GRACO

April 2, 2021

Docket Management Facility
U.S. Department of Transportation
West Building, Ground Floor, Room W12-140
1200 New Jersey Avenue S.E.
Washington, D.C. 20590

RE: ***Comments to Docket NHTSA-2020-0093***

Graco Children's Products Inc. ("Graco" or the "Company") respectfully submits these comments to the NHTSA's Notice of Proposed Rulemaking for Federal Motor Vehicle Safety Standards, Child Restraint Systems, Docket No. NHTSA-2020-0093. Graco has been a manufacturer of child restraint systems since the 1970s and has been a leading innovator in child passenger safety for many years. Graco supports the intent of the proposed updates to Federal Motor Vehicle Safety Standard No. 213 *Child Restraint Systems* and these comments are offered based on our experience as a manufacturer as well as the comprehensive test program that the Company undertook upon publication of the NPRM in November 2020. Please note that because of page count restraints, we are including all figures and tables referenced in these comments as Attachment A.

Graco Testing Program

To better inform the Company's comments, Graco undertook an extensive dynamic test program using all applicable testing requirements and identified equipment in the NPRM.

(1) Graco Test Program Summary

Since the draft version of the NPRM was released in September 2020, the Company has performed 348 dynamic tests across 18 different models of child restraint systems ranging from rear-facing only infant seats to backless belt-positioning boosters, as detailed in Table 1. The tests were performed at Calspan Corporation, Buffalo, NY, and at the Graco test center in Atlanta, GA. We intend to continue this program after the date of these comments and will be including some testing at MGA Corporation.

All tests used representative test benches fabricated per the drawings included in the subject docket, which were released previously as part of Docket No. NHTSA-2013-0055. The test method followed the NPRM and other materials available in the docket folder at www.regulations.gov. Both Calspan and Graco use HYGE accelerator sleds. Importantly, in order to assess test methods and outcomes using only the methods described in the current FMVSS No. 213, as modified by the draft rule, Graco did not use a FARO arm pre-test to locate the test dummies.

Accordingly, the comments offered by Graco are based on the Company's experience as a manufacturer and on testing using the proposed equipment and methods presented in the subject docket.

(2) Comparison of Labs: Graco Test Program and NHTSA R&R Report

A major goal of the Graco test program was to assess the test equipment and methods in the proposed standard for repeatability and reproducibility (R&R) between laboratories as a follow up to the work described in NHTSA's study[1]. As noted above, the NHTSA study at Calspan used a FARO measurement system to locate the car seat on the test bench and the ATD in the seat, with adjustments being made as needed so that "[F]rom test-to-test there was consistent positioning of the ATD and the CRS[2]." In the data below from both laboratories (Calspan and Graco), the car seat and ATD were placed on the representative test bench following the methods provided by FMVSS No. 213, and, as noted above, no FARO arm was used as there are no provisions to utilize this equipment in FMVSS No. 213 or in NHTSA's laboratory test procedure.

Graco conducted a statistical analysis of the data gathered in testing that used the Hybrid III 6-year-old dummy on seven different models of belt-positioning booster and one model of a child restraint using its internal harness and installed with the Type II belt system. The analysis was conducted using the JMP® Software[3] Measurement System Analysis tool to derive the Coefficient of Variation[4] (the "CV") by model.

As shown in Table 2, the HIC scores showed very high variation between and within the two labs, to the degree that they would fall into the "needs improvement" category in a measurement gauge R&R study. The CV for the other injury criteria were mostly in the "excellent" range and a few chest resultant scores in the "good" range.

To assess if the high CV results for HIC in Table 2 are a function of lab-to-lab variation, the HIC scores from just the units tested at Calspan were evaluated. As shown in Table 3, half of the eight seats have high variability (CV > 10%) and Seat E showed a marginally acceptable variability (CV exactly 10%).

The Graco study and conclusions are further supported by some of the findings in NHTSA Report No. 213R&R-CAL-19-018. An excerpt of Table 4 from that report is reproduced in Attachment A as Figure 1.

The "Chest Clip" values column is highlighted in Figure 1 with a red box. The table shows a mean of 51.5 g at Calspan and a mean of 58.8 at VRTC, yet the report suggests (relying on a CV of 4.2%) that this information supports a test process that is rated "excellent" for its repeatability and reproducibility test across laboratories. We acknowledge that intra-laboratory testing is consistent. However, when the data is taken as a whole the mean is 54.6 g and the standard deviation is 4.1 g, and the expected failure rate given these data is approximately 10% of units tested, which suggests an unacceptable process.

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[1] National Highway Traffic Safety Administration, "Final Summary Report of FMVSS No. 213 R&R Testing," Report No. 213R&R-CAL-19-018, 23 October 2019.

[2] Ibid., 14, Section 2.9.2.

[3] JMP Software is a suite of computer programs for statistical analysis produced by SAS Institute Inc.

[4] The Coefficient of Variation is a statistical measure of data points around the mean expressed as a percentage for a given sample, and is calculated by dividing the absolute value of the standard deviation by the mean. For process control, a CV less than 5% is excellent, a CV between 5% and 8% is good, a CV between 8% and 10% is marginal, and a CV greater than 10% indicates a process in need of improvement.

Similarly, Table 5 of NHTSA Report No. 213R&R-CAL-19-108 shows a difference in the mean values for head excursion between the two labs of 23.7 mm, although the CV was determined to be 2.7%, indicating excellent repeatability and reproducibility (see Figure 2 for an excerpt of the relevant portion of the table with the head excursion data inside a red box). Again, this illustrates that lab-to-lab variation does exist and can materially affect test outcomes.

As a result of these tests and a review of the NHTSA report, we are very concerned that the proposed representative test bench has not shown good repeatability and reproducibility in its current state, and that there are improvements that must be made to ensure more consistent test results. Several suggestions for changes to improve repeatability and reproducibility using the representative test bench and the test method are offered below. We have also identified several areas that warrant additional study that will take time beyond the close of the comment period.

Representative Test Bench

The following items were identified in the course of Graco' test program that can affect repeatability and reproducibility from test to test even with the same equipment used, as well as variations between benches and laboratories.

(1) Type 2 Cantilevered Anchorage Beam

During testing using the Type 2 belt system, we identified a structural concern with the Rear Shelf Mount, drawing 3021-850, that affects durability of the representative test bench and potentially the repeatability and reproducibility of test results over time. The Rear Shelf Mount spans the width of the representative test bench structure and serves to tie the Rear Locking Belt Mounting Bar Assembly (3021-333) to the structure, as shown in the detail from the bench seat schematic drawing in Figure 3 in the attachment. This item is made from 3/16-inch thick extruded angle with the material is specified as "mild steel." We observed upward flexing of this part when testing with all the child dummies, and it is most pronounced when testing with the Hybrid III 6- and 10-year-old dummies. This phenomenon is illustrated in Figure 4, which is a still image from a high speed video. The Rear Locking Belt Mounting Bar Assembly (marked before the test with yellow tape as seen in the image) is bending approximately 15 degrees from its normal, horizontal, orientation during the dynamic test. The moment arm created by the belt anchor location acting upon the Rear Shelf Mount is causing the Rear Shelf Mount to deform where the two parts are joined.

After numerous tests in the course of the evaluation program described above, we found that the Rear Shelf Mount was permanently deformed to 5.7 degrees from the horizontal, as shown in Figure 5. The main concern here is that this part of the structure is too thin and will eventually crack or tear. A suggestion is to make the angle iron thicker (1/4" – 3/8"), use a higher strength grade of steel, provide additional local reinforcement, and/or provide additional components in order to rigidize the connection point for the Rear Locking Belt Mounting Bar Assembly.

To assess the potential impact of the deformation described above on injury criteria, we secured the Rear Locking Belt Anchor to the main structure of the bench with a ratchet strap prevent some movement. Figure 6 has two still images from high-speed films showing the relative difference in motion of the Rear Locking Belt Mounting Bar Assembly during a dynamic test with and without the ratchet strap. By doing this we saw similar excursion values, similar or slightly increased chest resultant values, and an overall decrease in HIC values. Of concern is the likelihood that results will "creep" over time and maintenance cycles and that some child restraint systems may be more sensitive to the effects of bending of the Rear Shelf Mount during testing. The Company will continue its investigation of the effects of this bending after the date of these comments, and we will provide relevant supplemental materials to the docket after the comment period closes.

(2) Shoulder Belt D-Ring and Inboard Lap Belt Anchor

As shown in Figure 7, the shoulder belt D-ring (drawing 3021-123) and the inboard lap belt anchor (drawing 3021-120) are deforming during testing. This deformation was observed after only two or three tests with the 6-year-old Hybrid III dummy. There is a safety concern that over time one of these anchor points could fail during a test. This deformation also calls into question the repeatability and reproducibility of tests using undeformed and deformed anchors. We recommend making the D-ring and inboard anchor out of a harder type of steel and/or to increase their dimensions in the direction of loading to prevent them from bending under dynamic forces.

(3) Sharp Edge in the Tether Strap Routing Path

As shown in Figure 8 in the attachment, the child restraint tether passes over the top cross bar structure of the representative test bench. There is a sharp edge caused by the Bench Seat Back Plate (part number 3021-265) where the tether webbing makes contact, potentially resulting the webbing tearing, especially if this bench design is to be used for side impact in the future. As this is an artifact of the bench construction and does not represent real vehicle seating compartments, we recommend that the upper edge of the Bench Seat Back Plate be rounded off with a radius of at least half the thickness of the plate stock or lowered slightly from the top plane of the bench assembly such that it does not contact the webbing during testing.

(4) Foam

(a) Foam Thickness and Tolerances

The two foam pieces are detailed on drawings 3021-233 Seat Pan Cushion and 3021-248 Seat Back Cushion. The seat pan cushion is nominally 102 mm (4.00 in) thick with a tolerance of ±12.7 mm (±0.50 in); i.e. the thickness of individual foam blocks that meet the dimensional thickness requirement may range from 89.3 mm (3.50 in) to 114.7 mm (4.50 in) thick, a 25.4 mm (1.00 inch) span. The seat back cushion is nominally 51 mm (2.00 in) thick with a tolerance of ±6.4 mm (±0.25 in). In comparison, the foam pieces used on the current test bench have a tolerance on their thicknesses of ±1/8 in (±3.2 mm) per NHTSA drawing 2003HA300. Since variations in foam properties can significantly affect test outcomes, we recommend that the tolerance be reduced to the minimum amount feasible to better ensure repeatable and reproducible test results.

(b) Foam Indention Force-Deflection

The Foam Indentation Force-Deflection (IFD) for the 4-inch thick seat pan and seat cushion foam blocks has a tolerance range of ±10% at 50% deflection, with a nominal IFD of 98.9 lb (440 N). As part of the Graco test program, we assessed the potential effects of IFD close to both ends of the tolerance zone. For Seat H in Table 2 (see Attachment A), the IFD was measured and recorded before each dynamic test and Calspan and Graco. As shown in Figure 9, increasing the IFD strongly correlates to increased chest resultant accelerations.

IFD values can be affected by manufacturing (foam density and overall thickness) and, potentially, by temperature and humidity conditions during storage. Based upon our experience, we recommend that, in addition to tightening the tolerance on the thickness as explained above, that NHTSA reduce the permitted tolerance range of new foam IFD and provide guidance on the acceptable ranges of temperature and humidity for proper foam storage. Appendix C of the VRTC research test procedure[5] states the practice that was followed for their testing[6], but this information is not in the draft rule nor does the current TP-213-10 address foam storage.

(c) Foam Sensitivity to Temperature and Humidity

Based upon the Company's experience, we believe that the bench foam used in the current test bench may be sensitive to humidity and temperature. To explore this further for the proposed bench foam, the Center for Child Injury Prevention Studies "CChIPS" chartered a research project on 1 April 2021 titled "Effects of Temperature and Humidity on Dynamic Test Components." The research will conclude later in 2021 and findings will be placed into this docket once they are available.

(d) Foam Cutting and Forming – Effects on Repeatability and Reproducibility

As noted in their comments, the Juvenile Products Manufacturers Association is leading an effort across multiple test laboratories to assess foam samples fabricated with different techniques to assess their effects on test outcomes as well as their suitability for sustained testing. Graco is an active participant in that research, which will conclude after the close of the comment period and which will be made available to NHTSA once it is complete.

(5) Representative Test Bench Technical Drawing Package

Upon close examination of the May 2019 Child Frontal Impact Sled Drawing Package (NHTSA-213-2016), Graco identified four potential dimensioning issues that may lead to inconsistent bench manufacturing between different bench manufacturers. While these issues may not have a significant effect on crash testing results, we believe they are worth correcting for the sake of improving correlation between testing labs and ensuring that every bench manufacturer is making the same bench to NHTSA's specifications.

The first issue pertains to the tolerance specifications of the bench Z-point. On drawing 3021-015, Sheet 1, Revision D, the horizontal and vertical dimensions for the Z-point are given as 120 mm and 80 mm, respectively, with the lowermost and rearmost seat tubes being the references. The tolerance per Note 1 on 3021-015 is ±3 mm. The Z-point dimensions are called out once more on drawing 3021-1000, Sheet 1, Revision A. However, the tolerance for the Z-point here is specified in Note 1 as ±6 mm. Should bench manufacturers choose to use drawing 3021-1000 as their reference, there is a possibility that two benches made by different manufacturers could have Z-points off by as much as 12 mm vertically or horizontally. This maximum error difference of 12 mm versus 6 mm can have significant consequences in lab-to-lab correlation scenarios. Labs using coordinate measuring machines as part of a pre-test dummy positioning and/or child restraint

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[5] "NHTSA Research Test Procedure for the Proposed FMVSS No. 213 Frontal Impact Test," November 2020, published on Regulations.gov at Docket NHTSA-2020-0093-0016.

[6] Appendix C to the VRTC research test procedure states that, "Prior to conducting the IFD test, store the foam set in a temperature and humidity-controlled chamber with a temperature range of 21.1 ±2.8 degrees Celsius (70 ±5 degrees Fahrenheit) and a relative humidity range of 55 ±5 percent for a minimum of 24 hours."

positioning procedure can have larger errors should they use the Z-point as their origin. We request that a single tolerance value be harmonized across all drawings that are used to locate the Z-point.

The second issue pertains to multiple dimension call outs for the shoulder belt anchor hole. The location is identified in the drawing package four times, and three different vertical dimensions provided:

- 953 ±3 mm (3021-010, Sheet 1), using part 3021-209 as the reference plane
- 953 ±3 mm (3021-015, Sheet 1), using part 3021-209 as the reference plane
- 941 ±3 mm (3021-015, Sheet 2), using part 3021-200-9 as the reference plane
- 877 ±6 mm (3021-1000, Sheet 1), using part 3021-200-9 as the reference plane

Given there are three different dimensions provided to locate the same hole, it is unclear which dimension takes priority. Graco requests that a specific dimension be chosen, and, if the dimension is repeated elsewhere in the drawing package, that the tolerances for that dimension be consistent and that a common reference feature is used so as to not change the overall tolerance. We further suggest that the dimension be identified on the drawing showing the lowest state of bench assembly and that all other dimensions be changed to reference dimensions to the extent that they are important to keep in the drawing package.

Relatedly, drawing 3021-209 has a conflict between the plate thickness in the material note (thickness given as 12.5 mm) versus the dimension on the face of the drawing (12.7 mm). We believe the intent is to use standard gauge plate as suggested by the 0.5 inch Imperial unit for thickness referred to in the materials note, which would make the correct value 12.7 mm. We request that NHTSA reconcile the two dimensions.

The fourth issue pertains to a dimension that may be missing for a seat back support tube. On drawing 3021-015, Sheet 2, Revision D, section B-B, a vertical dimension is called out for the second support tube. However, there appears to be a dimension missing for the third support tube (see Figure 10). Graco suggests that a dimension be given for this third tube to ensure consistent bench assembly.

In addition to these three dimensioning/tolerancing issues, Graco requests clarification on the manufacturing intent of the bench when it comes to several important hole features. For context, on drawing 3021-265, Revision D, Note 1 calls for mounting holes to be drilled after bench assembly. This is a helpful note for bench manufacturers, as it communicates the significance of the hole locations and the manufacturing intent; should the holes be drilled into the individual parts before bench assembly, the resulting tolerance stack up might place the holes in locations that preclude the bench from being used as intended.

The clarification request focuses on three features. A note like the one mentioned above is omitted for three parts in the package:

- 3021-255, Sheet 1: Seat Frame Gusset Plate
- 3021-326, Sheet 1: D-Ring Anchor
- 3021-756, Sheet 1: Latch Belt Anchor Plate

Figure 11 shows the Z-point and shoulder belt anchor hole for 3021-255 and 3021-326, respectively, on drawing 3021-015, Sheet 1. Figure 12 shows the latch belt anchor hole for 3021-756 on drawing 3021-750, Sheet 1.

Because of the presence of Note 1 on 3021-265, and its omission on the drawings for the three parts listed, there may be some ambiguity as to whether these holes should be drilled and/or tapped before or after assembly. Had 3021-265 Note 1 not been present in the drawing package, it would be clear that the intent was to have these holes drilled or tapped after assembly; however, its presence on at one of four drawings where it could be relevant leaves some ambiguity for the manufacturing intent. Graco requests that the manufacturing intent of these features be clarified, either by an omission of Note 1 from 3021-265, or an addition of a similar note to the aforementioned parts' drawings.

(6) Representative Test Bench Technical Drawing Package – Materials Specifications

With the exception the bolt detailed on drawing 3021-332, none of the materials are specified beyond "steel" or "steel, mild." We request that the appropriate standard AISI, ASTM, SAE, or UNS grades are specified on each drawing to ensure consistency.

(7) Foam Cushion Drawings Density Specifications References

Drawings 3021-233 Seat Pan Cushion and 3021-248 Seat Back Cushion refer to a "NHTSA Specifications on Preliminary Bench" in the Procurement Specifications and Test Certification Specifications blocks (four references total). We request that these specifications be updated to indicated that they apply to the representative test bench specified in the NPRM.

Test Equipment and Test Method

In the course of the Company's evaluation test program, we have identified some areas that require additional clarification either in the standard or in the test procedure. Graco is also offering some laboratory practice recommendations to better ensure repeatability and reproducibility between individual tests and between test laboratories.

(1) Pre-test Harness Tension Measurement Method

Graco recommends that NHTSA adopt the pre-test harness tension method using a 3-prong gauge similar to that used by NHTSA's Vehicle Research and Test Center (VRTC) and described in their draft research test procedure posted to the subject docket folder. In support of this recommendation, Graco conducted a comparative study using the webbing tension pull device shown in FMVSS No. 213 Figure 9 and a 3-prong gauge like that used by VRTC. This work builds on the Mansfield et al. study that evaluated the effects of different gauge types on test variability[7].

Graco performed 12 dynamic tests at Calspan Corporation ("Calspan") using the proposed test seat assembly, the Hybrid III-6C dummy, and a single model of child restraint system installed with the Type II belt system. Variables explored in this test program[8] were

- Internal harness tension measurement tool

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[7] Mansfield, J., Baker, G., and Bolte, J., "Evaluation of Harness Tightening Procedures for Child Restraint System (CRS) Sled Testing," SAE Technical Paper 2019-01-0617, 2019, doi:10.4271/2019-01-0617.
[8] The test program, including results, is set forth in more detail in Attachment B to these comments.

- Test bench foam indentation force-deflection (IFD)
- Test technician

As shown in Table 4, when using the 3-prong gauge to establish pre-test harness tensions, the results demonstrated reduced Coefficient of Variation (CV) for the test dummy head and chest acceleration measures when compared to the current webbing tension pull device. These same data are also provided graphically in Figure 13. Head and knee excursion values did not vary significantly based on the tension method used. Importantly for the purposes of this comparison, the sled velocity and peak acceleration values were very close for this test series (CV of 0.1 and 0.2, respectively), demonstrating that any minor test-to-test variation was not significantly impacting the results. Use of the 3-prong gauge has the additional benefit of being easier to use when measuring harness tensions.

(2) Pre-test Tether Tension Measurement Method

The proposed S6.1.2(d)(1)(ii) merely specifies the range of acceptable tension values and directs that a load cell be used without noting a location for the measurement. We note that the tether routing on the Representative Test Bench does not reflect actual vehicle geometry and materials, particularly the routing of the tether across a steel box beam at the top of the seat back before turning the strap more than 90 degrees to the anchor location. This effectively creates two segments of the tether strap.

Graco recommends capturing pre-test tether tension values at the approximate midpoint of the section of the tether between the top of the seat back structure and the Tether Anchor Assembly, as shown in Figure 14 . Using this location has proven to result in more consistent readings. The Company has found that taking the measurement closer to either end of this span results in higher tension values. We further recommend that the appropriate zone in which to place the load cell be specified in S6.1.2(d).

Because of the effective segmentation of the tether strap, we are concerned that the tether tension may be different between the child restraint seat back and the top of the bench versus the tension in the segment between the top of the seat back and the tether anchor. This in turn may result in pre-test under- or overtightening of the tether, which can then lead to inconsistent results for otherwise like-to-like tests. Does NHTSA have a study or evidence that the tension in the tether strap between the child restraint seat back and the top of the bench is the same as the tension in the segment between the top of the seat back and the tether anchor?

Additionally, given the text of S6.1.2(d)(1)(ii) is changing to remove references certain harness systems, we also request that the option be provided to use a means other than a load cell to capture pre-test belt and tether tension. This would conform S6.1.2(d)(1)(ii) with S6.1.2(d)(1)(iii), which states

> When attaching a child restraint system to the tether anchorage and the child restraint anchorage system on the standard seat assembly, tighten all belt systems used to attach the restraint to the standard seat assembly to a tension of not less than 53.5 N and not more than 67 N, as measured by a load cell **or other suitable means used on the webbing portion of the belt**. [emphasis added]

This proposed change also aligns with Section 12.D.1.2(3) of TP-213-10, which states

Seat belt webbing load cells to monitor belt preload during seat installation. **This item is not required if an equivalent belt tension measurement device is utilized to determine the preload on the Type I and Type II seat belt assembly**. [emphasis added]

(3) Webbing

Presently, FMVSS No. 213 requires that webbing used for Type I and Type II vehicle belt testing simply meet the requirements of FMVSS No. 209 and have a width less than two inches. Test Procedure TP-213-10[9] Section 12.D.1.1 specifies a 5-panel webbing be used. The VRTC draft research test procedure indicates that a 7-panel webbing from an aftermarket parts supplier was used for development testing supporting the NPRM. The draft Section 6.1.1(a)(1)(ii) again only requires that the webbing meet FMVSS No. 209 requirements without defining the desired mechanical properties.

Even within the 5-panel and 7-panel families of automotive webbing, FMVSS No. 209 provides for significant variation in the elongation under load properties. Based on experience with the current standard test bench assembly, we note that the properties of the webbing used to secure the child restraint system to the bench can affect the test outcomes, sometimes significantly. To better ensure consistency between testing laboratories and in year over year testing, the Company recommends that NHTSA specify a narrow range for the elongation under load.

(4) Chest Clip Location

Another variable between tests is the location of the chest clip (sometimes referred to as a "retainer clip"). Most if not all manufacturers follow the practice of directing caregivers to install the chest clip at armpit level, which is also the direction provided in the 2020 National Child Passenger Safety Technician Guide. Some manufactures even indicate on their chest clips where that level should be aligned to. Graco typically measures the chest clip location and has found that variation in chest clip placement up or down the torso may have a correlation with injury and excursion values in some circumstances. We also note that for an ATD "armpit" is not as well defined as on an infant or toddler, which creates some natural ambiguity and room for interpretation.

To promote consistency in lab practices, we recommend that a means be provided to ensure more precision for chest clip placement. For instance, a target can be applied to the ATD chest jacket to designate the region of the torso that best aligns with a human's armpit and allowing for a quick visual reference when placing the chest clip on the dummy. Another method would be to use a rigid template with a reference point or points elsewhere on the ATD to locate the "armpit." Neither method creates any undue burden during test article set up and would serve to help eliminate some setup variation.

(5) Photographs and Camera Angles

Pre-test photographs provide a crucial analytical tool for diagnosing a child restraint's performance, especially when reviewing anomalous test results. Pre-test photographs can be used to assess the initial angle of the seat, the angle and placement of the vehicle belt relative to the test article, angle of the dummy head to its torso, placement of the internal harness on the dummy's

[9] Laboratory Test Procedure to FMVSS 213 Child Restraint Systems, OVSC Laboratory Test Procedure No. 213, February 16, 2014.

shoulders, etc. Based on our experience, we recommend that standardized locations for the camera lenses for both still photography and high-speed video cameras be identified in TP-213, with all locations specified in the three coordinates relative to fixed points on the representative test bench, similar to what was done by Calspan and VRTC in testing supporting this NPRM. This will resolve issues created by parallax differences between images and afford reviewers the ability to more reliably use photogrammetric analytical techniques.

Test Procedure TP-213 Update

In order to ensure that any further evaluations of the effects of the NPRM on testing are consistent, to better harmonize between testing labs, and to allow manufacturers to start product development with as few test set up variables as possible, Graco urges NHTSA to issue an update to Test Procedure TP-213 – even in draft form - that incorporates the dynamic test procedure changes from the current TP-213-10 version. As shown on Figures 15 and 16 and elsewhere in these comments, the new test representative test bench alone does not remove the significant variation seen within and between laboratories. We urge NHTSA to release an update to Test Procedure TP-213 – even in draft form – to eliminate at least some of the variation that results from inconsistent or unclear laboratory practices.

By way of example, the current section 12.D.1.1 of TP-213-10 specifies "five-panel polyester webbing" for tests using type I and type II vehicle belts; this is not specified in FMVSS 213 Section 6.1.1. Similarly, and as observed above, section 12.D.1.2(3) permits use of equipment other than load cells to capture pre-test belt tension, in conflict with S6.1.2(d)(ii) of FMVSS 213. Any elements of the test procedure equipment or set up that are not specified in FMVSS 213 need to be identified as soon as possible to prevent potential marketplace disruptions and unnecessary costs in the future.

Proposed S7.1.1 ATD Selection

Graco supports the proposed ATD selection criteria for dynamic testing as set forth in the draft Section 7.1.1.

Anthropometric Test Dummies

(1) Use of the Hybrid III 6-year-old Anthropometric Test Dummy and Repeatability

In the course of the Company's test program evaluating the proposed representative test bench, we conducted repeatability studies at Calspan that found the Hybrid III 6-year-old test dummy can experience chin-to-chest strikes in belt-positioning booster mode tests that artificially increase the HIC scores. This is not representative of a real-world injury mechanism; it is simply an artifact of the neck structure on this dummy. Figure 17 provides the head and chest resultant acceleration traces for two tests using the same child restraint model, test dummy, and test set up parameters. A representative still image taken from high-speed video is shown in Figure 18. In this image, the neck is chin is clearly in contact with the chest corresponding to the spikes in the acceleration traces.

Our testing with a single model of an all-in-one child restraint used as a belt-positioning booster found that slight child restraint and dummy pre-test setup variations allowed by the current TP-213 and the VRTC draft research test procedure cause the head to swing forward and down into the chest plate, generating HIC scores ranging from mid-500s to over 1000 over repeated tests, as provided in Table 5.

The Coefficient of Variation for the values in Table 5 exceeds 20 (see Figure 19), noting that any CV score greater than 10 is generally considered to be a high-variance measurement system in need of improvement.

We note that, at first glance, this conclusion is somewhat in conflict with the discussion in Section IX.d of the NPRM and the related data presented in Table 20 of that document. However, the data presented in this section of the NPRM were based on multiple tests with multiple child restraints (including at least one backless booster seat) from different manufacturers, whereas the data shown above relates to a test series where the only material difference between the tests was the performance of the Hybrid III 6-year-old dummy.

The results experienced by Graco in our testing are not unique to any particular product, manufacturer, or test laboratory, and were acknowledged by NHTSA in the final rule amending FMVSS No. 213 to make the option to use either of the available 6-year-old dummies permanent[10]. Specifically, NHTSA stated at 76 FR 55826

> The HIII–6C dummy has a softer neck than the H2–6C, which results in slightly greater head excursion results and larger HIC values (chin-to-chest contact) than the H2–6C. This, coupled with the stiff thorax of the HIII–6C dummy, accentuates the HIC values recorded by the dummy.

The upgrades to the HIII-6C discussed in detail in Note 7 of this final rule have not yet been instituted into the dummy.

Given the well-documented issues with the Hybrid III 6-year-old dummy, we suggest NHTSA keep the option to continue use of the Hybrid II 6-year-old dummy as is currently permitted at S7.1.3. Alternately or concurrently, NHTSA should accelerate its update of the HIII-6C and provide a methodology for evaluating chin-to-chest strikes and, when appropriate, provide a vehicle for relief from HIC scores above 1000 that were caused by this non-biofidelic artifact of the test dummy design.

(2) Use of the Hybrid II 6-year-old Anthropometric Test Dummy

Graco does not generally oppose a sunset on the current FMVSS 213 Section 7.1.3, which permits the optional use of the 49 CFR 572 Subpart I Hybrid II 6-year-old test dummy in lieu of the Hybrid III version. However, the Company requests that the provisions of S7.1.3 remain available as an option until they can be expired concurrently with the expiration of the current standard test bench requirements (currently at S6.1.1(a)(1)(ii) and proposed to be moved to S6.1.1(a)(1)(i)) and upon resolution of issues with the HIII-6C as discussed in the previous section.

(3) Hybrid III 3-year-old Dummy Head Drop for Calibration

For calibration purposes, the CRABI-12 dummy specification includes a front and rear head drop (see 49 CFR 572.152). Does NHTSA intend to update the Hybrid III 3-year-old head drop calibration procedure at 49 CFR 572.142 to include a rear head drop, or is the current front-only calibration method sufficient for both rear-facing and front-facing dynamic tests with child restraint systems?

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[10] Docket No. NHTSA–2011–0139, 76 FR 55825 *et seq*, 9 September 2011.

Belt-Positioning Booster Entry Weight Proposal

Graco supports NHTSA's proposal to harmonize with the Canadian regulation and increase the belt-positioning booster entry weight to 18.2 kg (40 lb).

Forward-Facing Harness Seat Entry Weight Proposal

In the NPRM, NHTSA seeks comments (Section VIII.b) on the proposed entry weight for forward-facing harness seats increasing to 26.5 lb. Graco supports an increase in the rear-facing/forward-facing transition weight in principal, but the Company recommends that the entry weight be expressed as a whole number, as most parents and caregivers do not track their child's weight to the half pound. Additionally, we recommend that the entry weight be an even multiple of five; in this case, 25 pounds. This value accomplishes NHTSA's stated goal of ensuring that most children would not be "eligible" to transition to ride forward-facing before their first birthday and couples it to an easy-to-remember weight milestone. According to data from the Centers for Disease Control and Prevention[11], a 95th percentile female weighs 25 pounds at her first birthday, as do approximately 80% of male infants.

As shown in more detail in Tables 6 and 7, an outcome of elevating the entry weight to 26.5 lb is that lighter children may not reach that threshold until 42 months (5th percentile female) or 36 months (5th percentile male)[12], and NHTSA should be prepared to address the potential for misuse if caregivers determine that their child will ride forward-facing after their first birthday regardless of their weight, consistent with NHTSA's guidelines for parents[13] and statements many manufacturers have voluntarily placed on their products for many years. We encourage NHTSA to include a mandatory statement that children must not use a forward-facing harnessed child restraint system until they are at least one year old. Using the first birthday as an additional criterion better addresses the well-known underlying concern that children do not yet have sufficient bone and muscle development to derive the same safety benefit from a child restraint system in a motor vehicle crash if they are forward-facing.

Proposed Label Changes

(1) Relocation of S5.5.2(f) from Bulleted Warnings

Presently, the overall product height and weight ranges must be presented in one of the formats provided in S5.5.2(f) and this information must be located within the bulleted warnings per S5.5.2(g)(1)(i). Graco supports moving this information out of the bulleted warnings and prominently displaying more detailed information by use mode (where applicable) elsewhere on the child restraint system. In response to the query posed by NHTSA in Section XII of the NPRM, we suggest that all proposed changes affecting labels (including but not limited to new entry weights and changes prompted by changes to the testing regime) become mandatory concurrently. We further suggest that manufacturers be provided the option to relocate the information in S5.5.2(f) upon issuance of the final rule or a short time thereafter.

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[11] CDC documents " Birth to 36 months: Girls Length-for-age and Weight-for-age percentiles" and "Birth to 36 months: Boys Length-for-age and Weight-for-age percentiles," https://www.cdc.gov/growthcharts/cdc_charts.htm. Accessed 26 March 2021.
[12] Ibid.
[13] For example, see NHTSA document 10849b-071219-v3a, "Car Seat Recommendations for Children," https://www.nhtsa.gov/equipment/car-seats-and-booster-seats. Accessed 26 March 2021.

(2) Deletion of Section 5.5.2(k)(2)

Graco supports the deletion of current S5.5.2(k)(2) as this requirement has created confusion on the part of caregivers for many years as to the actual maximum permitted rear-facing weight limit for their child restraint. We believe that the information consumers need to make the right decisions for proper use based on their child's weight and height will be better provided on the label(s) containing the information specified in S5.5.2(f).

Registration Program

Graco supports implementation as soon as practicable of the option for manufacturers to change the top portion of the registration card to use language that will encourage positive consumer action. With respect to including a statement that the registration information will not be used except in the event of a recall, Graco supports including this statement, which would align with the required statement included as part of the U.S. Consumer Product Safety Commission ("CPSC") children's products registration program at 16 CFR 1130.6(c).

Increasingly, consumer appliances and electronics are using QR codes or bar codes to allow consumers to register easily with their cell phone. To answer the questions posed at Section VIII.a of the NPRM, Graco supports adding an option to allow manufacturers to use a scannable code or a "tiny URL" to facilitate consumer access to each company's on-line registration portal. We do recommend, however, that any scannable registration aids only use open-source or non-proprietary methods and not require consumers to install any special software onto their cell phone, and that where a scannable graphic is used a full- or reduced-sized URL be printed on the card to allow direct access to the registration website.

NHTSA also asked at Section VIII.a about adding or removing information from the electronic form and the mail-in card. Graco supports providing consumers the option to enter their telephone number, which would align with the requirements for the CPSC children's products registration program at 16 CFR 1130.7.

In response to the inquiry posed in Section XIV regarding labor burdens associated with the registration, as observed in OMB Control Number 2127-0576 and Docket NHTSA-2018-0063, the labor burden on the consumer side will scale proportionally with the number of registrations. Since the purpose of allowing modifications to the top part of the card is to encourage participation in the registration program, the expected consumer labor burden will necessarily increase. For manufacturers, it is unclear at this time if the total burden will increase or remain roughly constant since it is as of yet unknown if the proportion of consumers using electronic registration will increase.

UMTRI Fit Study and Child Restraint Minimum Seat Back Height

Currently, FMVSS 213 S5.2.1.1(a) imposes minimum seat back height requirements that were originally proposed in 1978 and that went into force in 1981[14]. These requirements reflect the features of vehicles and child restraints in the market at that time, most significantly vehicles typically did not have head rests above the seat back and child restraint systems had fixed seat back lengths.

In order to better adapt to children of different sizes and developmental maturity, many manufacturers are offering child restraint systems with adjustable-height seat backs that "grow with the child."

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[14] See 43 FR 21486 (18 May 1978).

Adjustable products can thus continue to provide appropriate head support and they address the concerns brought out in the UMTRI study[15]. For dual-mode (rear- and forward-facing) child restraints, this also has the advantage for consumers of fitting in more vehicles rear-facing given practical space constraints in rear seating locations, while allowing a long-term use mode forward-facing without the purchase of a dedicated forward-facing CRS.

As currently written, S5.2.1.1(a) does not explicitly contemplate any CRS seat back height adjustments. The laboratories used by NHTSA for its annual compliance audit testing program are not consistently applying the requirement of S5.2.1.1(a) with respect to adjustments. The requirement can be clarified consistent with the intent of the existing regulation by maintaining the current limit of 500 mm for products rated for users less than 18 kg, and by requiring that the child restraint system be set up so as to accommodate the Hybrid III-3C dummy – including adjusting seat back height along with the location of the shoulder belts to the proper openings - before taking the measurement to ensure that the minimum seat back height of 560 mm is provided for all products rated for use by children over 18 kg. Note that these adjustments, including repositioning of the shoulder belts, are required of caregivers for proper use and it is realistic to make the same adjustments in the laboratory setting.

We observe that NHTSA addressed this in a 2008 interpretation request to Recaro. At that time, however, adjustable-height child restraints were rare; the Recaro product did not meet the 500 mm minimum without adjustment; and of the 20 rear- and forward-facing child restraints offered at that time only five could be used by children above 18 kg[16]. Further, child restraints offered as of 2021 do not create any unique safety risk as alluded to in the Recaro response since adjustments are simply part of the adaptation of the child restraint to the growing child.

<u>NHTSA Requests for Feedback</u>

(1) Virtual Child Models

To date, Graco has not used NHTSA's virtual child models and the Company is unlikely to do so in the future as they are provided in STL format and not particularly suitable for manipulation (such as changing the seating posture or reorienting the arms relative to the torso) in the computer aided design software used by the Company. NHTSA might consider making the models available in a data format that can be more readily integrated into users' computer aided modeling tools, such as Parasolid or STEP.

(2) Consistency with NHTSA's Use of ATDs in the Proposed Side Impact Test

NHTSA seeks comments in Section IX.g of the NPRM on whether the weight ranges in Table 24 should also be used for dummy selection in the proposed side impact test. As NHTSA observes elsewhere in Section IX, manufacturers are likely to align child restraint weight ranges to the test dummy requirements of Table 24 (proposed Section 7.1.1). Graco supports using the same weight ranges to determine test dummy selection in both the front and side impact tests as the same rationale regarding dummy sizes and applicability range applies and it will likely reflect how manufacturers will instruct their products be used.

[15] Manary. M., et al., ''Comparing the CRABI–12 and CRABI–18 for Infant Child Restraint System Evaluation.'' June 2015. DOT HS 812 156.
[16] American Academy of Pediatrics, "Car Safety Seats: A Guide for Families 2008,"www.aap.org. Accessed 1 April 2008.

(3) Consistency with the Proposal for the Side Impact Bench

NHTSA requested comments in Section III.b of the NPRM regarding updating the side impact test bench proposed in Docket No. NHTSA-2014-0012 to conform to the frontal impact representative test bench. We support using one representative test bench for both test modes. However, we encourage NHTSA to address the sharp edges in the tether routing path (see above) before implementing the proposed representative test bench.

(4) Timing of the Side Impact Final Rule

Related to the above items, and with the addition of the Q3s 3-year-old child side impact dummy to 49 CFR Part 572 at Subpart W[17], we encourage NHTSA to release a final rule for side impact factoring in any comments received in the 2014 docket as well as any adaptations resulting from the development of the new frontal impact test as soon as practicable. If the representative test bench described in this NPRM is to be used for side impact, we encourage NHTSA to conduct sufficient testing to ensure that using a common bench for frontal and side impacts does not significantly alter test methods or outcomes in side impact. To minimize disruption, we recommend that the effectivity dates of both the revised frontal and the new side impact test coincide.

Summary

Graco is committed to assist in the development of the proposed front and side impact standards. We welcome the opportunity to share any of our research data with NHTSA and we invite the agency to send us inquiries about any of the data underlying our comments today, and to partner with us on research testing to aid our common goal of a robust test methodology that reflects the reality of today's motor vehicles and the safety needs of child passengers. Our research testing will continue past the end of the comment period; however, we will be providing additional information in furtherance of these objectives as soon as it becomes available.

Thank you for your time and consideration of these comments.

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/attachments: Attachment A – Figures and Tables
Attachment B – Harness Tension Study

[17] Final Rule, 85 FR 69898 *et seq.*, 3 November 2020.