



## ATTACHMENT B – GRACO COMMENT HARNESS TENSION STUDY

Docket NHTSA-2020-0093

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*  
*Attachment B – Harness Tension Study*

This attachment provides additional details related to a study conducted by Graco Children's Products Inc. ("Graco") of effects of harness tension methods on dynamic test outcomes.

A series of 12 tests were performed on 1 February 2021 at Calspan using the proposed representative test bench on a Graco child restraint system. The mode for all tests was

- 6-year-old Hybrid III dummy secured with internal harness
- Type II vehicle belt system
- No tether

Variables from test to test were

- Two test technicians installed the test articles
- Tests used a low or high IFD foam
- Harness tensions were captured using one of two gauges (see Figure B-1)



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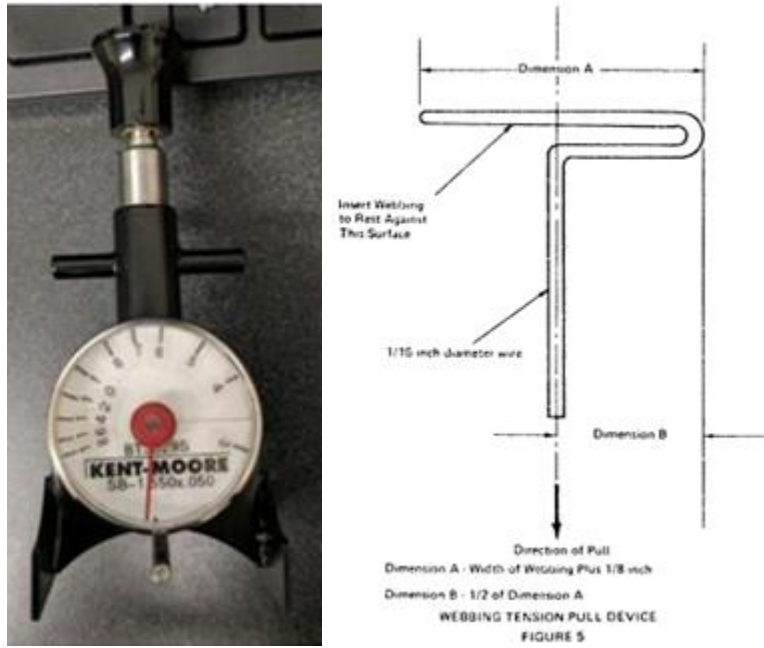


Figure B-1. Harness Tension Gauges.

Table B-1 details the sample plan for this test series.

Table B-1. Harness Tension Capture Method Sample Plan.

tension method	3-prong gauge						FMVSS 213 webbing tension pull device					
Test tech	1	1	1	2	2	2	1	1	1	2	2	2
IFD	Low	High	Low	High	Low	High	High	Low	High	Low	High	Low

Table B-2 provides a summary of the test results for each run.



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Table B-2. Test Results Summary.

Installer	Sled Acc [g]	Sled Vel [kph]	HIC	Chest Resultant [g]	Head Excursion [mm]	Knee Excursion [mm]	IFD 4" Bench Foam	Harness tension method
1	24.1	47.9	564	46.7	729	817	97	213
2	24.1	47.9	546	49.9	713	823	104	3 Prong
2	24.2	48.1	590	47.2	713	811	97	3 Prong
1	24.2	48.1	618	53.8	721	824	104	213
1	24.2	48	589	49.6	720	811	97	3 Prong
2	24.2	48	546	50.3	720	816	104	213
2	24.2	48	599	47	721	812	97	213
1	24.2	48	546	51.4	710	817	104	3 Prong
1	24.2	48	666	47.8	733	820	97	213
2	24.2	48	596	50.1	723	820	104	213
2	24.2	48	588	49	717	812	97	3 Prong
1	24.2	48	542	49.5	708	817	104	3 Prong

Based upon the results in Table B-2, the Coefficient of Variation (CV) was calculated for different each harness tension method combined with different input and results criteria. This is summarized in Table B-3.

Table B-3. Calculated Coefficients of Variation.

<i>Harness tension method</i>	<i>FMVSS 213 Criterion</i>	<i>CV [%]</i>
3 Prong	Sled Accel	0.2
3 Prong	Sled Velocity	0.1
3 Prong	HIC	<b>4.3</b>
3 Prong	Chest Resultant	<b>2.8</b>
3 Prong	Head Excursion	0.6
3 Prong	Knee Excursion	0.6
213 gauge	Sled Accel	0.2
213 gauge	Sled Velocity	0.1
213 gauge	HIC	<b>7.0</b>
213 gauge	Chest Resultant	<b>5.5</b>
213 gauge	Head Excursion	0.7
213 gauge	Knee Excursion	0.5



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Figure B-2 graphically presents the data in Table B-3 related to injury criteria. The acceleration-related test measures (HIC and chest resultant) were significantly impacted by the different harness tensioning methods, whereas the head and knee excursion values are in closer alignment. Based on the foregoing, we conclude that the 3-prong gauge provides more reliably repeatable results.

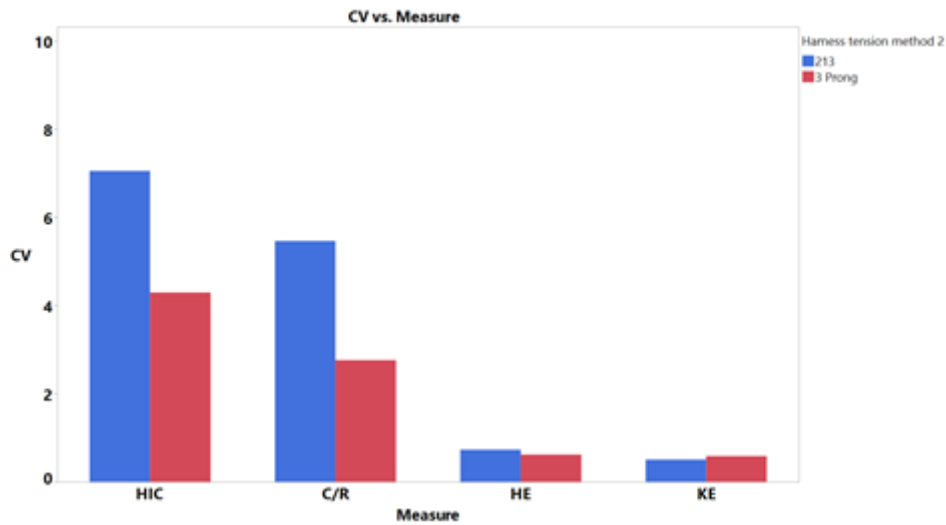


Figure B-2. Comparison of the Coefficients of Variance for Injury and Excursion Values.