

**REPORT NUMBER: TWG-MGA-2006-002**

**NEW CAR ASSESSMENT PROGRAM  
SIDE AIRBAG OUT-OF-POSITION INJURY TESTING**

**FORD MOTOR COMPANY  
2006 FORD FUSION  
NHTSA NUMBER: M60203TWG2**

**PREPARED BY:  
MGA RESEARCH CORPORATION  
5000 WARREN ROAD  
BURLINGTON, WI 53105**



**Test Date: June 7, 2006**

**Final Report Date: August 16, 2006**

**FINAL REPORT**

**PREPARED FOR:  
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NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
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Date: 8/16/06

### Technical Report Documentation Page

| <b>1. Report No.</b><br>TWG-MGA-2006-002                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>2. Government Accession No.</b>                          | <b>3. Recipient's Catalog No.</b>                                                                                                                                                                                               |                  |            |            |            |            |            |            |     |     |      |      |      |      |
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| <b>4. Title and Subtitle</b><br>Final Report<br>2006 Ford Fusion<br>NHTSA No.: M60203TWG2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                             | <b>5. Report Date</b><br>August 16, 2006                                                                                                                                                                                        |                  |            |            |            |            |            |            |     |     |      |      |      |      |
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| <b>9. Performing Organization Name and Address</b><br>MGA Research Corporation<br>5000 Warren Road<br>Burlington, WI 53105                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                             | <b>10. Work Unit No.</b>                                                                                                                                                                                                        |                  |            |            |            |            |            |            |     |     |      |      |      |      |
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| <b>15. Supplementary Notes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                             |                                                                                                                                                                                                                                 |                  |            |            |            |            |            |            |     |     |      |      |      |      |
| <b>16. Abstract</b><br>This side impact out-of-position test was performed in conjunction with a New Car Assessment Program (NCAP). This test was conducted at MGA Research Corporation in Burlington, Wisconsin, on June 7, 2006. <table style="margin-left: auto; margin-right: auto; border: none;"> <thead> <tr> <th style="text-align: center;">HIC 15</th> <th style="text-align: center;">HIC 36</th> <th style="text-align: center;">NIJ<br/>NTF</th> <th style="text-align: center;">NIJ<br/>NTE</th> <th style="text-align: center;">NIJ<br/>NCF</th> <th style="text-align: center;">NIJ<br/>NCE</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">3.3</td> <td style="text-align: center;">3.5</td> <td style="text-align: center;">0.07</td> <td style="text-align: center;">0.01</td> <td style="text-align: center;">0.10</td> <td style="text-align: center;">0.04</td> </tr> </tbody> </table> |                                                             |                                                                                                                                                                                                                                 |                  | HIC 15     | HIC 36     | NIJ<br>NTF | NIJ<br>NTE | NIJ<br>NCF | NIJ<br>NCE | 3.3 | 3.5 | 0.07 | 0.01 | 0.10 | 0.04 |
| HIC 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | HIC 36                                                      | NIJ<br>NTF                                                                                                                                                                                                                      | NIJ<br>NTE       | NIJ<br>NCF | NIJ<br>NCE |            |            |            |            |     |     |      |      |      |      |
| 3.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 3.5                                                         | 0.07                                                                                                                                                                                                                            | 0.01             | 0.10       | 0.04       |            |            |            |            |     |     |      |      |      |      |
| <b>17. Key Words</b><br><br>New Car Assessment Program (NCAP)<br>Side Airbag Out-of-Position                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                             | <b>18. Distribution Statement</b><br>Copies of this report are available from:<br>National Highway Traffic Safety Admin., Technical Ref. Division,<br>Room 5108 (NPO-230)<br>400 Seventh Street, S.W.<br>Washington, D.C. 20590 |                  |            |            |            |            |            |            |     |     |      |      |      |      |
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## TABLE OF CONTENTS

| <u>Section</u>        |                                                | <u>Page No</u>  |
|-----------------------|------------------------------------------------|-----------------|
| 1                     | Purpose and Summary of Test                    | 1               |
| 2                     | Occupant and Vehicle Information / Data Sheets | 2               |
| <u>Data Sheet No.</u> |                                                | <u>Page No.</u> |
| 1                     | Test Summary                                   | 2               |
| 2                     | Test Vehicle Information                       | 3               |
| 3                     | Dummy Positioning in Vehicle                   | 4               |
| 4                     | Dummy Injury Criteria Values                   | 5               |
| <u>Appendix</u>       |                                                |                 |
| A                     | Photographs                                    | A               |
| B                     | Dummy Response Data Traces                     | B               |
| C                     | Instrumentation Calibration Data               | C               |

## **SECTION 1**

### **PURPOSE AND SUMMARY OF TEST**

#### **PURPOSE**

The purpose of this test was to obtain data in a static out-of-position side impact. These data constitute part of the general consumer information collected by the New Car Assessment Program (NCAP) sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-03-D-12005.

#### **SUMMARY**

The effects of a curtain airbag deployment in a 2006 Ford Fusion with an out-of-position six-year-old child were evaluated. The test was performed by MGA Research Corporation on June 7, 2006. Pre and post test photographs of the vehicle and dummy can be found in Appendix A.

One real-time camera (24 fps) and three high-speed cameras (1000 fps) were used to document the side airbag deployment event. The following camera locations were used:

- Left Side Through Driver Window
- Front Through Windshield
- Left Side  $\frac{3}{4}$  View Through Windshield

One Part 572N, 6-year-old child dummy (Serial Number 144) was placed in the right front passenger seat situated in the inboard-facing position per Section 3.3.5.1 according to dummy placement instructions specified in the Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags as prepared by the Side Airbag Out-of-Position Injury Technical Working Group (TWG).

The child dummy was instrumented with head tri-axial accelerometers. In addition, upper and lower neck force and moment load cell sensors were utilized.

The 15 channels of data were recorded on an on-board data acquisition system. Appendix B contains the dummy head and neck response data traces. Appendix C contains the instrumentation calibration data.

The HIII 6-year-old child dummy's visible contact points were as follows: The curtain airbag to the top and the back of the head.

The HIII 6-year-old child dummy was placed on the foam booster block with its legs extended. With the head in its neutral orientation, the dummy's pelvis was pushed outboard until the dummy's back contacted the door trim panel. The dummy's pelvic angle was then adjusted until the head center of gravity was centered in the curtain airbag's deployment trajectory. The dummy's arms were bent at the elbow until the fingers just touched the booster seat. This orientation complies with Section 3.3.5.1 of the TWG Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags as defined by Lund, et al and the Technical Working Group First Revision dated July, 2003.

**SECTION 2**  
**OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS**

**DATA SHEET NO. 1**  
**TEST SUMMARY**

|                     | Test Data               | Description                                                 |
|---------------------|-------------------------|-------------------------------------------------------------|
| Seating Position    | P2                      | Right Front Seating Position                                |
| Test                | 3.3.5.1*                | Inboard-facing HIII 6-year-old child dummy on booster block |
| Airbag              | Roof-Rail Mounted       | Side curtain airbag                                         |
| Booster Block       | 300 mm x 455 mm x 75 mm | Block consisted of HD36 foam with a density of 44.8 g/L     |
| ATD Type/Serial No. | P572N / 144             | HIII 6-year-old child dummy                                 |

\* Procedure as defined by Lund, et al and the Technical Working Group dated July, 2003

|                            |    |
|----------------------------|----|
| Number of Data Channels    | 15 |
| Number of Real-Time Video  | 1  |
| Number of High-Speed Video | 3  |

| Visible Dummy Contact Points |                                        |
|------------------------------|----------------------------------------|
| Head Contact                 | Curtain airbag to top and back of head |
| Upper Torso Contact          | None                                   |
| Lower Torso Contact          | None                                   |
| Left Knee Contact            | None                                   |
| Right Knee Contact           | None                                   |

**DATA SHEET NO. 2****TEST VEHICLE INFORMATION**

Please note that this vehicle had previously been tested in an  
NCAP Frontal Impact on October 19, 2005

**TEST VEHICLE INFORMATION**

|                                                         |                   |
|---------------------------------------------------------|-------------------|
| Manufacturer                                            | Ford              |
| Model                                                   | Fusion            |
| Body Style                                              | Sedan             |
| NHTSA No.                                               | M60203TWG2        |
| VIN                                                     | 3FAHP08186R102253 |
| Color                                                   | Dark Blue Pearl   |
| Delivery Date                                           | 10/06/05          |
| Odometer Reading (mile)                                 | 60                |
| Dealer                                                  | Boucher Ford      |
| Transmission                                            | Automatic         |
| Final Drive                                             | Front             |
| Number of Cylinders                                     | 6                 |
| Engine Displacement (L)                                 | 3.0               |
| Engine Placement                                        | Lateral           |
| Automatic Door Lock (ADL)                               | Yes               |
| Owners Manual Details<br>Instructions on Disabling ADLs | Yes               |
| Bucket Seats                                            | Yes               |

**TEST VEHICLE OPTIONS**

|                                    |     |
|------------------------------------|-----|
| Front Airbag                       | Yes |
| Driver Side Curtain Airbag         | Yes |
| Driver Side Torso Airbag           | Yes |
| Rear Passenger Side Curtain Airbag | Yes |
| Rear Passenger Side Torso Airbag   | No  |
| Force Limiter                      | Yes |
| Pretensioner                       | Yes |
| Power Steering                     | Yes |
| Power Door Locks                   | Yes |
| Tilt Wheel                         | Yes |
| Air Conditioning                   | Yes |
| Anti-lock Brakes                   | Yes |
| Traction Control                   | Yes |
| All Wheel Drive                    | No  |
| Power Seats                        | Yes |

**DATA FROM CERTIFICATION LABEL**

|                     |                    |
|---------------------|--------------------|
| Manufactured By     | Ford Motor Company |
| Date of Manufacture | 08/05              |

|                 |      |
|-----------------|------|
| GVWR (kg)       | 1987 |
| GAWR Front (kg) | 1084 |
| GAWR Rear (kg)  | 925  |

| Measured Parameter      | Front  | Rear        | Third | Total |
|-------------------------|--------|-------------|-------|-------|
| Type of Seats           | Bucket | Split Bench |       |       |
| Number of Occupants     | 2      | 3           |       | 5     |
| Capacity Wt. (VCW) (kg) |        |             |       | 385   |
| Cargo Wt. (RCLW) (kg)   |        |             |       | 45.4  |

**DATA SHEET NO. 3**  
**DUMMY POSITIONING IN VEHICLE**

| Measurement                                 |           | Value |
|---------------------------------------------|-----------|-------|
| Total Fore/Aft Travel (mm)                  |           | 234   |
| Test Distance Rearward of Full-Forward (mm) |           | 117   |
| Total Fore/Aft Travel (detents)             |           | ---   |
| Placed in Position No. 2                    |           | ---   |
| Seat Back Angle                             | SA (°)    | 25    |
| Airbag Module Width                         | AMW (mm)  | 35    |
| Airbag Width                                | ABW (mm)  | 409   |
| Airbag Module Length                        | AML (mm)  | 227   |
| Airbag Length                               | ABL (mm)  | 1900  |
| Top of Airbag Module to Head/Neck Junction  | AN (mm)   | ---   |
| Head CG to Door Panel/Window                | HD (mm)   | 162   |
| Head to Seat Back Centerline                | HSC (mm)  | 166   |
| Head to B-Pillar (cg)                       | HB (mm)   | 229   |
| Head to Roof, Z (top of the head)           | HZ (mm)   | 133   |
| Head to Header                              | HHD (mm)  | 79    |
| Chest to Dash                               | CD (mm)   | 523   |
| Chest to Seatback                           | CS (mm)   | 196   |
| Right Arm to Seat Back Centerline           | RACL (mm) | ---   |
| Right Arm to Seat Back Centerline           | RACL (°)  | ---   |
| Left Arm to Seat Back Centerline            | LACL (mm) | ---   |
| Left Arm to Seat Back Centerline            | LACL (°)  | ---   |
| Right Arm to Door Panel                     | RA (mm)   | 101   |
| Left Arm to Door Panel                      | LA (mm)   | 126   |
| Knee to Knee                                | KK (mm)   | 94    |
| Toe to Toe                                  | TT (mm)   | 84    |
| Right Knee to Seat Cushion Centerline       | KSCR (mm) | 97    |
| Left Knee to Seat Cushion Centerline        | KSCL (mm) | 102   |
| Right Toe to Seat Cushion Centerline        | TSCR (mm) | 412   |
| Left Toe to Seat Cushion Centerline         | TSCL (mm) | 432   |
| Nose to Dash                                | ND (mm)   | 544   |
| Nose to Seatback                            | NS (mm)   | 262   |
| Nose to Header                              | HR (mm)   | ---   |
| Foam Block Depth                            | (mm)      | 300   |
| Foam Block Width                            | (mm)      | 455   |
| Foam Block Thickness                        | (mm)      | 75    |



**DATA SHEET NO. 4**  
**DUMMY INJURY CRITERIA VALUES**

**NHTSA No. M60203TWG2**

|                        |      | MAXIMUM VALUE  |           |         |           |
|------------------------|------|----------------|-----------|---------|-----------|
|                        |      | Position No. 2 |           |         |           |
| DESCRIPTION            | UNIT | MAXIMUM        | TIME (MS) | MINIMUM | TIME (MS) |
| Head X                 | g    | 11.0           | 25.1      | -2.4    | 59.5      |
| Head Y                 | g    | 2.1            | 38.2      | -6.7    | 17.8      |
| Head Z                 | g    | 3.4            | 19.7      | -1.4    | 18.6      |
| Head Resultant         | g    | 11.7           | 26.4      | 0.0     | 0.0       |
| Upper Neck Fx          | N    | 7.5            | 0.7       | -90.4   | 55.1      |
| Upper Neck Fy          | N    | 56.5           | 47.0      | -9.9    | 19.0      |
| Upper Neck Fz          | N    | 39.9           | 28.8      | -125.8  | 24.8      |
| Upper Neck F Resultant | N    | 141.8          | 24.8      | 0.3     | 13.2      |
| Upper Neck Mx          | N-m  | 5.4            | 38.6      | -0.6    | 103.0     |
| Upper Neck My          | N-m  | 6.9            | 47.6      | -0.7    | 25.8      |
| Upper Neck Mz          | N-m  | 1.9            | 84.1      | -4.3    | 38.7      |
| Upper Neck M Resultant | N-m  | 8.6            | 46.6      | 0.0     | 0.0       |
| Lower Neck Fx          | N    | 3.1            | 16.3      | -48.0   | 55.6      |
| Lower Neck Fy          | N    | 22.9           | 48.2      | -18.6   | 23.2      |
| Lower Neck Fz          | N    | 38.1           | 1.0       | -121.7  | 25.2      |
| Lower Neck F Resultant | N    | 124.0          | 25.3      | 0.2     | 0.0       |
| Lower Neck Mx          | N-m  | 10.8           | 43.1      | -1.0    | 101.3     |
| Lower Neck My          | N-m  | 17.6           | 56.1      | -0.2    | 14.2      |
| Lower Neck Mz          | N-m  | 2.3            | 85.8      | -3.3    | 37.9      |
| Lower Neck M Resultant | N-m  | 19.1           | 53.4      | 0.0     | 13.5      |

**DATA SHEET NO. 4 (continued)**  
**DUMMY INJURY CRITERIA VALUES**

| ATD position         | HEAD INJURY CRITERIA (HIC) |                          |                          |       |                          |                          |
|----------------------|----------------------------|--------------------------|--------------------------|-------|--------------------------|--------------------------|
|                      | HIC15                      |                          |                          | HIC36 |                          |                          |
|                      | HIC                        | T <sup>1</sup><br>(msec) | T <sup>2</sup><br>(msec) | HIC   | T <sup>1</sup><br>(msec) | T <sup>2</sup><br>(msec) |
| No. 2<br>Right Front | 3.3                        | 16.2                     | 31.2                     | 3.5   | 16.0                     | 34.5                     |

**Position 2 Neck Injury Summary (Hill 6-year-old – Out-of-Position)**

| Nij V10                           | Nij  | Time (msec)   | Z Force (N)<br>(CFC 600)               | X Force (N)<br>(CFC 600) | Y Moment (N-m)<br>(CFC 600) |
|-----------------------------------|------|---------------|----------------------------------------|--------------------------|-----------------------------|
| Ntf                               | 0.07 | 41.20         | 5.85                                   | -58.95                   | 5.97                        |
| Nte                               | 0.01 | 115.10        | 25.37                                  | -22.19                   | -0.02                       |
| Ncf                               | 0.10 | 49.50         | -41.83                                 | -69.44                   | 7.62                        |
| Nce                               | 0.04 | 17.50         | -110.84                                | -22.70                   | -0.18                       |
| <b>Peak Tension<br/>(CFC1000)</b> |      | <b>39.9 N</b> | <b>Peak Compression<br/>(CFC 1000)</b> |                          | <b>-125.8 N</b>             |

**Critical Values**

| Nij Intercepts        |                  |                  |        | Peak Limits |        |
|-----------------------|------------------|------------------|--------|-------------|--------|
| Tension (CVt)         | 2800 N           | Extension (mCVe) | 37 N-m | Tension     | 1490 N |
| Compression (CVc)     | 2800 N           | Flexion (mCVf)   | 93 N-m | Compression | 1820 N |
| <b>Condyle Offset</b> | <b>0.01778 m</b> |                  |        |             |        |

**APPENDIX A**  
**PHOTOGRAPHS**

**TABLE OF PHOTOGRAPHS**

|               |                                                     | <u>Page No.</u> |
|---------------|-----------------------------------------------------|-----------------|
| Photo No. 1.  | Pre-Test Vehicle Left Side View                     | A-2             |
| Photo No. 2.  | Post-Test Vehicle Left Side View                    | A-2             |
| Photo No. 3.  | Vehicle Certification Placard                       | A-3             |
| Photo No. 4.  | Vehicle Tire Placard                                | A-3             |
| Photo No. 5.  | Pre-Test Child Dummy Frontal View                   | A-4             |
| Photo No. 6.  | Post-Test Child Dummy Frontal View                  | A-4             |
| Photo No. 7.  | Pre-Test Child Dummy Right $\frac{3}{4}$ Side View  | A-5             |
| Photo No. 8.  | Post-Test Child Dummy Right $\frac{3}{4}$ Side View | A-5             |
| Photo No. 9.  | Pre-Test Child Dummy Right Side View                | A-6             |
| Photo No. 10. | Post-Test Child Dummy Right Side View               | A-6             |
| Photo No. 11. | Pre-Test Child Dummy Head View                      | A-7             |
| Photo No. 12. | Post-Test Child Dummy Head View                     | A-7             |
| Photo No. 13. | Pre-Test Child Dummy Head View (Through Window)     | A-8             |
| Photo No. 14. | Post-Test Child Dummy Head View (Through Window)    | A-8             |
| Photo No. 15. | Pre-Test Child Dummy Torso View                     | A-9             |
| Photo No. 16. | Post-Test Child Dummy Torso View                    | A-9             |



Pre-Test Vehicle Left Side View



Post-Test Vehicle Left Side View





Vehicle Certification Placard



Vehicle Tire Placard





Pre-Test Child Dummy Frontal View



Post-Test Child Dummy Frontal View



Pre-Test Child Dummy Right 3/4 Side View



Post-Test Child Dummy Right 3/4 Side View





Pre-Test Child Dummy Right Side View



Post-Test Child Dummy Right Side View





Pre-Test Child Dummy Head View



Post-Test Child Dummy Head View





Pre-Test Child Dummy Head View (Through Window)



Post-Test Child Dummy Head View (Through Window)





Pre-Test Child Dummy Torso View



Post-Test Child Dummy Torso View

**APPENDIX B**

**DUMMY RESPONSE DATA TRACES**

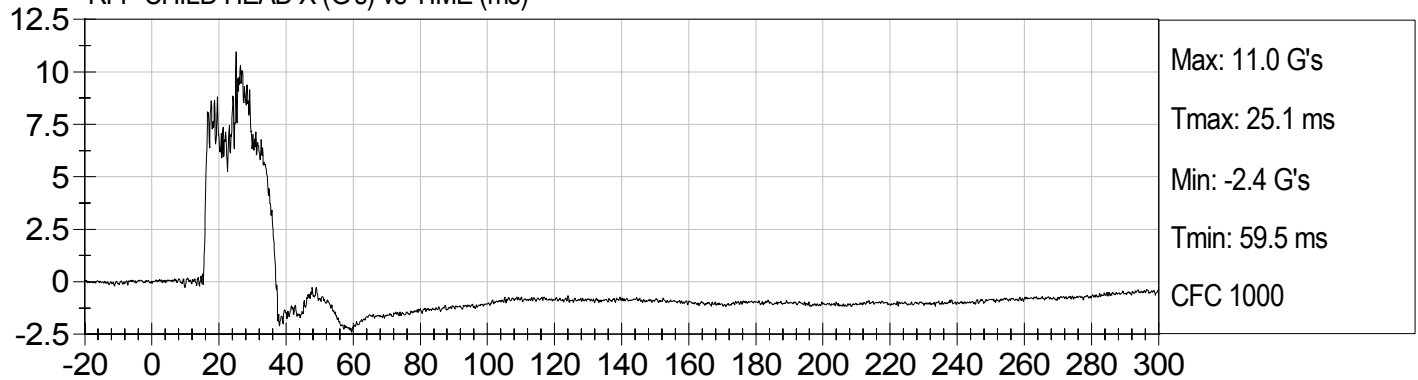
**TABLE OF DATA PLOTS**

|                                                               | <u>Page No.</u> |
|---------------------------------------------------------------|-----------------|
| Figure No. 1. RFP Child Head X Acceleration vs. Time          | B-2             |
| Figure No. 2. RFP Child Head Y Acceleration vs. Time          | B-2             |
| Figure No. 3. RFP Child Head Z Acceleration vs. Time          | B-2             |
| Figure No. 4. RFP Child Head Resultant Acceleration vs. Time  | B-2             |
| Figure No. 5. RFP Child Head X Velocity vs. Time              | B-3             |
| Figure No. 6. RFP Child Head Y Velocity vs. Time              | B-3             |
| Figure No. 7. RFP Child Head Z Velocity vs. Time              | B-3             |
| Figure No. 8. RFP Child Upper Neck X Force vs. Time           | B-4             |
| Figure No. 9. RFP Child Upper Neck Y Force vs. Time           | B-4             |
| Figure No. 10. RFP Child Upper Neck Z Force vs. Time          | B-4             |
| Figure No. 11. RFP Child Upper Neck Resultant Force vs. Time  | B-4             |
| Figure No. 12. RFP Child Upper Neck X Moment vs. Time         | B-5             |
| Figure No. 13. RFP Child Upper Neck Y Moment vs. Time         | B-5             |
| Figure No. 14. RFP Child Upper Neck Z Moment vs. Time         | B-5             |
| Figure No. 15. RFP Child Upper Neck Resultant Moment vs. Time | B-5             |
| Figure No. 16. RFP Child Lower Neck X Force vs. Time          | B-6             |
| Figure No. 17. RFP Child Lower Neck Y Force vs. Time          | B-6             |
| Figure No. 18. RFP Child Lower Neck Z Force vs. Time          | B-6             |
| Figure No. 19. RFP Child Lower Neck Resultant Force vs. Time  | B-6             |
| Figure No. 20. RFP Child Lower Neck X Moment vs. Time         | B-7             |
| Figure No. 21. RFP Child Lower Neck Y Moment vs. Time         | B-7             |
| Figure No. 22. RFP Child Lower Neck Z Moment vs. Time         | B-7             |
| Figure No. 23. RFP Child Lower Neck Resultant Moment vs. Time | B-7             |

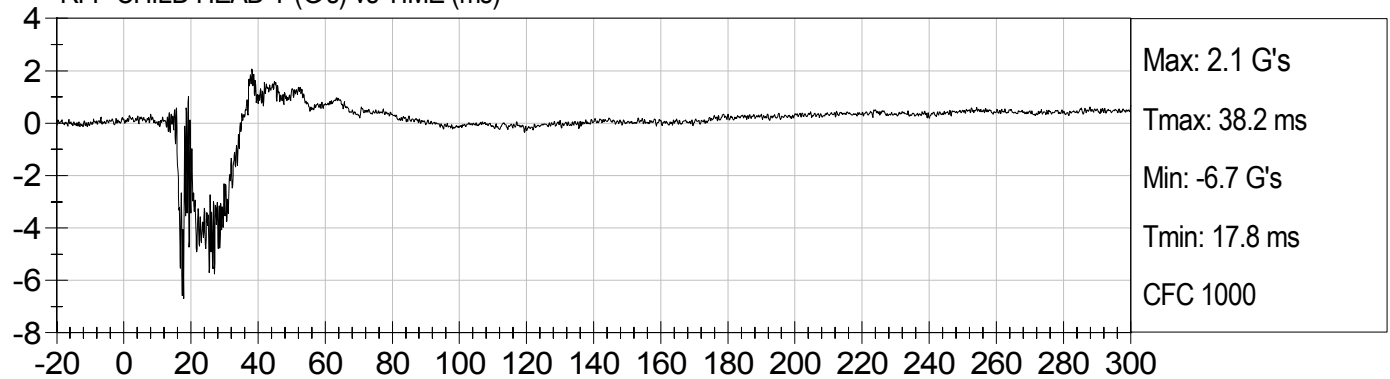




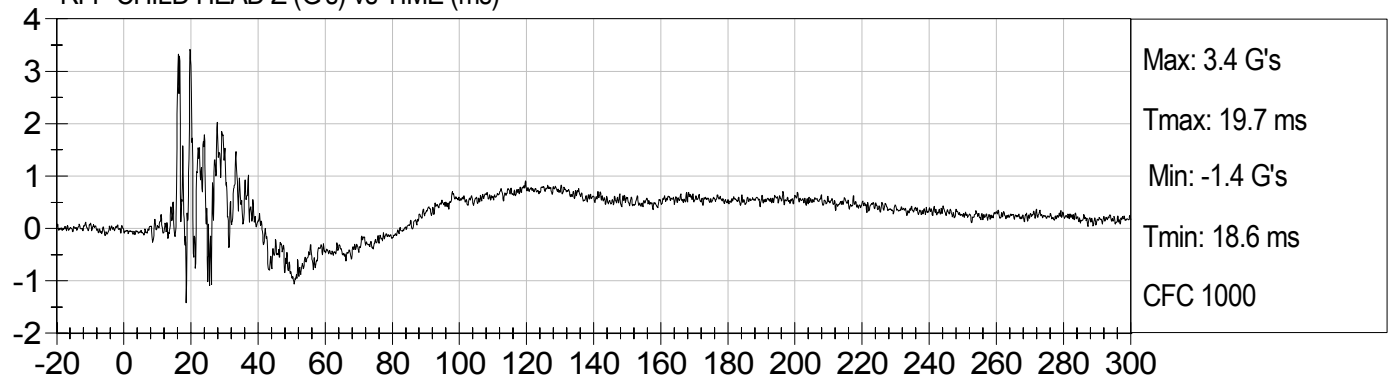
RFP CHILD HEAD X (G's) vs TIME (ms)



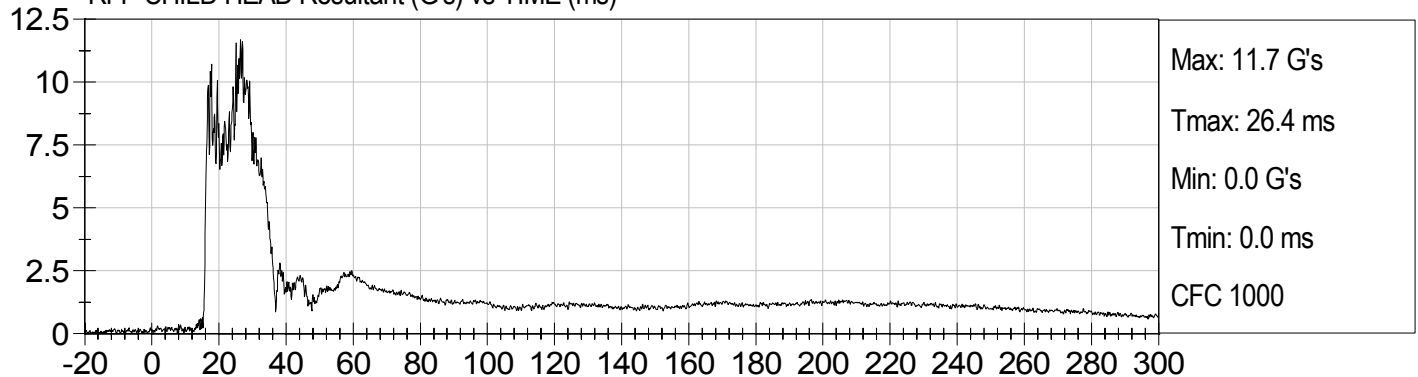
RFP CHILD HEAD Y (G's) vs TIME (ms)



RFP CHILD HEAD Z (G's) vs TIME (ms)

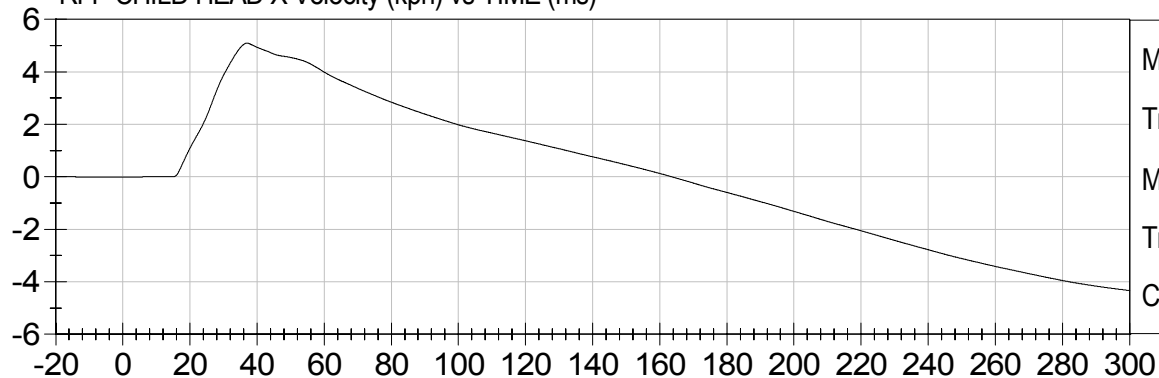


RFP CHILD HEAD Resultant (G's) vs TIME (ms)

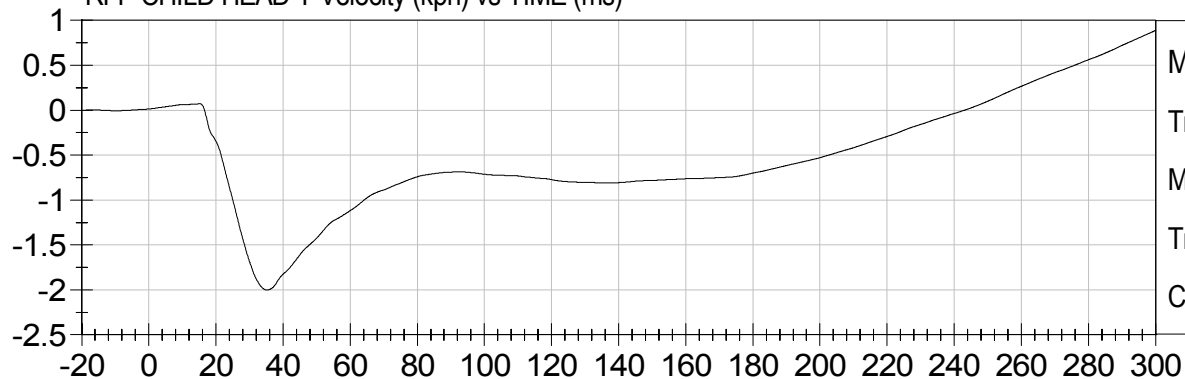




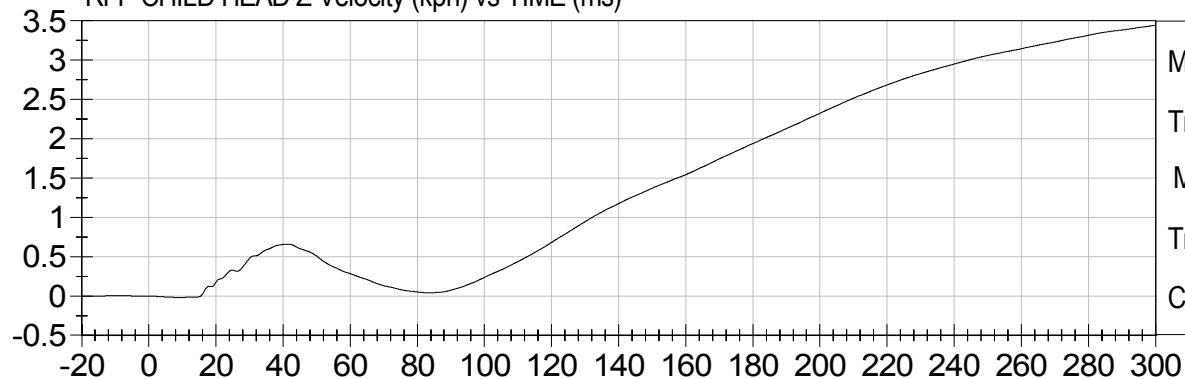
RFP CHILD HEAD X Velocity (kph) vs TIME (ms)

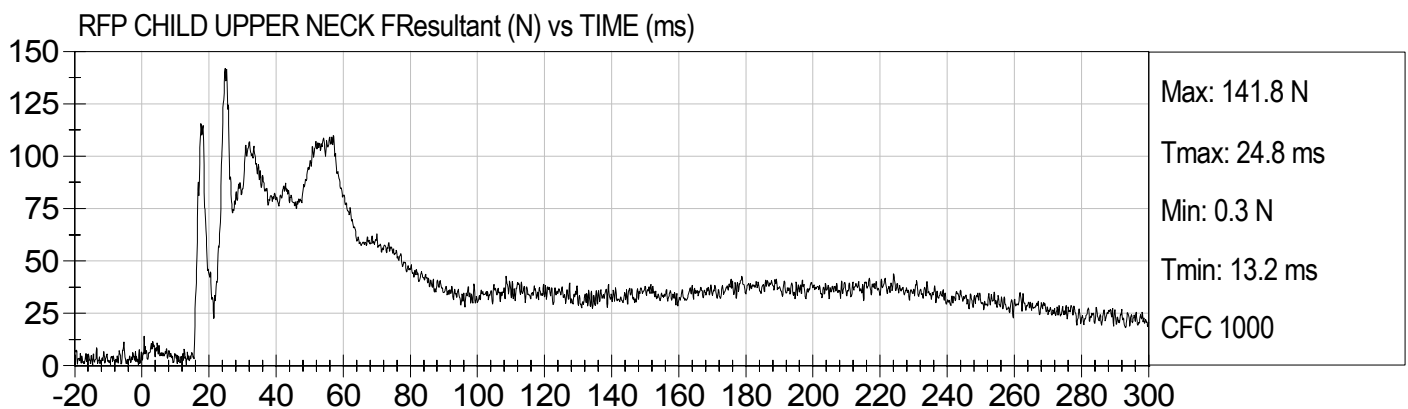
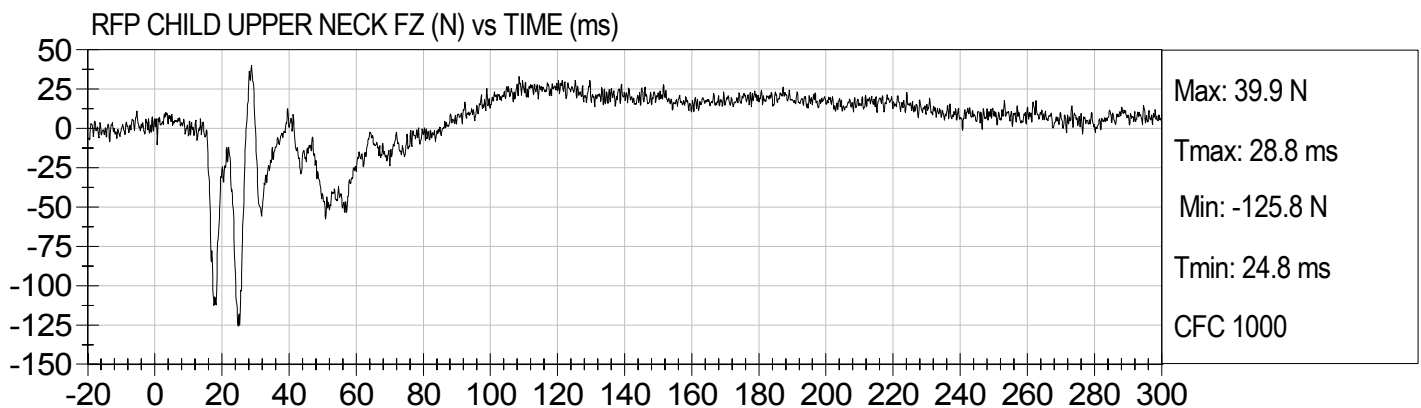
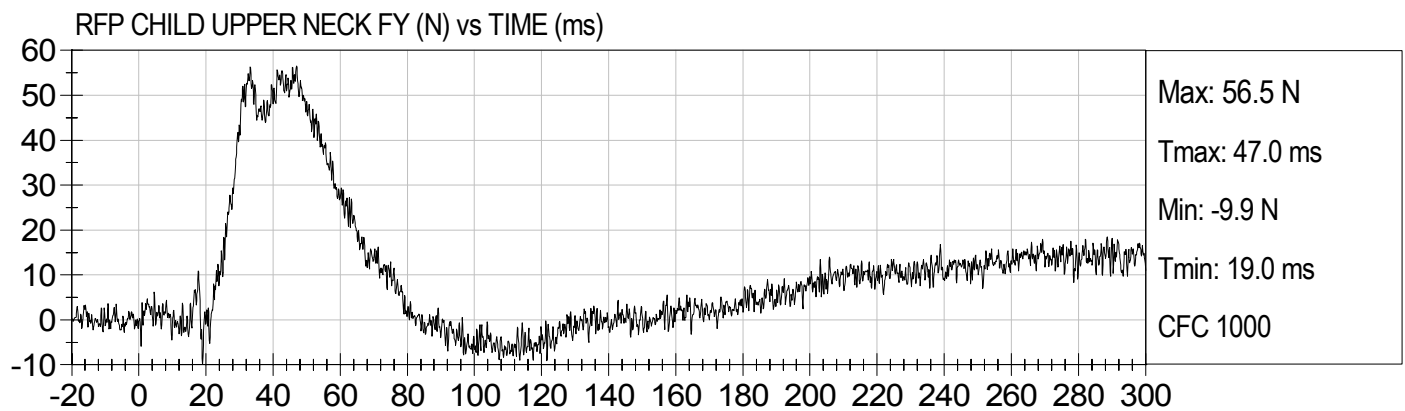
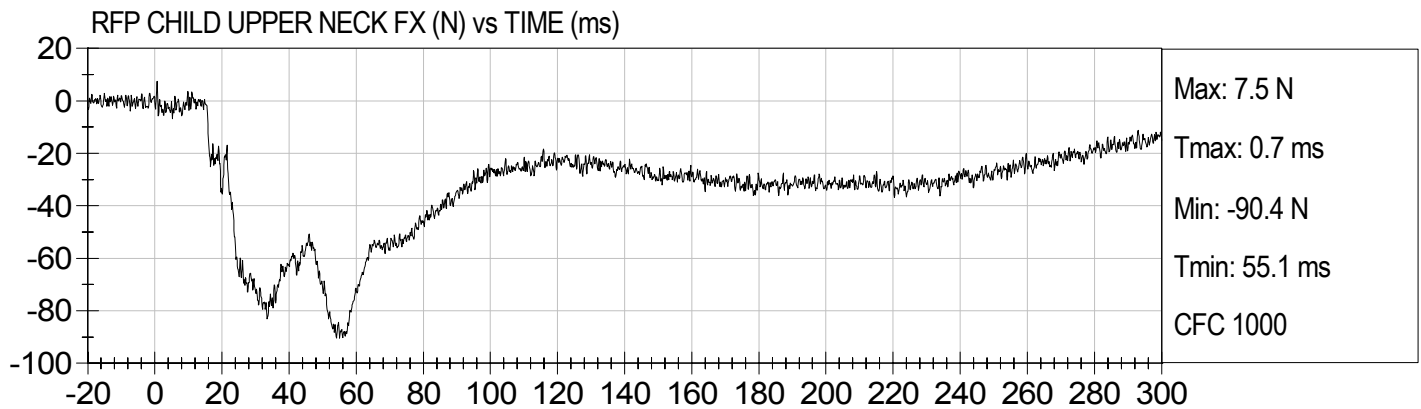


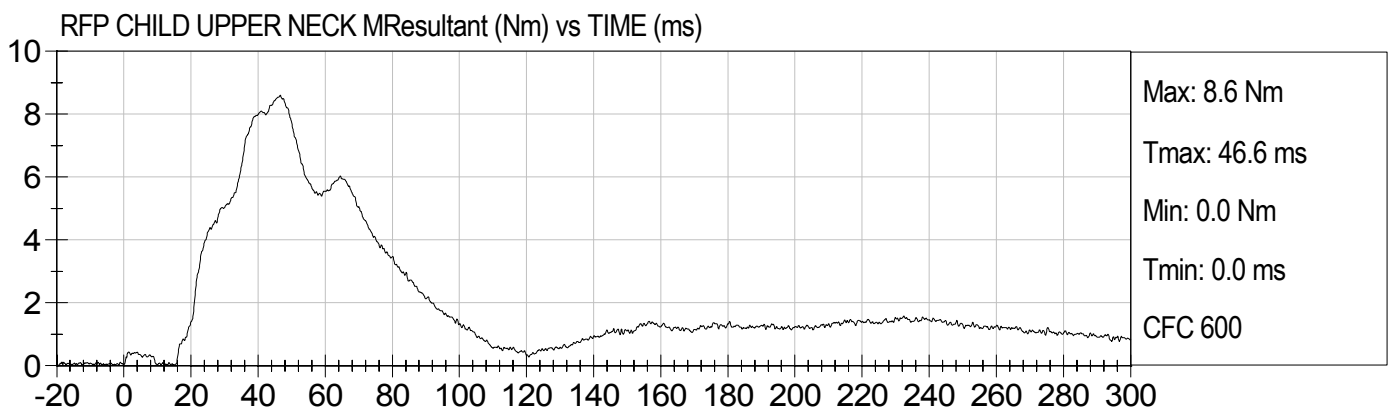
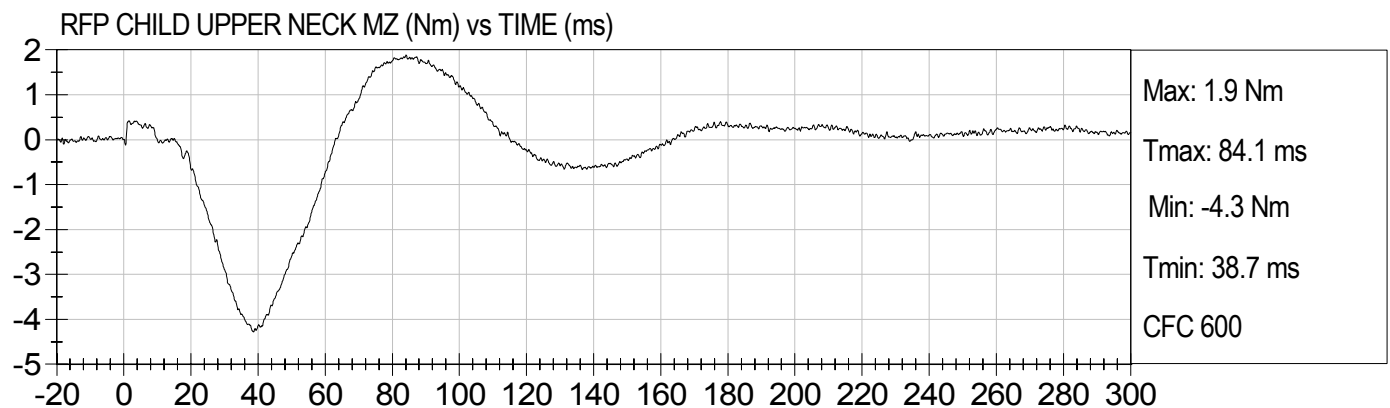
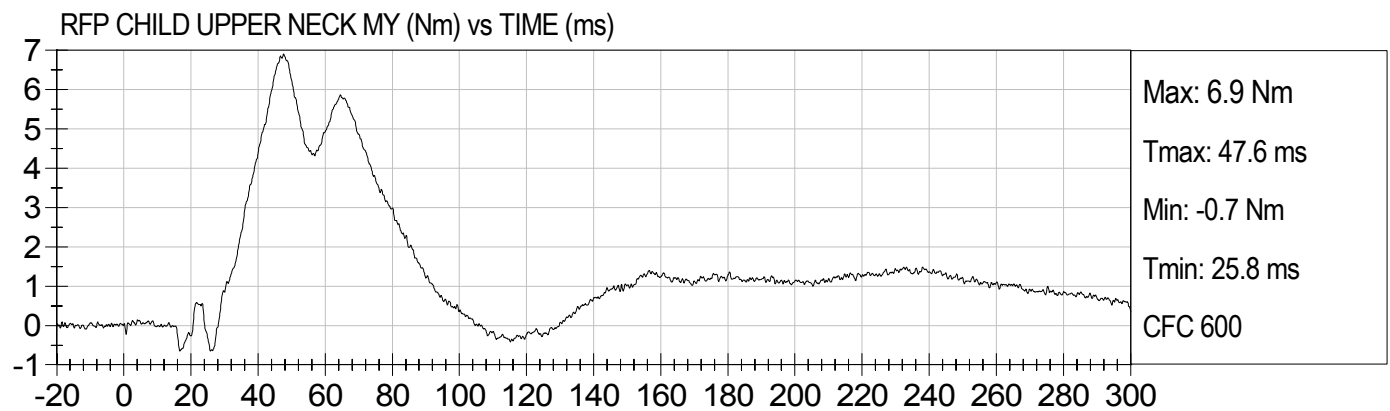
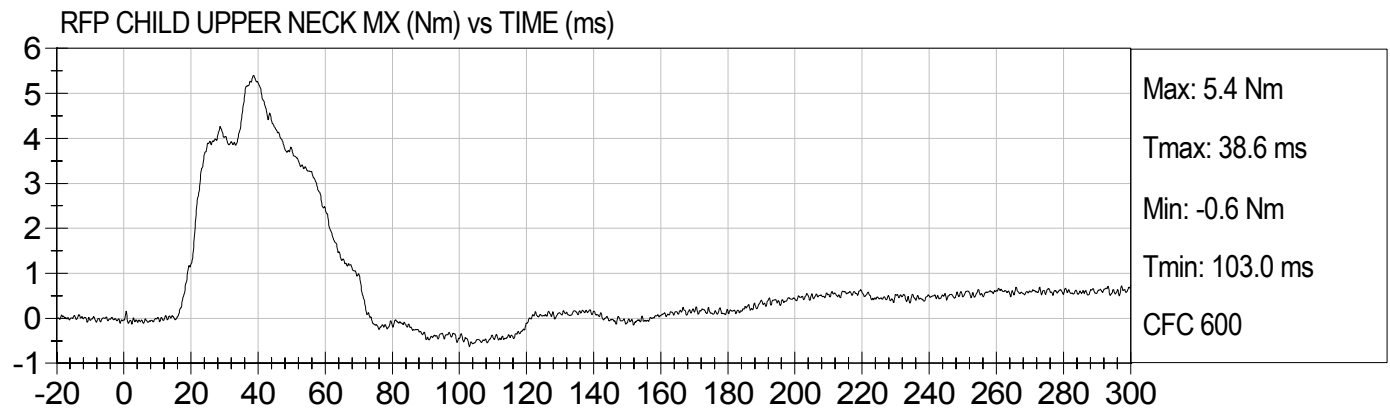
RFP CHILD HEAD Y Velocity (kph) vs TIME (ms)



RFP CHILD HEAD Z Velocity (kph) vs TIME (ms)



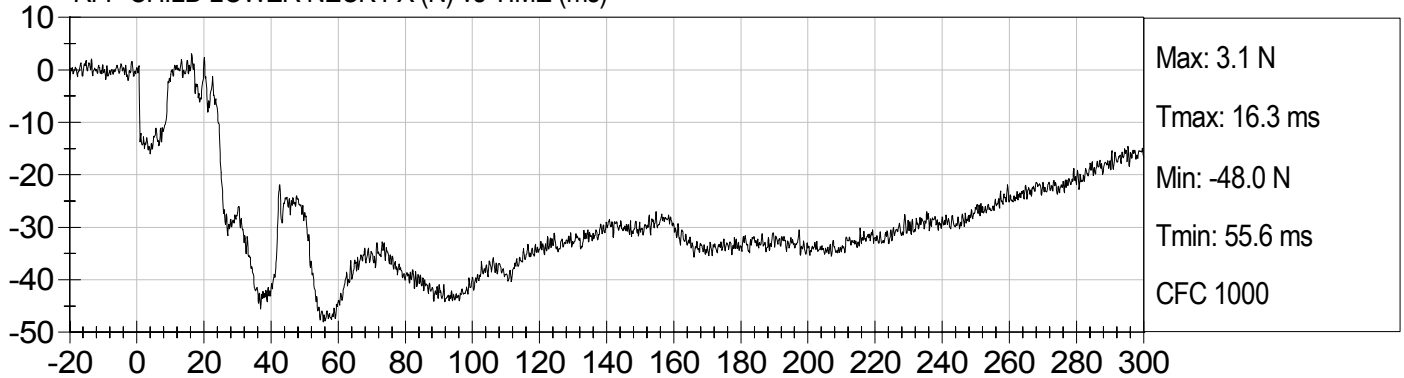




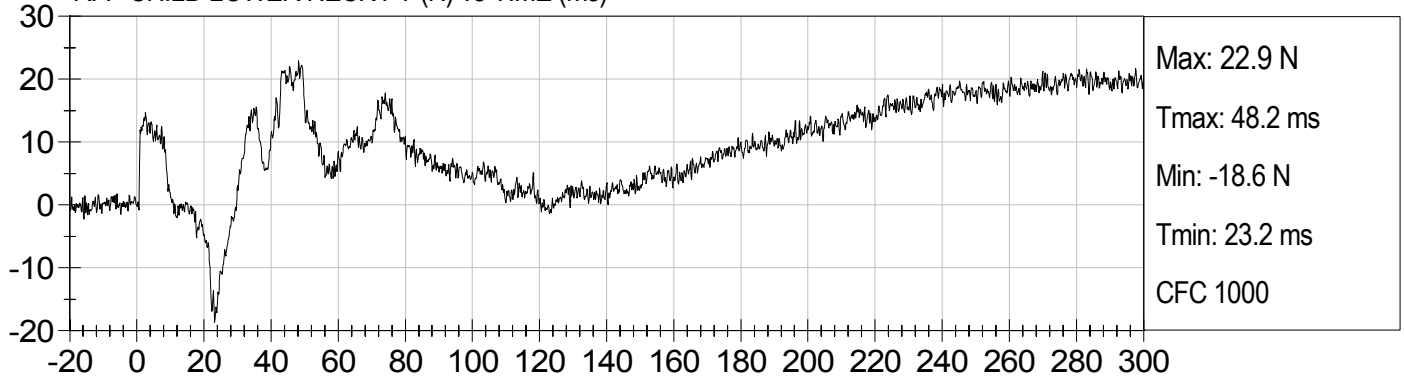




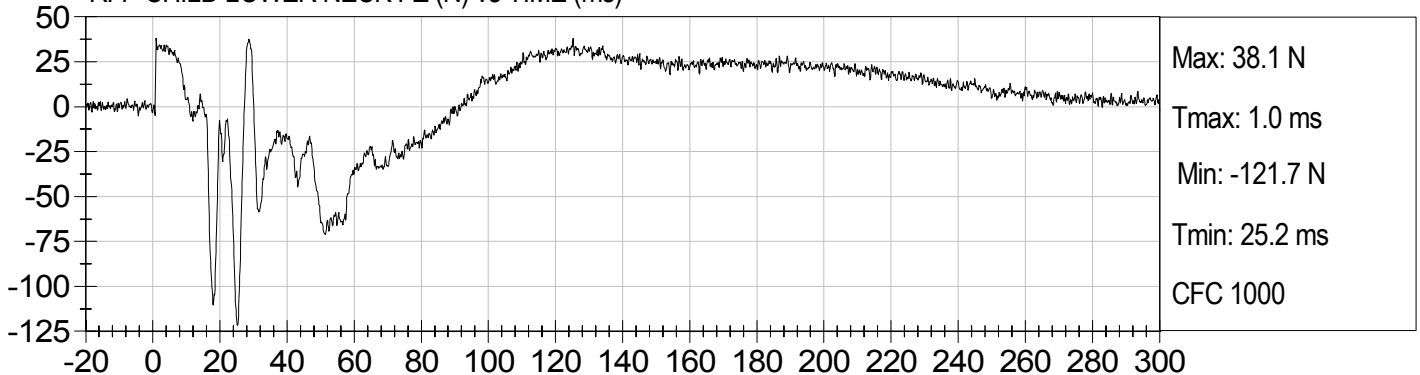
RFP CHILD LOWER NECK FX (N) vs TIME (ms)



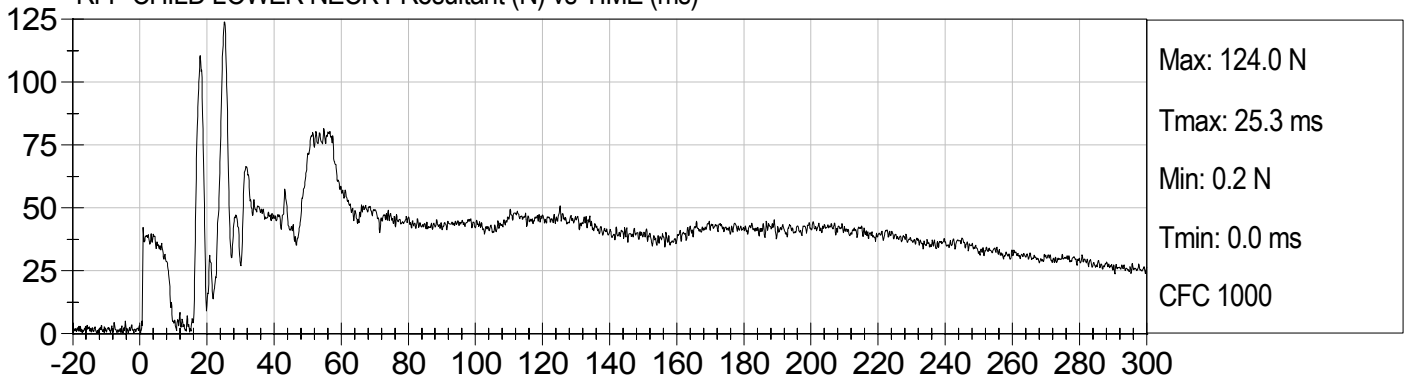
RFP CHILD LOWER NECK FY (N) vs TIME (ms)



RFP CHILD LOWER NECK FZ (N) vs TIME (ms)

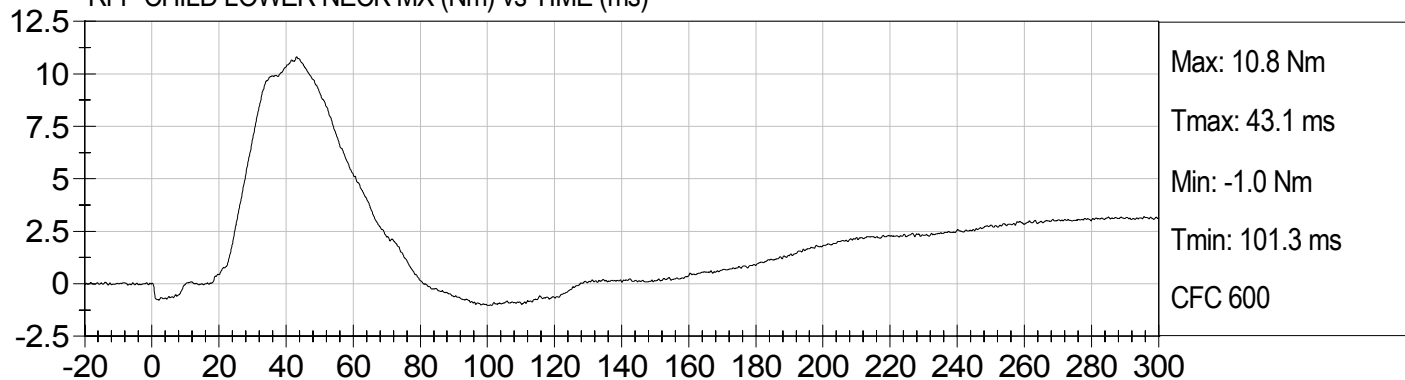


RFP CHILD LOWER NECK FResultant (N) vs TIME (ms)

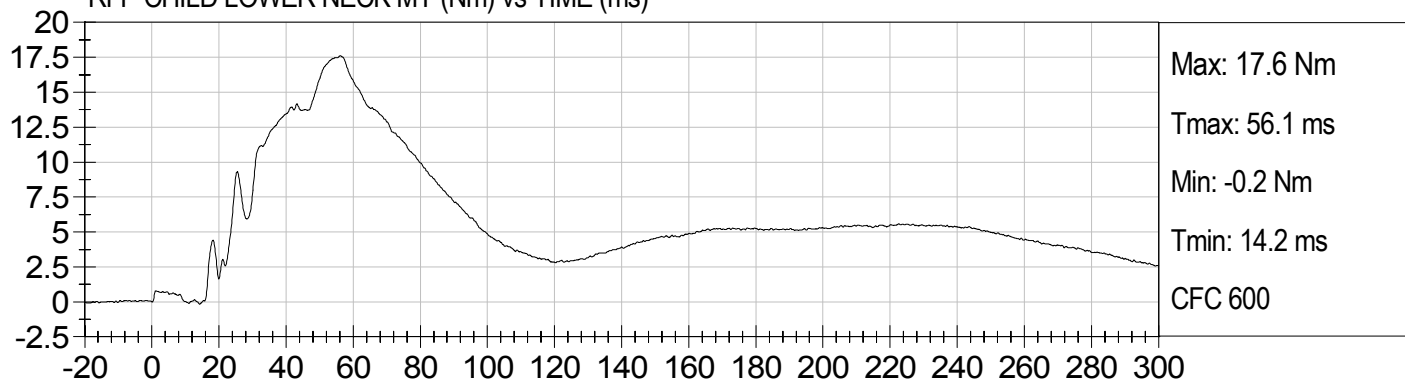




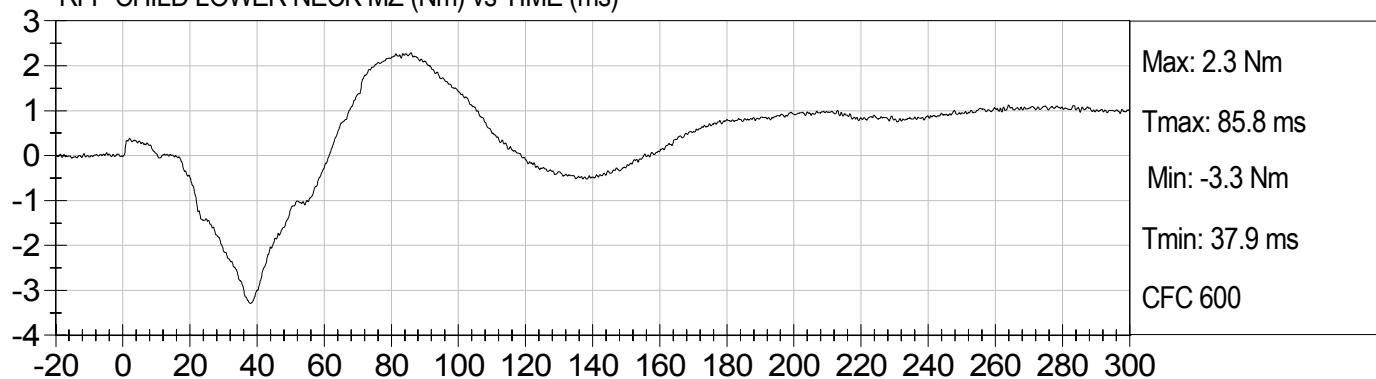
RFP CHILD LOWER NECK MX (Nm) vs TIME (ms)



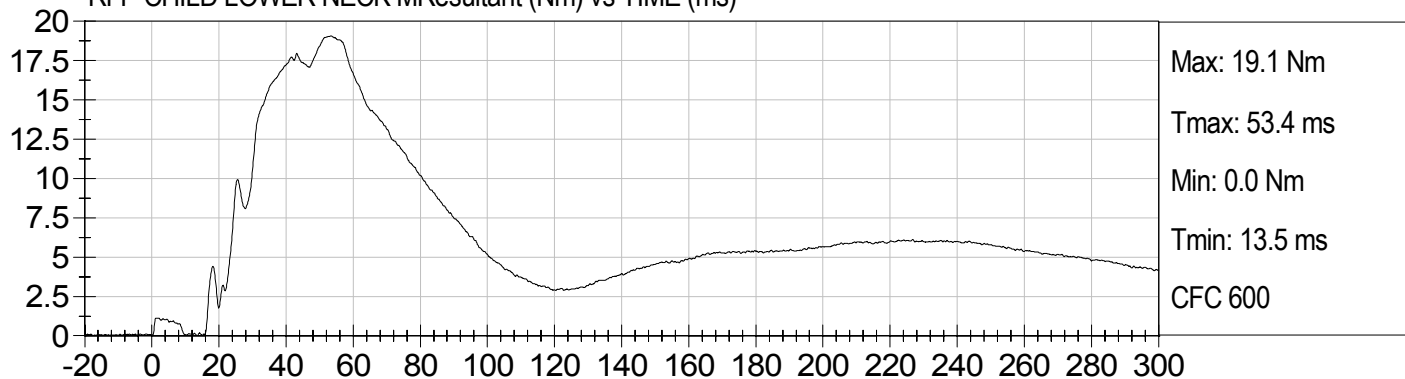
RFP CHILD LOWER NECK MY (Nm) vs TIME (ms)



RFP CHILD LOWER NECK MZ (Nm) vs TIME (ms)



RFP CHILD LOWER NECK MResultant (Nm) vs TIME (ms)



## APPENDIX C

### INSTRUMENTATION CALIBRATION DATA

#### SIX YEAR OLD – SERIAL NUMBER 144

|                      | SERIAL NO. | MANUFACTURER | CALIBRATION DATE |
|----------------------|------------|--------------|------------------|
| Head X               | G29-X17    | Entran       | 5/24/06          |
| Head Y               | G29-X47    | Entran       | 5/24/06          |
| Head Z               | G29-X06    | Entran       | 5/24/06          |
| Upper Neck Load Cell | N197       | FTSS         | 5/03/06          |
| Lower Neck Load Cell | LNG147     | Denton       | 5/18/06          |