

REPORT NUMBER: TWG-CAL-09-03

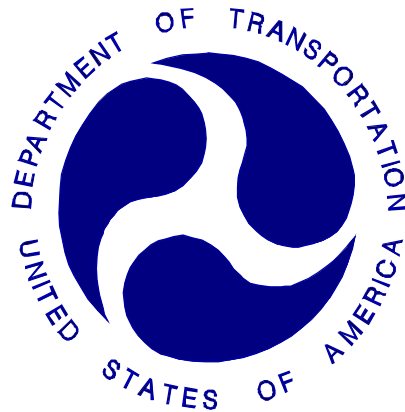
**NEW CAR ASSESSMENT PROGRAM (NCAP)**  
SIDE AIRBAG OUT-OF-POSITION INJURY TESTING

FORD MOTOR COMPANY  
2009 FORD ESCAPE  
4-DOOR MPV

NHTSA NUMBER: M90204TWG

CALSPAN TEST NUMBER: 8883-TWG-3

CALSPAN  
ADVANCED INFORMATION ENGINEERING SERVICES  
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June 4, 2009

FINAL REPORT

U. S. DEPARTMENT OF TRANSPORTATION  
National Highway Traffic Safety Administration  
Rulemaking  
Office of Crashworthiness Standards  
Mail Code: NVS-111  
1200 New Jersey Ave SE, Room W43-410  
Washington, DC 20590

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# **TECHNICAL REPORT STANDARD TITLE PAGE**

|                                                                                                                                                                                                                                                                          |                                |                                                     |                 |                                                                                                                                                                                                                                                                               |                 |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|
| 1. Report No.<br>TWG-CAL-09-03                                                                                                                                                                                                                                           |                                | 2. Government Accession No.                         |                 | 3. Recipient's Catalog No.                                                                                                                                                                                                                                                    |                 |                 |
| 4. Title and Subtitle<br>Final Report<br>2009 Ford Escape 4-Door MPV, TWG/Out-of-Position Tests<br>NHTSA No.: M950204TWG                                                                                                                                                 |                                |                                                     |                 | 5. Report Date<br>June 4, 2009                                                                                                                                                                                                                                                |                 |                 |
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| 9. Performing Organization Name and Address<br>Calspan Corporation<br>Transportation Sciences Center<br>P.O. Box 400<br>Buffalo, New York 14225                                                                                                                          |                                |                                                     |                 | 10. Work Unit No.                                                                                                                                                                                                                                                             |                 |                 |
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| 15. Supplementary Notes                                                                                                                                                                                                                                                  |                                |                                                     |                 |                                                                                                                                                                                                                                                                               |                 |                 |
| 16. Abstract<br>This side impact Out-Of-Position test was performed in conjunction with a New Car Assessment Program (NCAP). This test was conducted at the Calspan Advanced Information Engineering Services Crash Test Facility in Buffalo, New York, on June 4, 2009. |                                |                                                     |                 |                                                                                                                                                                                                                                                                               |                 |                 |
| <b>Injury Summary</b>                                                                                                                                                                                                                                                    |                                |                                                     |                 |                                                                                                                                                                                                                                                                               |                 |                 |
| <b>HIC15</b>                                                                                                                                                                                                                                                             | <b>Chest Displacement (mm)</b> | <b>Chest Displacement Rate (m/s)</b>                | <b>NIJ(NTF)</b> | <b>NIJ(NTE)</b>                                                                                                                                                                                                                                                               | <b>NIJ(NCF)</b> | <b>NIJ(NCE)</b> |
| 1.3                                                                                                                                                                                                                                                                      | -0.8                           | 0.7                                                 | 0.14            | 0.26                                                                                                                                                                                                                                                                          | 0.12            | 0.00            |
| 17. Key Words<br>New Car Assessment Program (NCAP)<br>Side Airbag Out-Of-Position                                                                                                                                                                                        |                                |                                                     |                 | 18. Distribution Statement                                                                                                                                                                                                                                                    |                 |                 |
|                                                                                                                                                                                                                                                                          |                                |                                                     |                 | Copies of this report are available from:<br>National Highway Traffic Safety Administration<br>Technical Reference Division<br>Room 5111 (NAD-52)<br>1200 New Jersey Ave SE, Room W43-410.<br>Washington, D.C. 20590<br>Telephone No. (202) 366-4946<br>ATTN: Robert Hornicle |                 |                 |
| 19. Security Classification of Report<br>UNCLASSIFIED                                                                                                                                                                                                                    |                                | 20. Security Classification of Page<br>UNCLASSIFIED |                 | 21. No. of Pages<br>32                                                                                                                                                                                                                                                        |                 | 22. Price       |

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## SECTION 1

### PURPOSE AND SUMMARY OF TEST M95304TWG

#### 1.1 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 No. DTNH22-06-D-00024.

#### 1.2 SUMMARY

The effects of both a seat-mounted side airbag and a curtain airbag deployment in a 2009 Ford Escape 4-Door MPV with an out-of-position six-year-old child were evaluated. The test was performed by Calspan Corporation on June 4, 2009. Pre-and post-test photographs of the vehicle and dummy can be found in Appendix A.

One high-speed digital camera was used to document the side airbag deployment event. The camera was placed perpendicular to the right-front seat centerline as to capture the deployment event. The recorded image rate is 1000 frames per second.

One part 572, Hybrid III six-year-old child anthropomorphic test device (ATD), was placed in the right front seat situated in the forward facing position 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 triaxial accelerometers. In addition, chest displacement and upper and lower six axial neck force and moment load cell sensors were utilized.

Ten channels of data were recorded using an on-board data acquisition system. Appendix A contains photographs. Appendix B contains dummy response data traces. Appendix C contains the Instrumentation Data Channel assignments.

The six-year old child dummy was placed on the outboard edge of foam block, aligning the upper spine with the deployment trajectory of the airbag. The dummy's head was placed in between the seat bolster and pillar trim to minimize the fore-aft clearance between the neck and the seatback. The head remained in its neutral orientation. The legs were aligned such that they crossed the heel placement points but the feet did overhang the seat cushion. The dummy was then positioned so the dummy's neck/torso junction was aligned vertically with the top edge of the airbag module. While maintaining the neck/torso top of the airbag module alignment, the vehicle door was closed and the pelvis was moved outboard until it made contact the door trim/armrest. The outboard forearm was placed on the armrest. The inboard arm was positioned such that the upper arm contacted the seat back and the fingertips contacted the booster seat. The dummy's arms were then bent at the elbow until the fingers contacted the booster seat. This orientation complies with section 3.3.3.5 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

### DATA SHEET NO. 1

#### TEST SUMMARY

##### TEST CONFIGURATION INFORMATION:

|                             |                      |                                                                     |
|-----------------------------|----------------------|---------------------------------------------------------------------|
| <b>Seating Position:</b>    | P2                   | Right Front Seating Position                                        |
| <b>Test:</b>                | 3.3.3.5              | Forward facing Hybrid-III six-year-old child dummy on booster block |
| <b>Airbag:</b>              | Seat                 | Seat mounted – outside seam                                         |
| <b>Airbag:</b>              | Side Rail            | Side curtain airbag.                                                |
| <b>Booster Block:</b>       | 300mm x 450mm x 75mm | Block consisted of HD36 foam with a density of 44.8 g/L             |
| <b>ATD Type/Serial No.:</b> | 144                  | Hybrid III six-year-old child dummy                                 |

|                                |     |                           |
|--------------------------------|-----|---------------------------|
| <u>Number of Data Channels</u> | 10  |                           |
| <u>Number of Cameras:</u>      | 0   | <u>Real Time</u>          |
|                                | 1 * | <u>High Speed Digital</u> |
|                                | 0   | <u>High Speed Film</u>    |

##### VISIBLE DUMMY CONTACT POINTS

|                             |                        |
|-----------------------------|------------------------|
| <b>Head Contact:</b>        | Side Curtain airbag    |
| <b>Upper Torso Contact:</b> | Seat side torso airbag |
| <b>Lower Torso Contact:</b> | Seat side torso airbag |
| <b>Left Knee Contact:</b>   | No Contact             |
| <b>Right Knee Contact:</b>  | No Contact             |

\* The high speed video camera did not function properly during the test.

## DATA SHEET NO. 2

### VEHICLE PARAMETER DATA

#### TEST VEHICLE INFORMATION

Year/Make/Model/Body Style: 2009 Ford Escape 4-Door MPV

NHTSA No. : M90204TWG; VIN: 1FMCU93G89KA03191 ; Color: Black

Engine Data: 6 cylinders; - CID; 3.0 Liters; - cc

Placement: - Longitudinal or In-Line; X Transverse or Lateral

Transmission Data: 6 speeds; - Manual; X Automatic; - Overdrive

Final Drive: - Rear Wheel Drive; - Front Wheel Drive; X Four Wheel Drive

Safety Belt Features – Driver X Pretensioner (Shoulder); X Load Limiter; X Adj. Anchorage

Safety Belt Features - Passenger X Pretensioner (Shoulder); X Load Limiter; X Adj. Anchorage

Major Options: X A/C; X Pwr.Strg.; X Pwr. Brakes

X Pwr. Windows; X Pwr. Door Locks; X Tilt Wheel

Date Received: 7/18/08 ; Odometer Reading 77 km

Selling Dealer: West-Herr Ford, Inc.

& Address: 5025 Camp Road, Hamburg, NY 14075

#### DATA FROM TIRE VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Ford Motor Company

Date of Manufacture 06/08

GVWR: 2123 kg; GAWR: 1107 kg FRONT; 1061 kg REAR

#### DATA FROM TIRE PLACARD:

Recommended Tire Size: P235/70R16

\* Recommended Cold Tire Pressure: 220 kPa FRONT; 220 kPa REAR

#### DATA FROM TIRE SIDEWALL:

Size of Tires on Test Vehicle: P235/70R16 ; Manufacturer: Michelin

Tire Pressure with Maximum Capacity Vehicle Load: Front: 300 kPa; Rear: 300 kPa

Treadwear: 720 ; Traction: A ; Temperature: A

#### VEHICLE CAPACITY DATA:

Type of Front Seats: - Bench; X Bucket; - Split Bench

Number of Occupants: 2 Front; 3 Rear; 5 Total

Vehicle Capacity Weight (VCW) = 457.0 kg

No. of Occupants x 68.04 kg = 340.2 kg

Rated Cargo/Luggage Weight (RCLW) = 116.8 kg

\*Tire pressure used for test

‡Vehicle had previously undergone a New Car Assessment Program Barrier Impact Test on July 31, 2008.

### DATA SHEET NO. 3

#### CHILD DUMMY POSITIONING IN VEHICLE

NHTSA No. M90204TWG

| Measurement                                    |            | Value        |
|------------------------------------------------|------------|--------------|
| Total Fore/Aft Travel (mm)                     |            | 230          |
| Test Distance Rearward of Full-Forward (mm) §§ |            | 40           |
| Total Fore/Aft Travel (Detents)                |            | 25           |
| Placed in Position # §§                        |            | 5            |
| Seat Back Angle                                | SA ( ° )   | 17.5 degrees |
| Airbag Module Width                            | AMW (mm)   | -            |
| Airbag Width                                   | ABW (mm)   | -            |
| Airbag Module Length                           | AML (mm)   | -            |
| Airbag Length                                  | ABL (mm)   | -            |
| Top of Airbag Module to Head/Neck Junction     | AN (mm)    | -            |
| Head CG to Door Panel/Window                   | HD (mm)    | -            |
| Head to Seat Back Centerline                   | HSC (mm)   | 125          |
| Head to B-Pillar (cg)                          | HB (mm)    | -            |
| Head to Roof, Z (top of the head)              | HZ (mm)    | 270          |
| Head to Header                                 | HHH (mm)   | 430          |
| Chest to Dash                                  | CD (mm)    | 455          |
| Chest to Seatback                              | CS (mm)    | 225          |
| Right Arm to Seat Back Centerline              | RACL (mm)  | 250          |
| Right Arm to Seat Back Centerline              | RACL ( ° ) | 250          |
| Left Arm to Seat Back Centerline               | LACL (mm)  | 25           |
| Left Arm to Seat Back Centerline               | LACL ( ° ) | 80           |
| Right Arm to Door Panel                        | RA (mm)    | 45           |
| Left Arm to Door Panel                         | LA (mm)    | 265          |
| Knee to Knee                                   | KK (mm)    | 115          |
| Toe to Toe                                     | TT (mm)    | 130          |
| Right Knee to Seat Cushion Centerline          | KSCR (mm)  | 135          |
| Left Knee to Seat Cushion Centerline           | KSCL (mm)  | 30           |
| Right Toe to Seat Cushion Centerline           | TSCR (mm)  | 10           |
| Left Toe to Seat Cushion Centerline            | TSCL (mm)  | 105          |
| Nose to Dash                                   | ND (mm)    | 552          |
| Nose to Seatback                               | NS (mm)    | 215          |
| Nose to Header                                 | NR (mm)    | 480          |
| Foam Block Depth                               | (mm)       | 300          |
| Foam Block Width                               | (mm)       | 450          |
| Foam Block Thickness                           | (mm)       | 75           |
| HD36 foam density                              | (g/L)      | 44.8         |

§§ The seat was positioned to achieve clearance for the side seat torso airbag deployment

# DATA SHEET 4

## CHILD DUMMY INJURY CRITERIA VALUES

NHTSA No. M90204TWG

|                        |      | MAXIMUM VALUE |       |        |       |
|------------------------|------|---------------|-------|--------|-------|
|                        |      | Position #2   |       |        |       |
| DESCRIPTION            | Unit | Pos           | msec  | Neg    | msec  |
| Head X                 | g    | 7.4           | 40.1  | -1.2   | 54.3  |
| Head Y                 | g    | 1.0           | 183.8 | -7.8   | 37.7  |
| Head Z                 | g    | 2.8           | 49.0  | -6.3   | 35.1  |
| Head Resultant         | g    | 10.0          | 39.1  | 0.0    | -10.6 |
| Upper Neck Fx          | N    | 182.9         | 40.1  | -33.3  | 139.6 |
| Upper Neck Fy          | N    | 26.0          | 171.8 | -154.6 | 40.3  |
| Upper Neck Fz          | N    | 99.1          | 48.6  | -65.3  | 35.2  |
| Upper Neck F Resultant | N    | 240.0         | 40.1  | 0.0    | -2.3  |
| Upper Neck Mx          | N-m  | 10.8          | 39.5  | -14.8  | 49.0  |
| Upper Neck My          | N-m  | 14.9          | 40.1  | -9.1   | 57.7  |
| Upper Neck Mz          | N-m  | 1.3           | 34.2  | -2.9   | 42.7  |
| Upper Neck M Resultant | N-m  | 18.1          | 39.9  | 0.0    | 17.9  |
| Lower Neck Fx          | N    | 192.2         | 34.1  | -324.6 | 38.8  |
| Lower Neck Fy          | N    | 119.3         | 38.6  | -107.8 | 34.4  |
| Lower Neck Fz          | N    | 91.4          | 35.9  | -88.3  | 38.0  |
| Lower Neck F Resultant | N    | 350.2         | 38.7  | 0.0    | 5.6   |
| Lower Neck Mx          | N-m  | 6.5           | 179.9 | -23.3  | 54.2  |
| Lower Neck My          | N-m  | 7.6           | 139.0 | -25.1  | 39.1  |
| Lower Neck Mz          | N-m  | 1.9           | 154.3 | -19.5  | 39.6  |
| Lower Neck M Resultant | N-m  | 36.9          | 39.2  | 0.0    | -6.4  |
| Chest Displacement     | g    | 0.3           | 35.5  | -0.8   | 41.7  |

# DATA SHEET 4

## CHILD DUMMY INJURY CRITERIA VALUES (CONTINUED)

VEHICLE: 2009 Ford Escape 4-Door MPV

NHTSA No. M90204TWG

| HEAD INJURY CRITERIA (HIC) |     |                       |                       |                                                          |
|----------------------------|-----|-----------------------|-----------------------|----------------------------------------------------------|
| HIC15                      |     |                       |                       |                                                          |
|                            | HIC | t <sub>1</sub> (msec) | t <sub>2</sub> (msec) | Average Acceleration<br>t <sub>1</sub> to t <sub>2</sub> |
| Position #2 - Right        | 1.3 | 36.7                  | 44.9                  | 7.6                                                      |

| THORAX CRITERIA       |                 |        |          |
|-----------------------|-----------------|--------|----------|
|                       | Critical Values | Actual | Time(ms) |
| Deflection (mm)       | 40              | -0.8   | 41.7     |
| Deflection Rate (m/s) | 8.5             | 0.7    | 42.2     |

### Position 4 Neck Injury Summary (HIII 6 year old – In Position)

| Nij V10 | Nij  | Time (ms) | Z Force (N) | X Force (N) | Y Moment (N-m) |
|---------|------|-----------|-------------|-------------|----------------|
| Ntf     | 0.14 | 40.0      | 34.3        | 178.0       | 11.6           |
| Nte     | 0.26 | 57.8      | 35.4        | 13.2        | -9.3           |
| Ncf     | 0.12 | 41.5      | -0.4        | 170.1       | 10.7           |
| Nce     | 0.00 | -         | -0.8        | -0.1        | 0.0            |

Peak Tension (CFC1000) 99.1 N Peak Compression (CFC1000) -65.3 N

### Critical Values

| Nij Intercepts    |        |                  |        | Peak Limits |         |
|-------------------|--------|------------------|--------|-------------|---------|
| Tension (CVt)     | 3096 N | Extension (mCVe) | 42 N-m | Tension     | 1890 N  |
| Compression (CVc) | 2800 N | Flexion (mCVf)   | 93 N-m | Compression | -1820 N |

Condyle Offset -0.01778

## **APPENDIX A**

### **PHOTOGRAPHS**

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| Figure A- 4   | VEHICLE TIRE PLACARD               | A- 4        |
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| Figure A- 6   | POST-TEST FRONTAL VIEW OF DUMMY    | A- 5        |
| Figure A- 7   | PRE-TEST RIGHT SIDE VIEW OF DUMMY  | A- 6        |
| Figure A- 8   | POST-TEST RIGHT SIDE VIEW OF DUMMY | A- 6        |
| Figure A- 9   | PRE-TEST LEFT SIDE VIEW OF DUMMY   | A- 7        |
| Figure A- 10  | POST-TEST LEFT SIDE VIEW OF DUMMY  | A- 7        |



Figure A-1: Pre-Test Vehicle Left Side View



Figure A-2: Post-Test Vehicle Left Side View

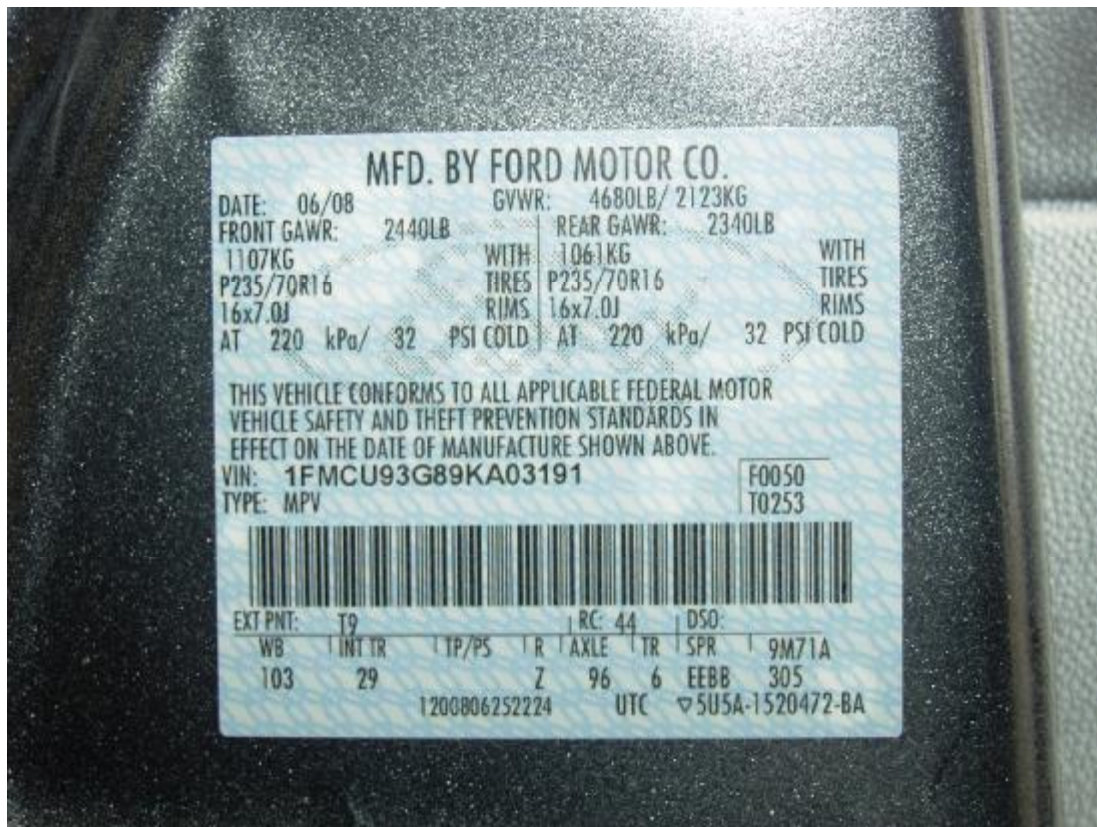


Figure A-3: Vehicle Certification Placard



Figure A-4: Vehicle Tire Placard



Figure A-5: Pre-Test Frontal View of Dummy



Figure A-6: Post-Test Frontal View of Dummy



Figure A-7: Pre-Test Left Side View of Dummy



Figure A-8: Post-Test Left Side View of Dummy



Figure A-9: Pre-Test Right Side View of Dummy



Figure A-10: Post-Test Right Side View of Dummy

## **APPENDIX B**

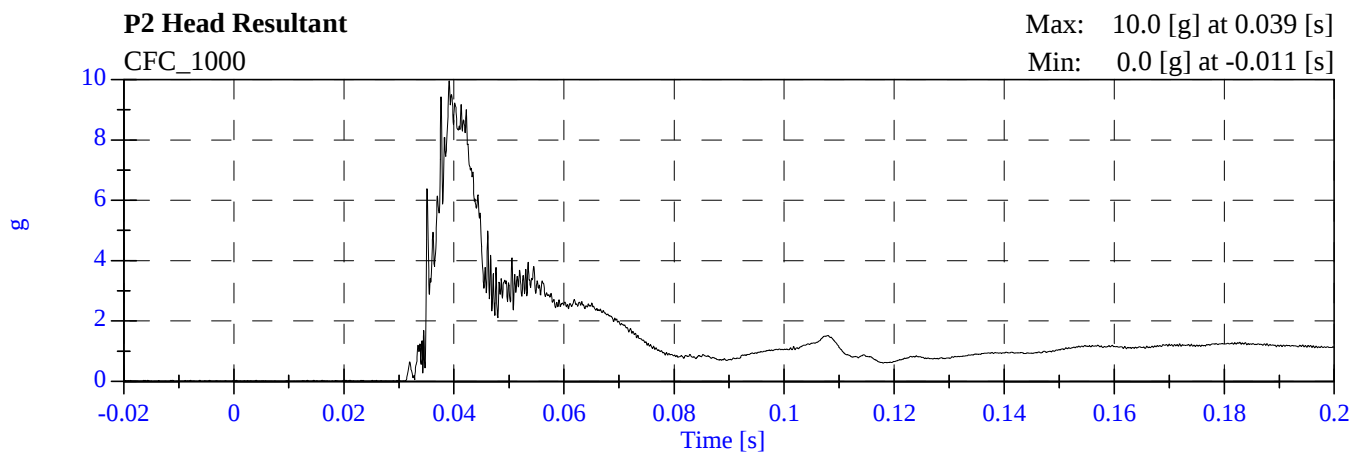
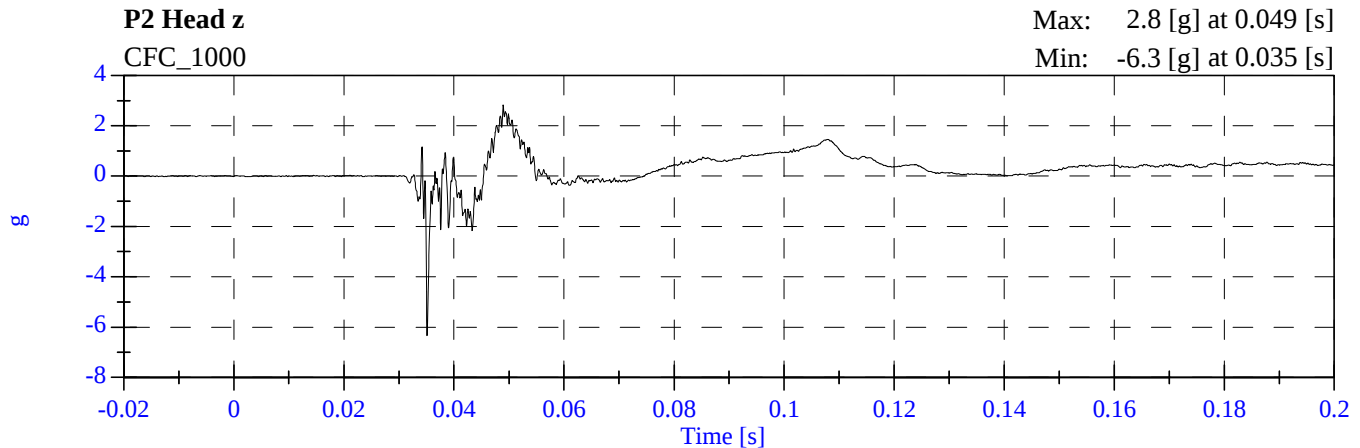
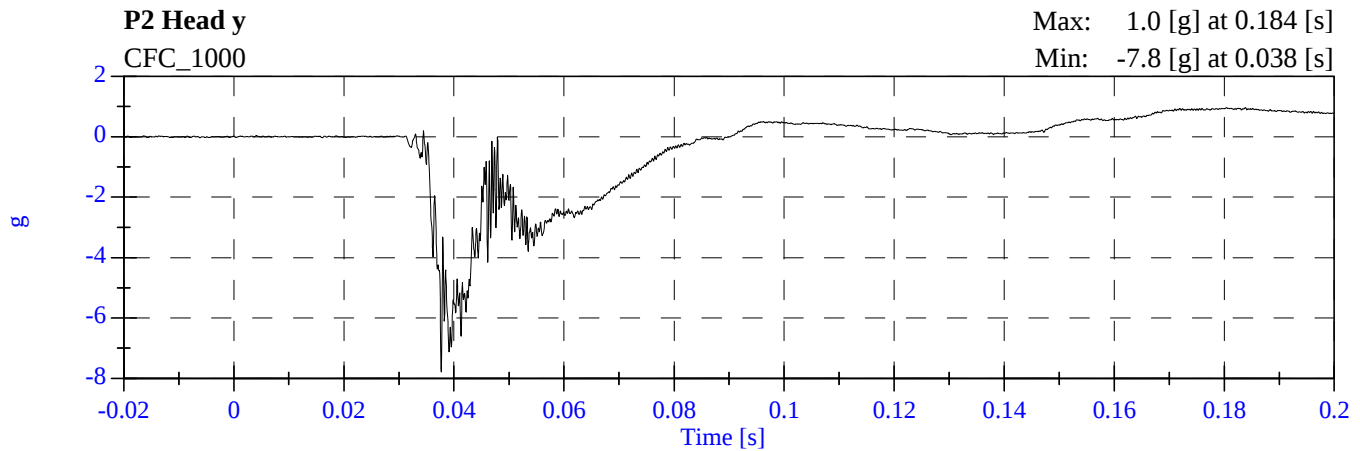
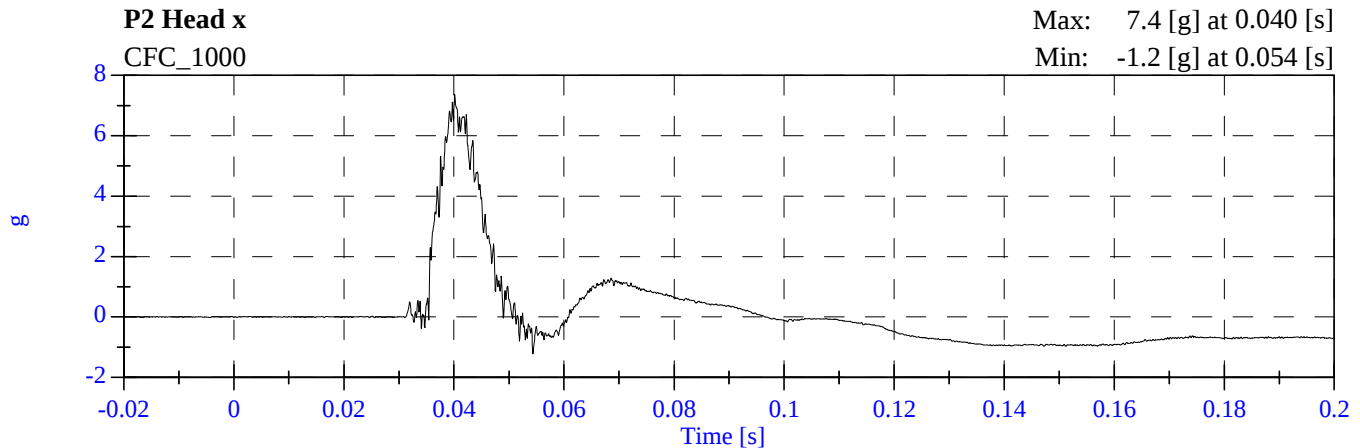
### **CHILD DUMMY RESPONSE DATA TRACES**

## TABLE OF DATA PLOTS

| PLOT | PLOT NAME[UNITS, CHANNEL FILTER CLASS]   | PAGE |
|------|------------------------------------------|------|
| 1    | P2 Head x [g, CFC_1000]                  | B-3  |
| 2    | P2 Head y [g, CFC_1000]                  | B-3  |
| 3    | P2 Head z [g, CFC_1000]                  | B-3  |
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| 10   | P2 Upper Neck My [N-m, CFC_600]          | B-5  |
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| 14   | P2 Lower Neck Fy [N, CFC_1000]           | B-6  |
| 15   | P2 Lower Neck Fz [N, CFC_1000]           | B-6  |
| 16   | P2 Lower Neck F Resultant [N, CFC_1000]  | B-6  |
| 17   | P2 Lower Neck Mx [N-m, CFC_600]          | B-7  |
| 18   | P2 Lower Neck My [N-m, CFC_600]          | B-7  |
| 19   | P2 Lower Neck Mz [N-m, CFC_600]          | B-7  |
| 20   | P2 Lower Neck M Resultant [N-m, CFC_600] | B-7  |
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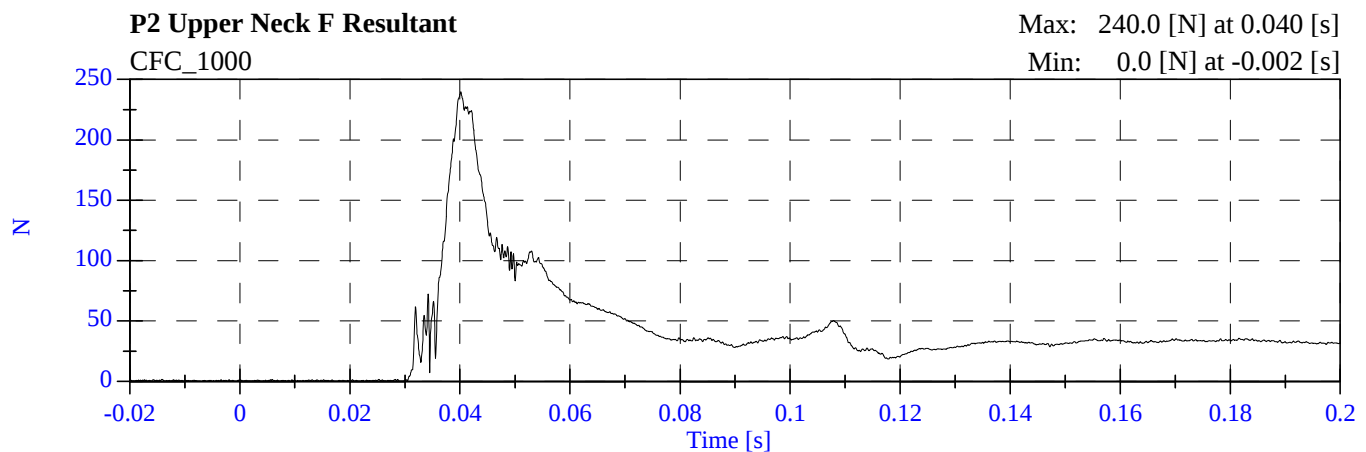
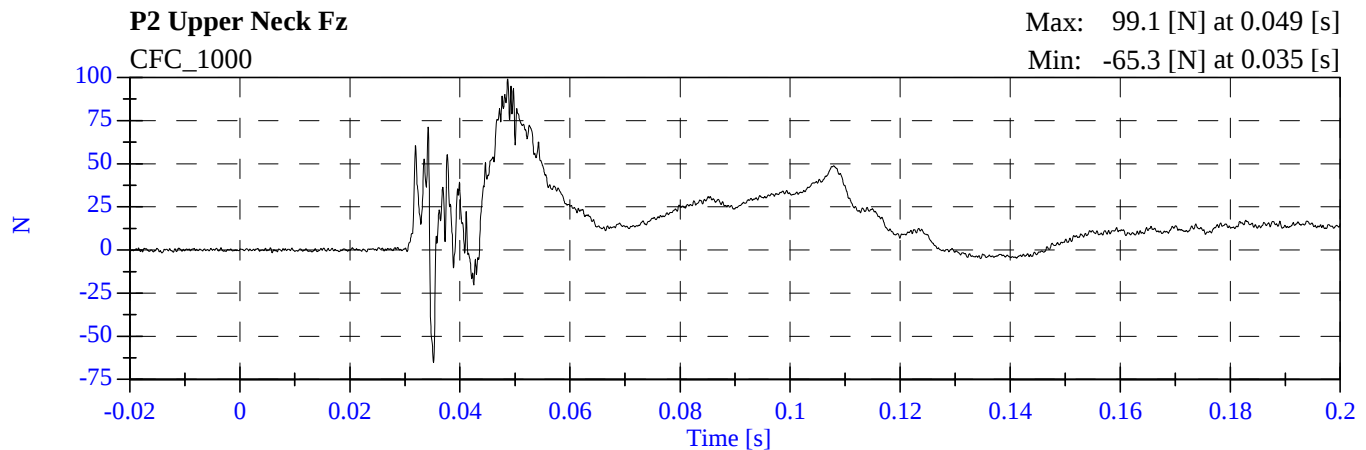
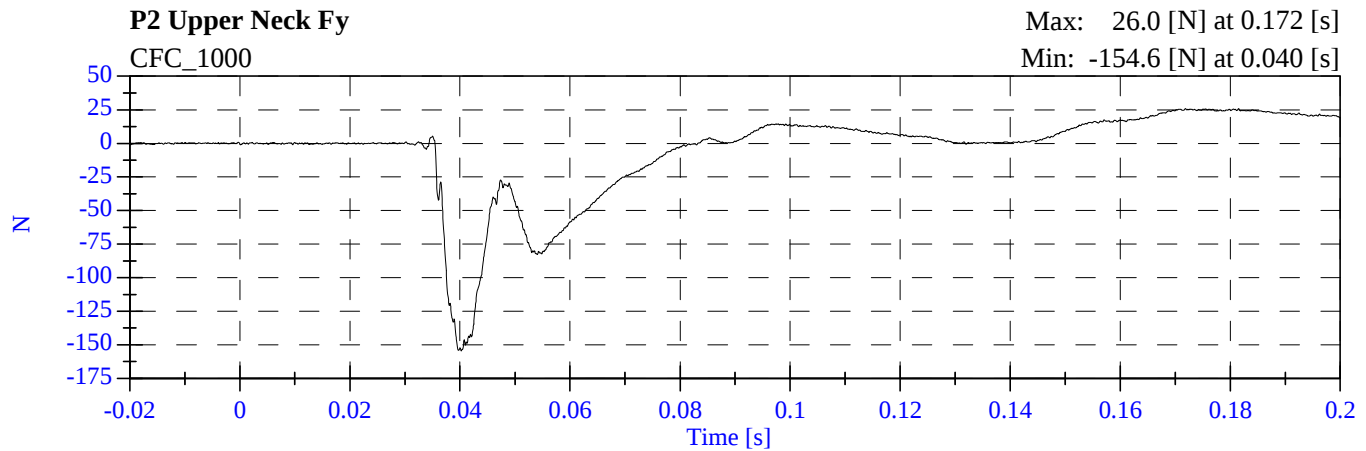
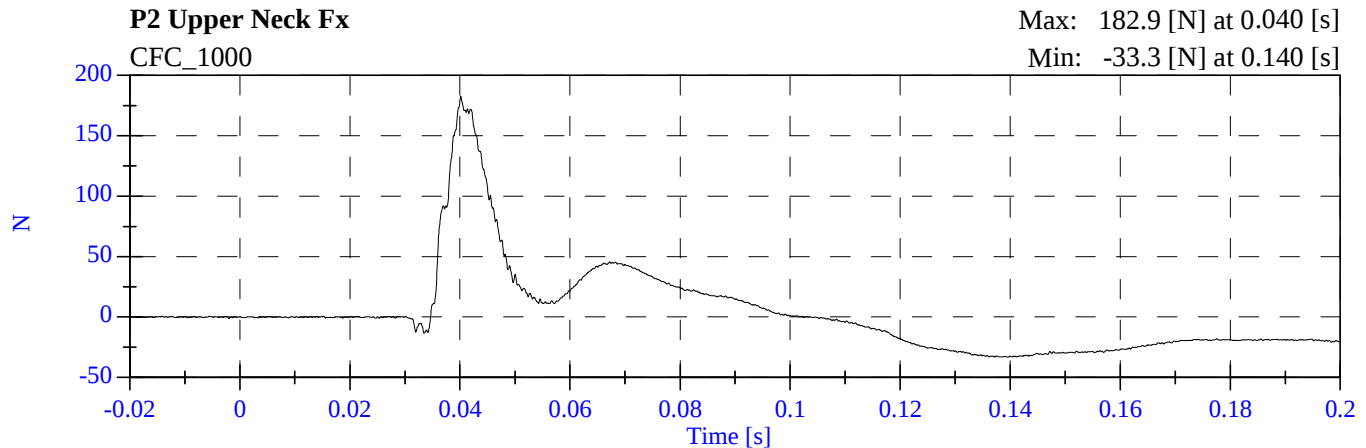
# 2009 Ford Escape - TWG/OOP

## M90204 - June 04, 2009



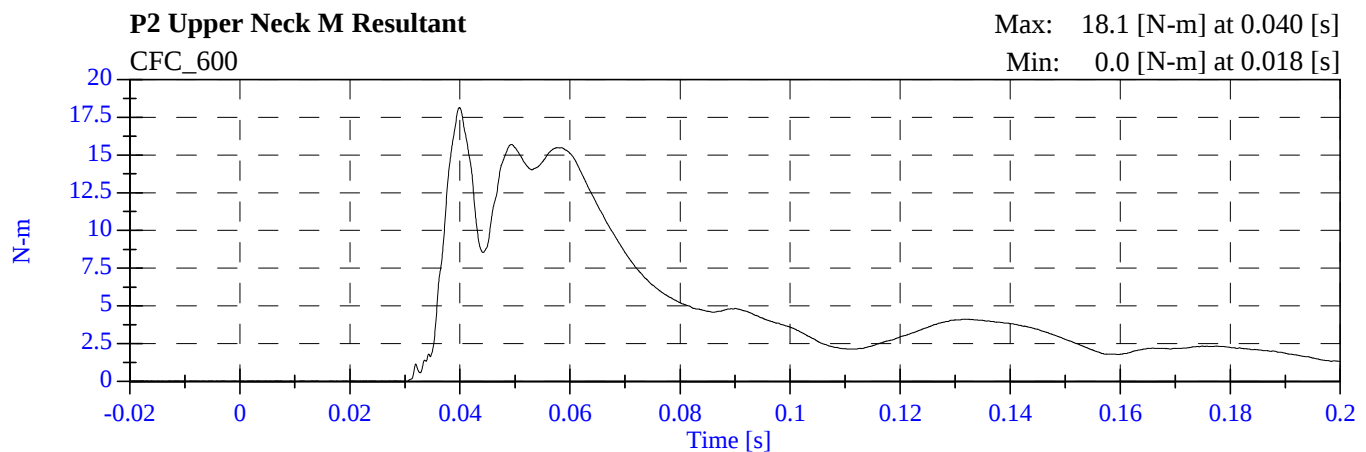
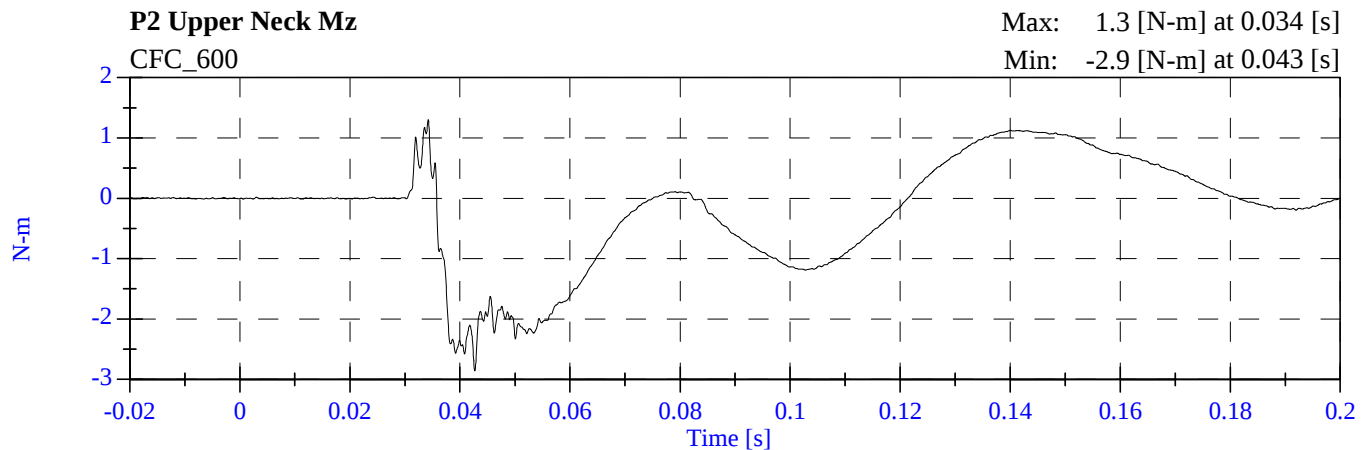
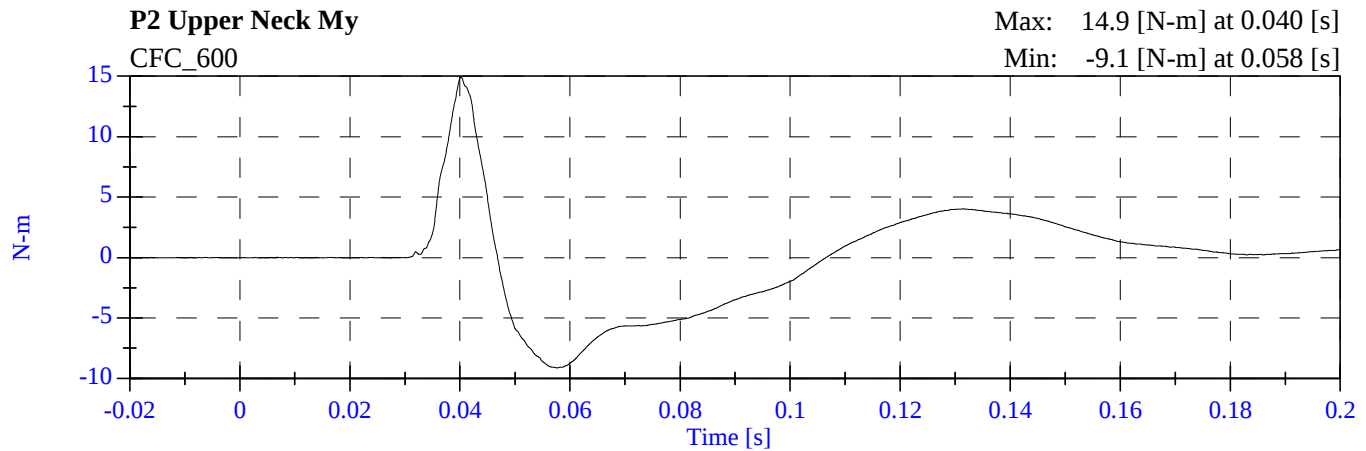
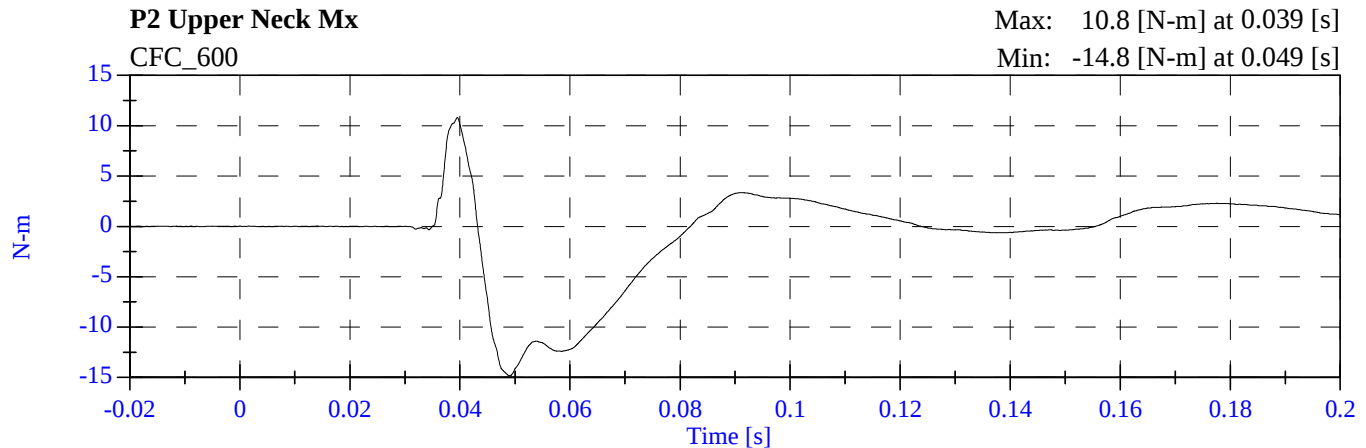
# 2009 Ford Escape - TWG/OOP

## M90204 - June 04, 2009



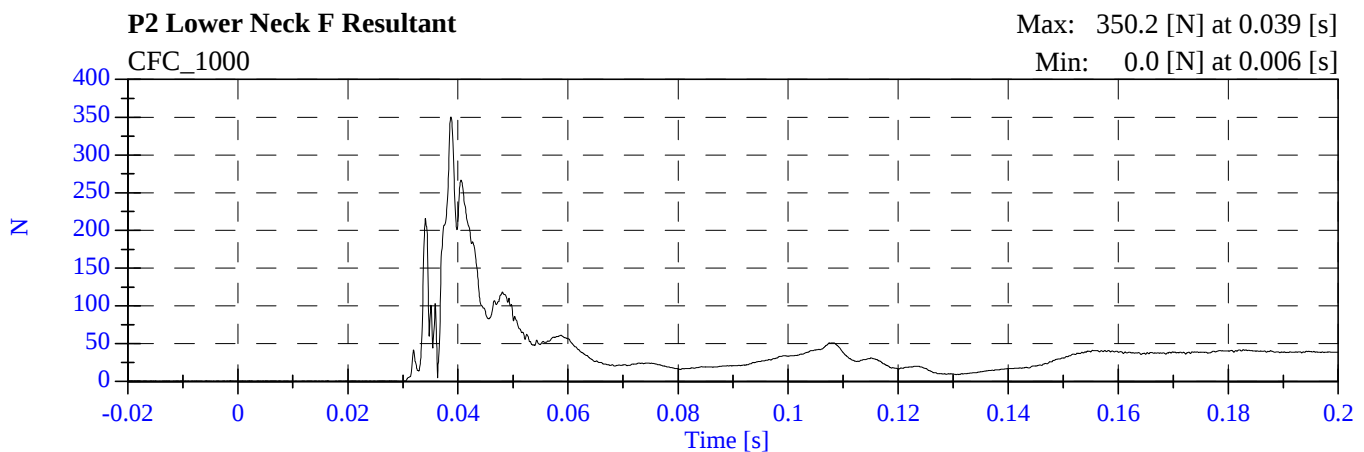
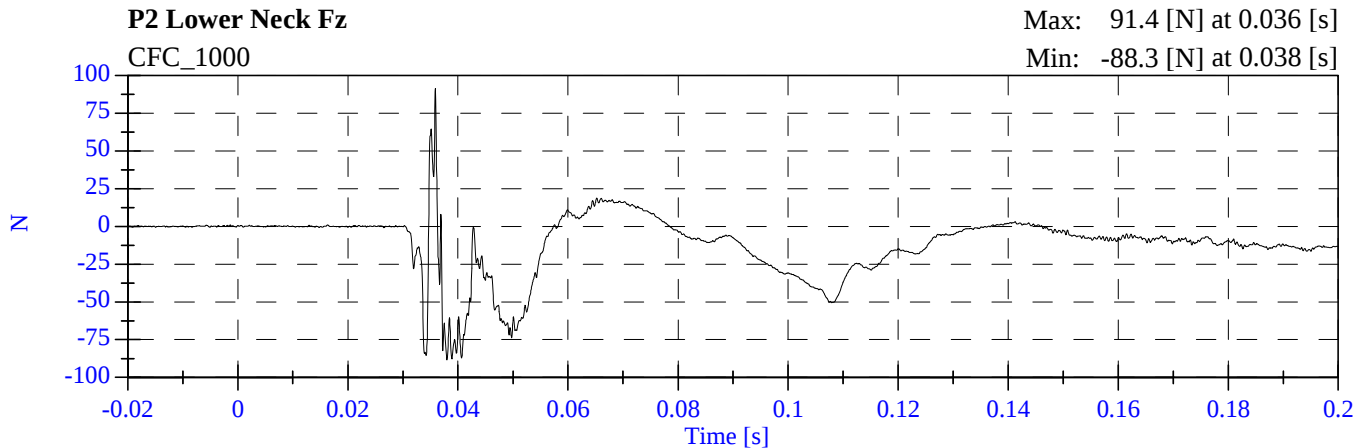
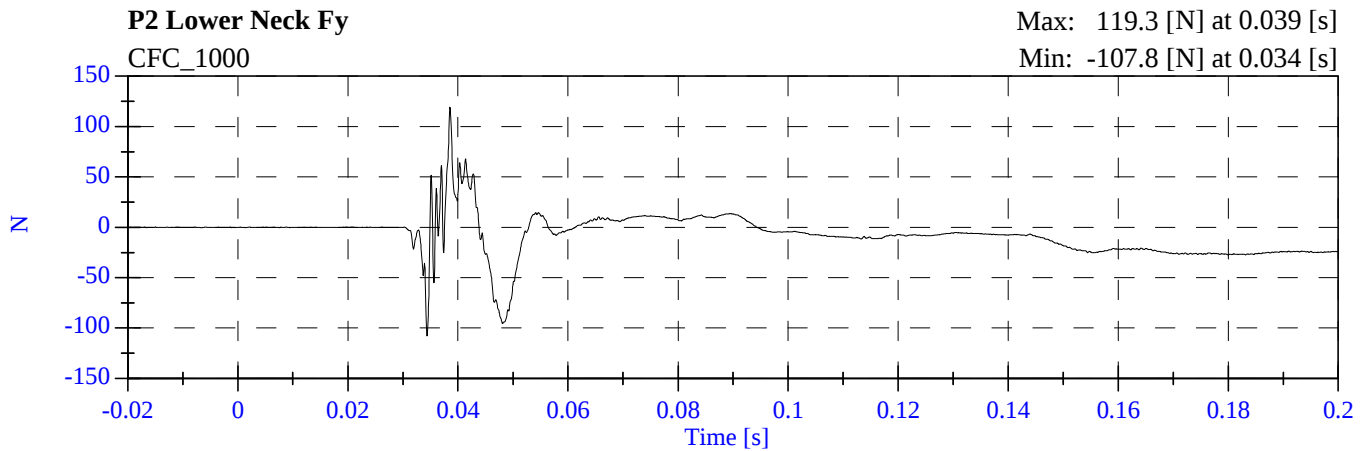
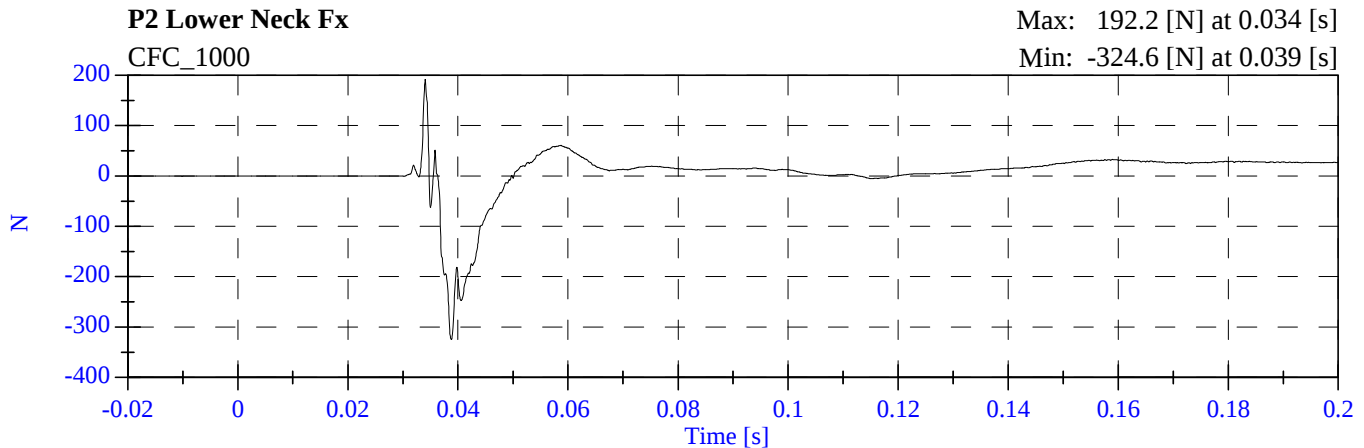
# 2009 Ford Escape - TWG/OOP

## M90204 - June 04, 2009



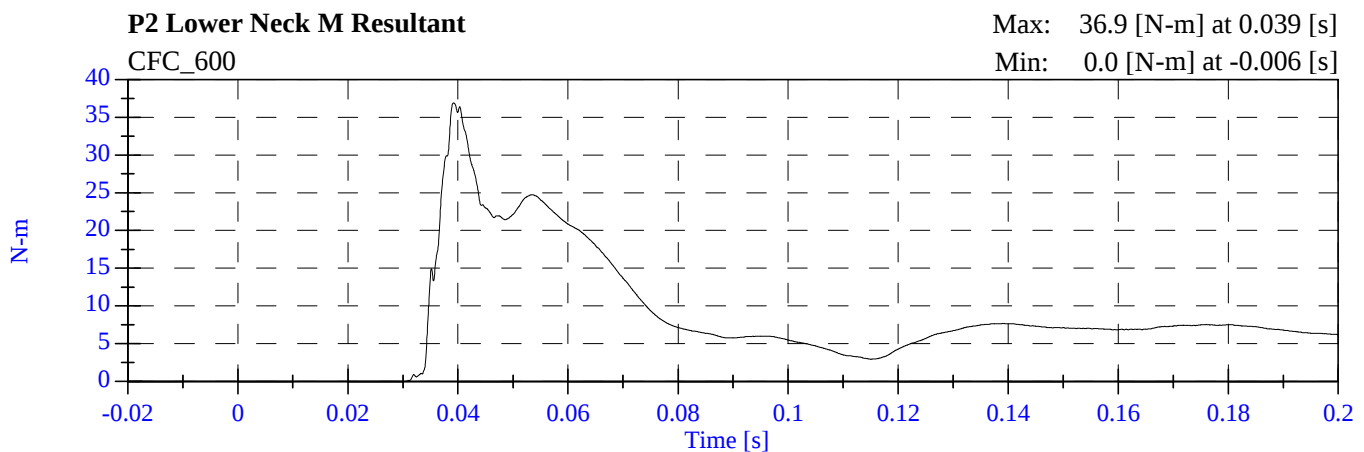
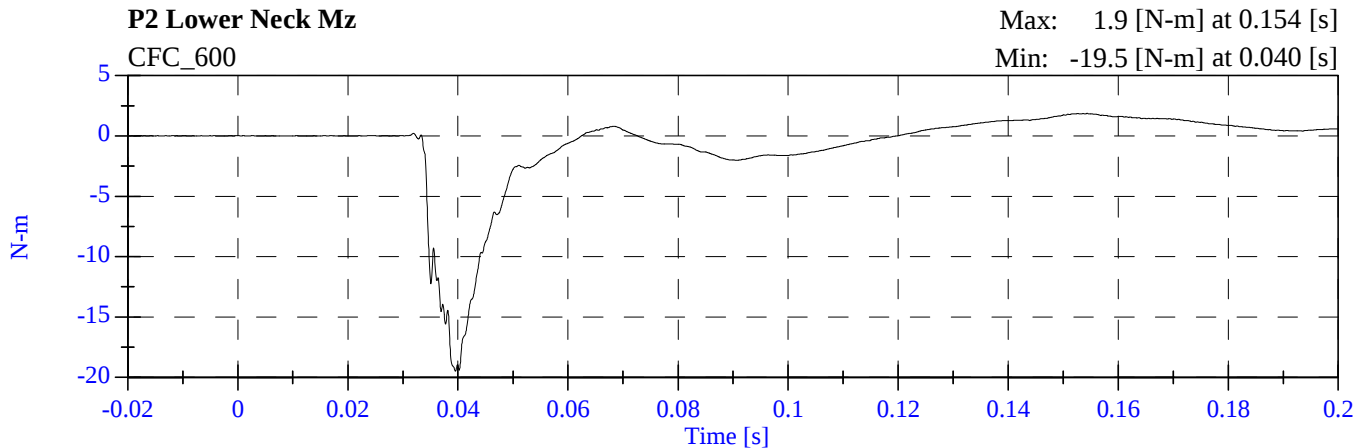
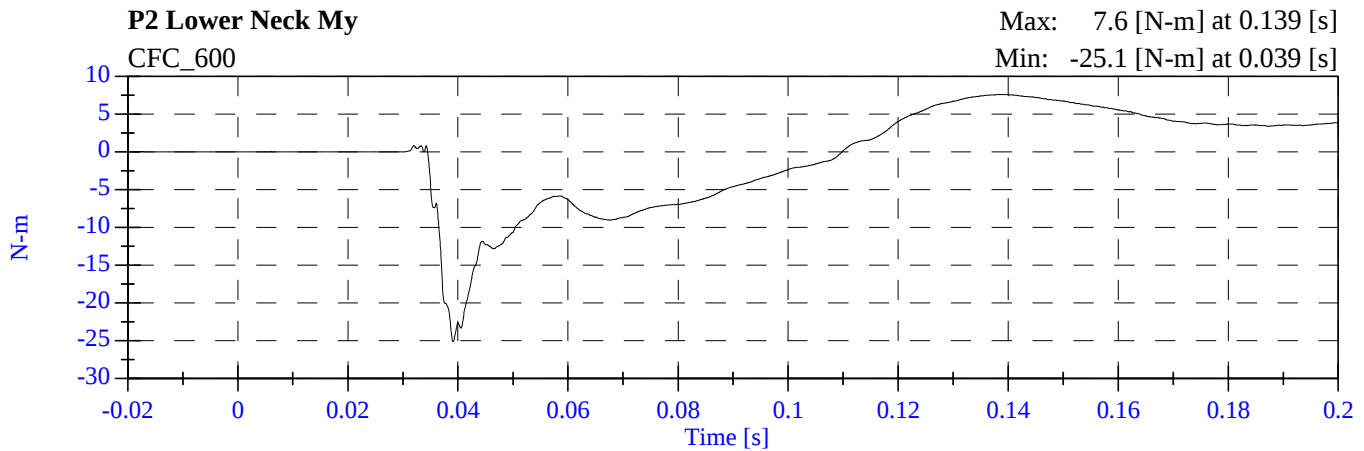
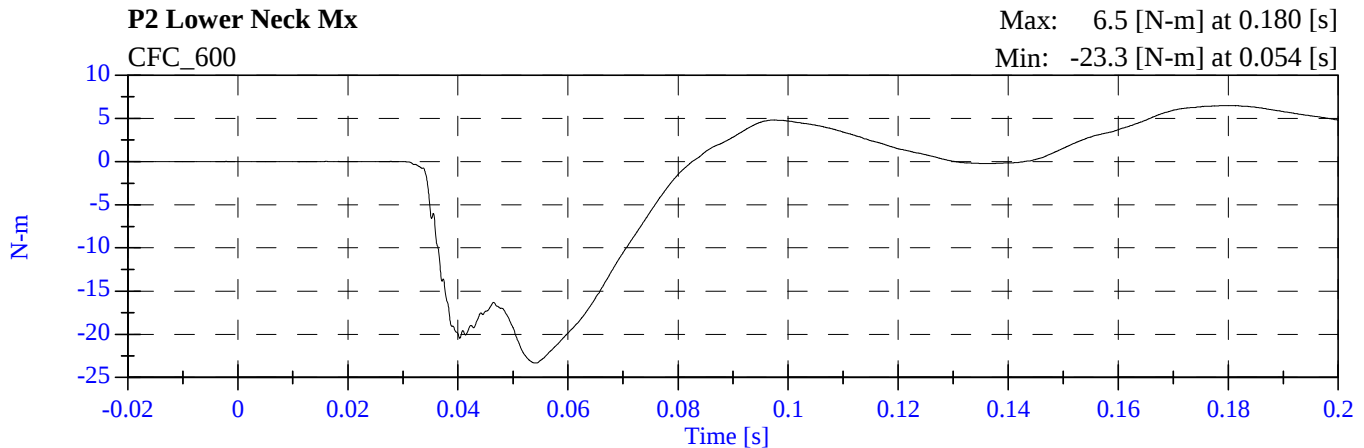
# 2009 Ford Escape - TWG/OOP

## M90204 - June 04, 2009

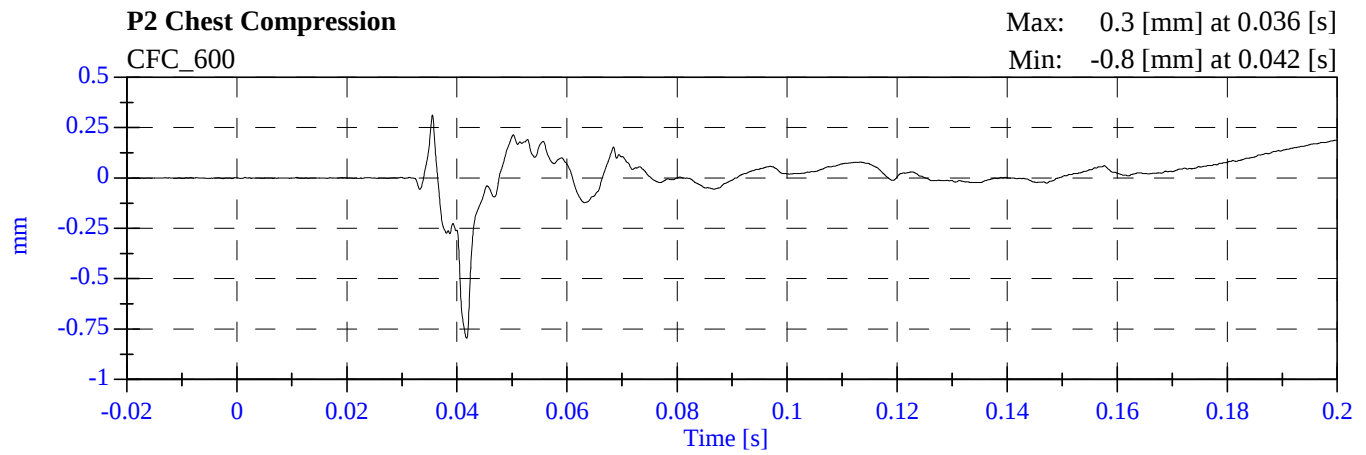


# 2009 Ford Escape - TWG/OOP

## M90204 - June 04, 2009



**2009 Ford Escape - TWG/OOP**  
**M90204 - June 04, 2009**



## **APPENDIX C**

### **TEST EQUIPMENT LIST AND CALIBRATION INFORMATION**

# TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

## P572C INSTRUMENTATION

|                      | POSITION #2 (RIGHT) SERIAL NO.: M95304TWG |              |                  |
|----------------------|-------------------------------------------|--------------|------------------|
|                      | SERIAL NUMBER                             | MANUFACTURER | CALIBRATION DATE |
| HEAD AX              | AC-P51280                                 | ENDEVCO      | 4/14/09          |
| HEAD AY              | AC-P49194                                 | ENDEVCO      | 4/13/09          |
| HEAD AZ              | AC-P58799                                 | ENDEVCO      | 4/15/09          |
| UPPER NECK FX        | LC-1647Fx                                 | DENTON       | 4/14/09          |
| UPPER NECK FY        | LC-1647Fy                                 | DENTON       | 4/14/09          |
| UPPER NECK FZ        | LC-1647Fz                                 | DENTON       | 4/14/09          |
| UPPER NECK MX        | LC-1647Mx                                 | DENTON       | 4/14/09          |
| UPPER NECK MY        | LC-1647My                                 | DENTON       | 4/14/09          |
| UPPER NECK MZ        | LC-1647Mz                                 | DENTON       | 4/14/09          |
| LOWER NECK FX        | LC-146Fx                                  | DENTON       | 4/20/09          |
| LOWER NECK FY        | LC-146Fy                                  | DENTON       | 4/20/09          |
| LOWER NECK FZ        | LC-146Fz                                  | DENTON       | 4/20/09          |
| LOWER NECK MX        | LC-146Mx                                  | DENTON       | 4/20/09          |
| LOWER NECK MY        | LC-146My                                  | DENTON       | 4/20/09          |
| LOWER NECK MZ        | LC-146Mz                                  | DENTON       | 4/20/09          |
| CHEST DISPLACEMENT X | DS-144                                    | DENTON       | 4/20/09          |