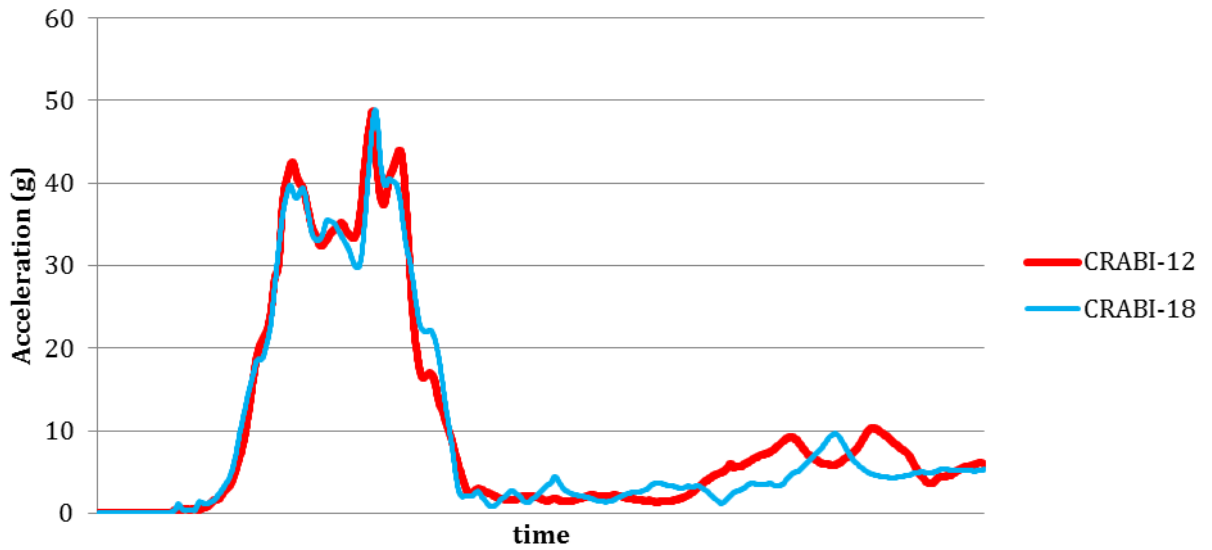


Figure 7. Comparison of head and chest resultant acceleration histories for the Evenflo Embrace 35 with both ATDs.

Discussion and Conclusions

The anthropometry of the CRABI-18 is closer to that of a 95th percentile 1-year-old child than that of the CRABI-12. The static assessment showed that the CRABI-12 had no fit issues in the current set of commercially available rear-facing CRSs that were evaluated. In contrast, the CRABI-18 often did not have the best practice clearance of 25 mm between the top of the head and the top of the CRS shell. In addition, the shoulder width of the CRABI-18, though narrower than that of the 95th percentile 1-year-old, was not accommodated in about half of the rear-facing CRSs evaluated.

One explanation for the poor fit of the CRABI-18 in some CRSs is that the ATD is simply not widely available to CRS designers. Another potential source of this information is spacers or clearance tools that would indicate the volume needed for larger children.

The two ATDs performed similarly in FMVSS No. 213 sled testing and both passed all dynamic criteria. The current FMVSS No. 213 requirement for head containment demands that the CG of the ATD's head be kept within the CRS shell. The peak rotation photos from the tests of the CRABI-18 suggest that some CRS designs do not always keep the leading edge of the ATD's head fully protected. Evaluation of forward-facing child restraints requires tracking the leading edge of the ATD's head to measure excursion.

The key findings from this investigation are that the CRABI-18 does not fit well in a large portion of rear-facing only CRSs due to lack of accommodation of the ATD's shoulder width and the lack of a full 25 mm of clearance between the ATD's head and top of the CRS shell. The CRABI-12 and CRABI-18 perform very similarly in dynamic testing per FMVSS No. 213.

References

- American Academy of Pediatrics, Committee on Injury, Violence, and Poison Prevention. (2011). Policy statement: Child passenger safety. *Pediatrics* 127:788-793.
- Henary, B., Sherwood, C. P., Crandall, J. R., Kent, R. W., Vaca, F. E., Arbogast, K. B., & Bull, M. J. (2007). Car safety seats for children: rear facing for best protection. *Injury Prevention* 13:398–402. doi: 10.1136/ip.2006.015115.
- Isaksson-Hellman, I., Jakobsson, L., Gustafsson, C., & Norin, H. (1997). Trends and effects of child restraint systems based on Volvo's Swedish accident database. (Report No. SAE 973299). In: Child Occupant Protection 2nd Symposium Proceedings, 43-54. Warrendale, PA: Society of Automotive Engineers.
- Jakobsson, L., Wiberg, H., Isaksson-Hellman, I., Gustafsson, J. (2007). Rear seat safety for the growing child—a new 2-state integrated booster cushion. (Paper Number 07-0322). Proceedings of the 20th International Technical Conference on the Enhanced Safety of vehicles, Lyon, France.
- National Highway Traffic Safety Administration. (2007, April; Revised, 2010, October). National Child Passenger Safety Certification Training student manual. (Report No. DOT HS 810 731) Washington DC: Author. Available at www.cpsboard.org/pdf/techmanual/StudentManual_R1010_Complete_WebQuality.pdf

Appendix – Data From Static Fit Testing

Table A.1 Static Data

	1	2	3	4	5	6
Infant Seat Model Name	KeyFit30	B-Safe 30	Snugride 30	Via	onBoard 35 air	Snugride 35
Manufacturer	Chicco	Britax	Graco	First Years/Lamazé	Safety 1st	Graco
Model Number	00061472450070	E9LE53C	1759021 JJ	I470-LMGY	22395-MCK	1806993 JJ
Date of Manuf	01/2011	5/5/11	10/6/10	4/20/11	3/31/11	9/8/11
Weight Range	4-30 lb	4-30 lb	4-30 lb	5-22 lb	4-35 lb	4-35 lb
Height Range	30 in or less	32 in or less	30 in or less	32 in or less	32 in or less	32 in or less
# of Shoulder Slots	3	4	4	Moving slots (5 Pos)	4	3
# of Crotch Slots	1	2	2	1	3	1
<i>All Measurements below in cm</i>						
Seatback Height	50	48	51	51	50	49
Seat Length	27	31.5	25	27	30	27
Slot Height:						
(lowest) 1	17.5	13	17	18.5	11.5	16
2	22.5	18	20	-	16	22.5
3	28	22	26	-	21	27
4	-	27	30.5	-	26	-
(or highest) 5	-	-	-	31.5	-	-
Crotch dist from bight:						
(closest) 1	10	9.5	4	13	6.5	13
2	-	14	12	-	10	-
(farthest) 3	-	-	-	-	14.5	-
Seat interior width at:						
bight	24	25	23	26	26	24
slot 1 (lowest)	24.5	24	24	26	26	24
slot 2	24	24	24	-	26	24
slot 3	23	24	23	-	24	23
slot 4	-	23	19	-	20	-
(or highest) 5	-	-	-	22	-	-
crotch 1 (closest)	24	25	23	26	27	23
crotch 2	-	25	22	-	27	-
crotch 3	-	-	-	-	28	-
belt path	22	22	25	39	23	24
max exterior width location	handle hub	handle hub	middle seat	lock-off clips on seat	handle hub	handle hub
max exterior width	43	45	44	44	44	48
height top head to top shell:						
12-MO	3.5	3	5	6.5	5	6
18-MO	1	1	3	3.5	2	3
Fit issues	None	None	Little tight at the shoulders for 18MO	Little tight at the shoulders for 18MO	None	None
Location	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor
Date	12/6/12	12/6/12	12/6/12	12/6/12	12/6/12	12/6/12
Investigator	N. Orton	N. Orton	N. Orton	N. Orton	N. Orton	N. Orton

Table A.1 Static Data (continued)

	7	8	9	10	11
Infant Seat Model Name	onBoard 35	Snugride	Flex-Loc	Snugride Click Connect 40	Prodigy
Manufacturer	Safety 1st	Graco	BabyTrend	Graco	Summer Infant
Model Number	IC-146 AWAD/GB1A2	1806996 JJ	CS31705	1839195 JJ	21050
Date of Manuf	7/13/12	9/13/11	1/1/12	8/14/12	7/23/11
Weight Range	4-35 lb	5-22 lb	5-30 lb	4-40 lb	4-32 lb
Height Range	32 in or less	29 in or less	30 in or less	35 in or less	32 in or less
# of Shoulder Slots	4	2	moving slots (7 pos)	moving slots	moving slots
# of Crotch Slots	3	1	1	2	2
<i>All Measurements below in cm</i>					
Seatback Height	50	49	40-49	35-50.5	50
Seat Length	30	26.5	24	29	31
Slot Height:					
(lowest) 1	12.5	19	21	13.5	17
2	17.5	25.5	-	-	-
3	22.5	-	-	-	-
4	27.5	-	-	-	-
(or highest) 5	-	-	29	29.5	30.5
Crotch dist from bight:					
(closest) 1	6	13.5	10	11 @HR bot / 12 @ HR top	6
2	9	-	-	15 @HR bot / 16 @ HR top	11
(farthest) 3	14	-	-	-	-
Seat interior width at:					
bight	27	23	23	24	22
slot 1 (lowest)	26	23.5	25	17	23
slot 2	26	23.5	-	-	-
slot 3	25	-	-	-	-
slot 4	24	-	-	-	-
(or highest) 5	-	-	24	17	20
crotch 1 (closest)	27	24	23	24	23
crotch 2	28	-	-	24	24
crotch 3	29	-	-	-	-
belt path	22	? Wrong base	26	24	21
max exterior width location	base	handle hub	handle hub	handle hub	handle hub
max exterior width	43	43	42	45	46.5
height top head to top shell:					
12-MO	4.5	3	3.5	4	4.5
18-MO	2	1.5	1	3.5	2
Fit issues	None	None	Shoulders of 18MO touch bottom of headrest	12MO shoulders touch bottom of head rest, 18MO shoulders are crammed under HR forcing pelvis forward on seat	None
Location	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor	BabiesRUs Ann Arbor
Date	12/6/12	12/6/12	12/6/12	12/6/12	12/6/12
Investigator	N. Orton	N. Orton	N. Orton	N. Orton	N. Orton

Table A.1 Static Data (continued)

	12	13	14	15	16
Infant Seat Model Name	Chaperone	Primo Viaggio	Discovery 5	Comfy Carry	Shuttle 35
Manufacturer	Britax	Peg Perego	Evenflo	Cosco	Combi
Model Number	E9L692K	IMUN004535FG13PL46	30211248 PQ2	IC-021 AKT/GB1A2	8035116
Date of Manuf	7/2012	3/2/10	2/24/12	6/5/12	9/3/11
Weight Range	4-30 lb	5-30 lb	5-22 lb	4-22 lb	0-35 lb
Height Range	32 in or less	30 in or less	29 in or less	29 in or less	33 in or less
# of Shoulder Slots	moving slots	moving slots	3	4	moving slots
# of Crotch Slots	2	1	2	3	1
<i>All Measurements below in cm</i>					
Seatback Height	40-51	40-46.5 on HR / 50 on shell	50.5	47.5	44-54.5 on HR/ 47 on shell
Seat Length	23	25.5 @ HRbtm, 28 @ Hrtop	24.5	28	26 @ HRbtm, 27.5 @ HRtop
Slot Height:					
(lowest) 1	17	18	15.5	13	19.5
2	-	-	20.5	18	-
3	-	-	26.5	23	-
4	-	-	-	28	-
(or highest) 5	27.5	25	-	-	36
Crotch dist from bight:					
(closest) 1	5	12 @HRbtm / 14 @ HRtop	7.5	8.5	10.5 @HRbtm / 12 @ HRtop
2	8	-	11.5	12.5	-
(farthest) 3	-	-	-	16.5	-
Seat interior width at:					
bight	22	25	24	26	22
slot 1 (lowest)	24	25	23	26	21
slot 2	-	-	23	25	-
slot 3	-	-	21	25	-
slot 4	-	-	-	24	-
(or highest) 5	24	24	-	-	21
crotch 1 (closest)	23	25	25	26	25
crotch 2	23	-	25	26	-
crotch 3	-	-	-	24	-
belt path	23	25	24	21	23
max exterior width location	handle hub	handle hub	handle hub	handle hub	handle hub
max exterior width	48	44	42	43	43
height top head to top shell:					
12-MO	5	3 @ HR, 5 @ shell	6.5	4	8
18-MO	3.5	1.5 above HR, 1 below shell	4	1.5	5.5
Fit issues	12MO shoulders touch bottom of head rest, 18MO shoulders are crammed against btm HR but pelvis fully back in seat	12MO shoulders touch bottom of head rest, 18MO shoulders are crammed into HR but pelvis fully back in seat	Little tight at the shoulders for 18MO	None	18MO shoulders fit tight within head rest but pelvis fully back in seat, top slots are above 18MO shoulders
Location	BuyBuyBaby Canton	BuyBuyBaby Canton	Walmart Canton	Walmart Canton	BabiesRUsNorthville
Date	12/7/12	12/7/12	12/7/12	12/7/12	12/8/12
Investigator	N. Orton	N. Orton	N. Orton	N. Orton	N. Orton

Table A.1 Static Data (continued)

	16	17	18	19
Infant Seat Model Name	Shuttle 35	Comfy Carry Elite	Embrace 35	KeyFit22
Manufacturer	Combi	Safety 1st	Evenflo	Chicco
Model Number	8035123	IC-096 BCR/GB1A2	48411392	06060414930070
Date of Manuf	8/25/12	9/17/12	10/26/12	8/12
Weight Range	0-35 lb	4-22 lb	4-35 lb	4-22 lb
Height Range	33 in or less	29 in or less	17-30 in	30 in or less
# of Shoulder Slots	moving slots	4	3	3
# of Crotch Slots	1	3	2	1
<i>All Measurements below in cm</i>				
Seatback Height	44-54.5 on HR/ 47 on shell	48	48	49
Seat Length	26 @ HRbtm, 27.5 @ HRtop	27.5	27.5	26
Slot Height:				
(lowest) 1	20	14.5	12.5	19
2	-	18.5	19	24
3	-	23.5	25	29
4	-	28.5	-	-
(or highest) 5	36	-	-	-
Crotch dist from bight:				
(closest) 1	10.5 @HRbtm / 12 @ HRtop	8	10.5	9.5
2	-	11.5	16	-
(farthest) 3	-	15	-	-
Seat interior width at:				
bight	23	25	22	23
slot 1 (lowest)	21	26	21	24
slot 2	-	26	22	23
slot 3	-	25	21	22
slot 4	-	25	-	-
(or highest) 5	20	-	-	-
crotch 1 (closest)	25	26	24	24
crotch 2	-	26	24	-
crotch 3	-	25	-	-
belt path	23	21	23	23
max exterior width location	handle hub	handle hub	handle hub	handle hub
max exterior width	43	43	48	43
height top head to top shell:				
12-MO	8	3	4.5	3.5
18-MO	5.5	1.5 above shell	1	1.5
Fit issues	18MO shoulders fit tight within head rest but pelvis fully back in seat, top slots are above 18MO shoulders	None	Little tight at the shoulders for 18MO	None
Location	UMTRI	UMTRI	UMTRI	UMTRI
Date	12/17/12	12/11/12	12/19/12	1/4/13
Investigator	N. Orton	N. Orton	N.Orton	N.Orton



Seat



Measurement Tool



12 Month Old

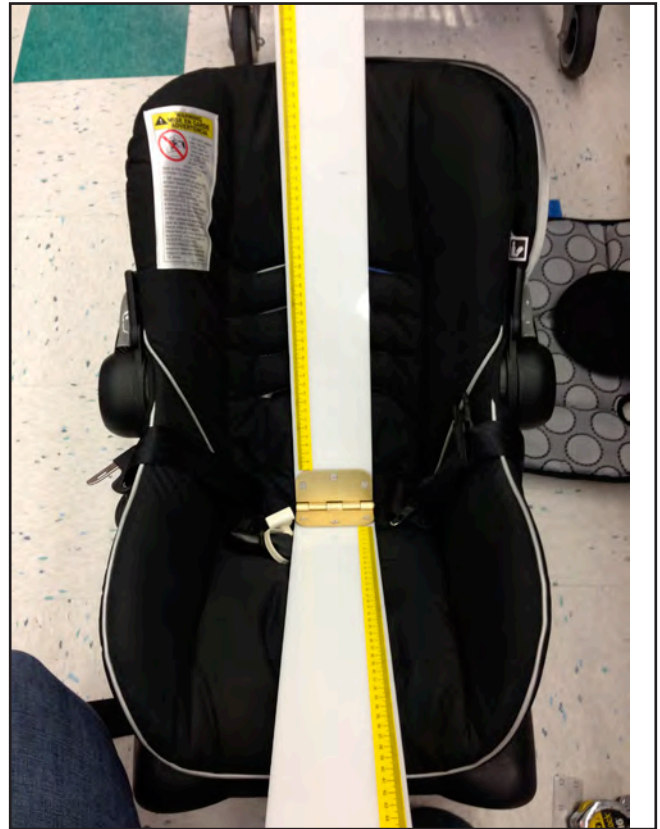


18 Month Old

Figure A.1 Chicco KeyFit30



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.2 Britax B-Safe 30



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.3 Graco Snugride 30



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.4 First Years/Lamaze Via



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.5 Safety 1st onBoard 35 air



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.6 Graco Snugride 35



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.7 Safety 1st onBoard 35



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.8 Graco Snugride



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.9 Baby Trend Flex Loc



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.10 Graco Snugride Click Connect 40



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.11 Summer Infant Prodigy



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.12 Britax Chaperone



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.13 Peg Perego Primo Viaggio



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.14 Evenflo Discovery 5



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.15 Cosco Comfy Carry



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.16 Combi Shuttle 35



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.17 Safety 1st Comfy Carry Elite



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.18 Evenflo Embrace 35



Seat



Measurement Tool



12 Month Old



18 Month Old

Figure A.19 Chicco KeyFit 22

DOT HS 812 156
June 2015



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**National Highway
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