

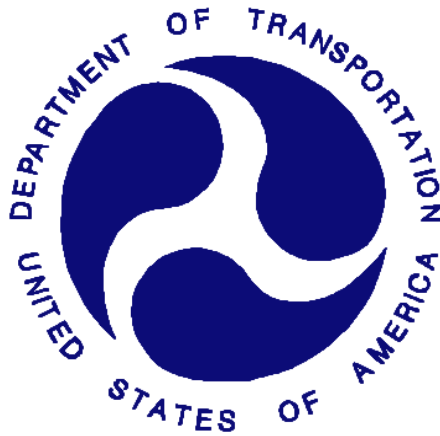
REPORT NUMBER: TWG-TRC-19-01

NEW CAR ASSESSMENT PROGRAM (NCAP)  
Side Airbag Out-of-Position Test

BAYERISCHE MOTOREN WERKE AG  
2019 BMW X5 5-DR SUV

NHTSA NUMBER: M20194105TWG3  
TRC TEST NUMBER: 190709-1

PREPARED BY:  
TRANSPORTATION RESEARCH CENTER INC.  
10820 State Route 347  
P.O. BOX B-67  
East Liberty, OH 43319



Test Date: July 9, 2019

FINAL REPORT

Alpha Technology Associate, Inc.  
2810 Old Lee Highway, Suite 120  
Fairfax, VA 22031

This Final Test Report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-13-D-00311L, Alpha Technology PO 15GT153. This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

Prepared By: ILO Projects Operations Group

Approved By:   
John Shultz  
Project Manager

Approval Date: June 26, 2020

FINAL REPORT ACCEPTANCE BY:

Accepted By: \_\_\_\_\_

Acceptance Date: \_\_\_\_\_

## TECHNICAL REPORT DOCUMENTATION PAGE

1. <u>REPORT NO.</u> TWG-TRC-19-01	2. <u>GOVERNMENT ACCESSION NO.</u>	3. <u>RECIPIENT'S CATALOG NO.</u>	
4. <u>TITLE AND SUBTITLE</u> Final Report of New Car Assessment Program Side Air Bag Out-of-Position Testing of 2019 BMW X5 5-DR SUV NHTSA No. M20194105TWG3		5. Report Date June 26, 2020	
		6. <u>PERFORMING ORGANIZATION CODE</u> TRC	
7. <u>AUTHOR(S)</u> John Shultz, Project Manager		8. <u>PERFORMING ORGANIZATION REPORT NO.</u> 190709-1	
9. <u>PERFORMING ORGANIZATION NAME AND ADDRESS</u> Transportation Research Center Inc. 10820 State Route 347 East Liberty, OH 43319		10. <u>WORK UNIT NO.</u>	
		11. <u>CONTRACT OR GRANT NO.</u> DTNH22-13-D-00311L	
12. <u>SPONSORING AGENCY NAME AND ADDRESS</u> Alpha Technology Associate, Inc. 2810 Old Lee Hwy, Suite 120 Fairfax, VA 22031		13. <u>TYPE OF REPORT AND PERIOD COVERED</u> Final Test Report July 9, 2019 – June 26, 2020	
		14. <u>SPONSORING AGENCY CODE</u> NRM-110	
15. <u>SUPPLEMENTARY NOTES</u>			
16. <u>ABSTRACT</u> <p>A side air bag out of position test was conducted on the subject 2019 BMW X5 5-DR SUV in accordance with the specifications of the Office of Crashworthiness Standards SAB OOP NCAP Laboratory Test Procedure for the generation of consumer information on vehicle side air bag protection. The test was conducted at the by Transportation Research Center Inc. in East Liberty, Ohio, on July 9, 2019.</p> <p>The curtain and torso side air bags were deployed and responses were measured on a Hybrid III 3-year-old. Three high speed cameras recorded the event. The ambient temperature at the time of air bag deployment was 22.1°C.</p>			
<b>Section 3.3.3.3 – Hybrid III 3-year-old – Position 3</b>			
<b>Measurement Description</b>		<b>Units</b>	<b>IARV</b>
Head Injury Criteria (HIC15)		N/A	570
Nij		N/A	1
Upper Neck Tension		Newton	1130
Upper Neck Compression		Newton	1380
Maximum Chest Compression		mm	36
Maximum Chest Compression rate		m/sec	8.0
17. <u>KEY WORDS</u> New Car Assessment Program Side Air Bag Out-of-position (OOP) Technical Working Group (TWG)		18. <u>DISTRIBUTION STATEMENT</u> Copies of this report are available from the following: Alpha Technology Associate, Inc. 2810 Old Lee Hwy, Suite 120 Fairfax, VA 22031 Phone: (703) 876-0010 FAX: (703) 876-0120 Attn: Steven Kim	
19. <u>SECURITY CLASSIFICATION OF REPORT</u> Unclassified	20. <u>SECURITY CLASSIFICATION OF PAGE</u> Unclassified	21. <u>NO. OF PAGES</u> 55	22. <u>PRICE</u>

## TABLE OF CONTENTS

<b><u>Section</u></b>		<b>Page No.</b>
1	Test Purpose and Procedure	1
2	Summary of Test Results	2
3	Data Sheets	3
	Data Sheet 1 – Test Summary	3
	Data Sheet 2 – General Test and Vehicle Parameter Data	4
	Data Sheet 3 – Seat Adjustment Data	5
	Data Sheet 4 – Dummy Setup and Positioning Data	6
	Data Sheet 5 – Dummy Injury Criteria Data	7
	Data Sheet 6 – Camera Setup and Description	9
A	Photographs	A-1
B	Dummy Response Data Plots	B-1
C	Test Equipment List and Calibration Information	C-1
D	Dummy Configuration and Performance Verification Data	D-1

## **SECTION 1 – TEST PURPOSE AND PROCEDURE**

This side air bag out-of-position test is part of the MY19 New Car Assessment Program (NCAP), sponsored by the National Highway Traffic Safety Administration (NHTSA), under contract number DTNH22-13-D-00311L. The purpose of this test is to obtain data on the performance of side air bags with an out-of-position occupant in a 2019 BMW X5 5-DR SUV. The air bag test was conducted in accordance with the Office of Crashworthiness Standard's Laboratory Test Procedure, dated April 2018.

## SECTION 2 – SUMMARY OF TEST RESULTS

The effects of both a seat-mounted side air bag and a curtain air bag deployment in a 2019 BMW X5 5-DR SUV on an out-of-position Hybrid III 3-year-old were evaluated. The test was performed by TRC on July 9, 2019. Pre and post-test photographs of the vehicle and ATD can be found in Appendix A.

The vehicle had previously undergone crash testing as part of the NCAP. After conducting the crash test and before conducting the air bag deployment test, the vehicle was inspected for damage. The vehicle was found to be in good condition to undergo the air bag deployment test.

Three high-speed cameras were used to record the air bag deployment event. High speed images were recorded at rates of 1,000 frames per second. Cameras were placed relative to the position 3 and were positioned to capture the deployment event from the side, the front, and the oblique views.

The Hybrid III 3-year-old was placed in the right rear (passenger) seat situated on the seat lying on its back with its arms aligned. This placement followed the ATD placement instructions in the NCAP Laboratory Test Procedure as well as 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 specific test section was section 3.3.3.3.

The Hybrid III 3-year-old was instrumented with head X, Y, and Z accelerometers, a six-axis upper neck load cell, and a six-axis lower neck load cell. During the air bag deployment, a total of twenty channels of data were recorded using an on-board data acquisition system. Appendix B contains the ATD response data traces and Appendix C contains the instrumentation list and calibration information. Appendix D contains the dummy's pre-test qualification performance verification data.

No Injury Reference Values were exceeded during the test. The occupant data is summarized below:

Measurement Description	Units	Passenger ATD Hybrid III 3-year-old	
		IARV	Result
Head Injury Criteria (HIC15)	N/A	570	200
Nij	N/A	1	0.57
Upper Neck Tension	N	1130	559.70
Upper Neck Compression	N	1380	-73.96
Thorax Compression	mm	36	
Thorax Compression rate	m/sec	8.0	

### SECTION 3 DATA SHEET

#### DATA SHEET NO. 1 TEST SUMMARY

Test Vehicle: 2019 BMW X5 5-DR SUV  
Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
Test Date: 7/9/2019

#### TEST SUMMARY

##### TEST CONFIGURATION INFORMATION

Seating Position:	P3	Right Rear Seating Position
Test Section:	3.3.3.3	Hybrid III 3-Year-Old Child Dummy Lying on Seat with Head on Armrest (Passenger Positions with Seat-Mounted Airbags)
Airbag 1:	Seat	Seat mounted – outside seam
Airbag 2:	Side Rail	Side curtain airbag
Booster Block:	Foam	Wedge
ATD Type/Serial No.:	Hybrid 3-Year-Old	040
Vehicle	BMW	X5
Previous Crash Test	MDB	1/9/2019 & M20194105

##### EQUIPMENT INFORMATION

Number of Data Channels	22
Number of High Speed Video Cameras	3
Number of Real Time Video Cameras	0

##### VISIBLE DUMMY CONTACT POINTS

Head	None Visible
Upper Torso	None Visible
Lower Torso	None Visible
Knee	None Visible

**DATA SHEET NO. 2  
GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: 2019 BMW X5 5-DR SUV  
 Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
 Test Date: 7/9/2019

**TEST CONFIGURATION INFORMATION**

NHTSA No.	M20194105
Model Year	2019
Make	BMW
Model	X5
Body Style	MPV
VIN	5UXCR6C57KMK79699
Body Color	Arctic Grey Metallic
Odometer Reading (km/mi)	9 mi
Engine Displacement (L)	3.0
Type/No. Cylinders	Gas/6
Engine Placement	Front/Longitudinal
Transmission Type	Automatic
Transmission Speeds	8
Overdrive	Yes
Final Drive	AWD
Roof Rack	No
Sunroof/T-Top	Yes
Running Boards	No
Tilt Steering Wheel	Yes
Power Seats	Yes
Anti-Lock Brakes (ABS)	Yes

Traction Control System (TCS)	Yes
Auto-Leveling System	No
Automatic Door Locks (ADL)	Yes
Power Window Auto-Reverse	Yes
Other Optional Feature	No
Driver Front Airbag	Yes
Driver Curtain Airbag	Yes
Driver Head/Torso Airbag	No
Driver Torso Airbag	No
Driver Torso/Pelvis Airbag	Yes
Driver Pelvis Airbag	No
Driver Knee Airbag	Yes
Rear Pass. Curtain Airbag	Yes
Rear Pass. Head/Torso Airbag	No
Rear Pass. Torso Airbag	No
Rear Pass. Torso/Pelvis Airbag	Yes
Rear Passenger Pelvis Airbag	No
Driver Seat Belt Pretensioner	Yes
Rear Pass. Seat Belt Pretensioner	Yes
Driver Load Limiter	Yes
Rear Passenger Load Limiter	Yes
Other Safety Restraint	No

**DATA FROM CERTIFICATION LABEL**

Manufactured By	BAYERISCHE MOTOREN WERKE AG
Date of Manufacture	10/18
Vehicle Type	MPV

GVWR (kg)	2795
GAWR Front (kg)	1325
GAWR Rear (kg)	1640

**VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION**

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity DSC)	2	3	N/A	5	
Capacity Weight (VCW) (kg)				385	(A)
DSC x 68.04 (kg)				340.2	(B)
Cargo Weight (RCLW) (kg)				44.8	(A-B)

**VEHICLE SEAT TYPE**

Seating Location	Type of Seat Pan				Type of Seat Back		
	Bucket	Bench	Split Bench	Contoured	Fixed	Adjustable	
						w/ Lever	w/ Knob
Front Seat	Yes	N/A	N/A		N/A	Yes	N/A
Rear or Second Row Seat	N/A	N/A	Yes	Yes	Yes	N/A	N/A
Third Row Seat	N/A	N/A	N/A	N/A	N/A	N/A	N/A



**DATA SHEET NO. 3**  
**SEAT ADJUSTMENT DATA**

Test Vehicle: 2019 BMW X5 5-DR SUV  
Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
Test Date: 7/9/2019

**VEHICLE SEAT FORE/AFT POSITION**

Seat Location	Total Fore/Aft Travel		Test Position from Forwardmost Position	
	mm	# Detents	mm	# Detents
Front Right	220	N/A	0	N/A
Rear Right	N/A	N/A	N/A	N/A

Seat Fore/Aft Position Per TWG Guidelines	Full forward
Reason for Deviation from TWG Guidelines	No deviations

**VEHICLE SEAT BACK ANGLE ADJUSTMENT**

Seat Location	Total Seat Back Angle Range		Test Position from Most Upright (Vertical)	
	Degrees	# Detents	Degrees	# Detents
Front Right	62.4	N/A	19.0	N/A
Rear Right	0	N/A	25.3	N/A

OEM Back Angle Design Position	25.3 degrees
Method of Measuring Back Angle Position	N/A
Seat Back Angle Position Per TWG Guidelines	Fixed
Reason for Deviation from TWG Guidelines	No deviations

**VEHICLE SEAT HEIGHT ADJUSTMENT**

Seat Location	Total Height Adjustment Range		Test Position from Lowest Position	
	mm	# Detents	mm	# Detents
Front Right	75	N/A	75	N/A
Rear Right	Fixed	N/A	N/A	N/A

Seat Height Adjustment Per TWG Guidelines	Fixed
Reason for Deviation from TWG Guidelines	No deviations

**DATA SHEET NO. 4  
DUMMY SETUP AND POSITIONING DATA**

Test Vehicle: 2019 BMW X5 5-DR SUV  
 Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
 Test Date: 7/9/2019

**DUMMY INFORMATION**

ATD Type	Hybrid 3-Year-Old
Serial Number	040
Qualification Date	6/27/2019
Qualification Type	Partial
Clothing	Cotton shirt and pants
Other ATD Prep	Electrical tape on the seam of skull cap and baby power on the head

**DUMMY POSITIONING INFORMATION**

TWG Setup Instructions	As specified in the 3.3.3.3 Test Procedure; Seat is fixed; ATD positioned to 3.3.3.3.1
Actual Setup	The dummy is placed on the seat lying on its back with its rearmost arm contacting the seatback. The rearmost upper arm is set to an orientation of 45 degrees forward of the torso centerline and the forearm on the same side is set to an orientation of 90 degrees to the upper arm. The back of the head is touching the armrest and the CG of the head aligns as close as possible with the vertical centerline of the module. The dummy's back is being supported with a wedge-shaped foam block so that the head is not forced into flexion or extension. The dummy's arm closest to the front edge of the seat is parallel to the torso but does not rest on the foam block. The fifth digit fingertip is just touching the seat cushion.

**DATA SHEET NO. 5  
DUMMY INJURY CRITERIA DATA**

Test Vehicle: 2019 BMW X5 5-DR SUV  
 Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
 Test Date: 7/9/2019

**RECORDED DATA - MINIMUMS AND MAXIMUMS**

Channel	Unit	CFC	Maximum	Time (ms)	Minimum	Time (ms)
Head X	G	1000	74.22	6.48	-6.58	22.72
Head Y	G	1000	53.99	6.00	-5.78	28.88
Head Z	G	1000	11.83	7.60	-10.13	6.40
Head Resultant	G	1000	85.53	6.48		
Head Red X	G	1000	74.13	6.48	-6.81	22.72
Head Red Y	G	1000	54.18	6.00	-5.70	28.88
Head Red Z	G	1000	11.32	7.60	-9.84	6.40
Head Red Resultant	G	1000	85.47	6.48		
Upper Neck X	N	1000	4.35	4.96	-218.68	11.28
Upper Neck Y	N	1000	22.72	9.76	-142.41	21.60
Upper Neck Z	N	1000	559.70	9.84	-73.96	6.16
Upper Neck Resultant	N	1000	582.74	10.40		
Upper Neck X	Nm	600	3.93	60.00	-13.94	24.48
Upper Neck Y	Nm	600	5.52	34.40	-8.84	11.84
Upper Neck Z	Nm	600	3.98	92.80	-6.65	29.52
Upper Neck Resultant	Nm	600	15.34	24.16		
Lower Neck X	N	1000	59.26	64.64	-553.53	22.00
Lower Neck Y	N	1000	229.57	19.76	-0.71	5.36
Lower Neck Z	N	1000	269.36	92.48	-556.67	34.64
Lower Neck Resultant	N	1000	768.77	22.24		
Lower Neck X	Nm	600	2.11	7.76	-9.08	18.80
Lower Neck Y	Nm	600	0.20	5.68	-6.99	20.56
Lower Neck Z	Nm	600	7.25	10.32	-0.56	6.32
Lower Neck Resultant	Nm	600	11.36	18.88		

**HEAD INJURY SUMMARY**

HIC15	T1 (ms)	T2 (ms)	HIC36	T1 (ms)	T2 (ms)
200	5.68	12.80	200	5.68	12.80

**DATA SHEET NO. 5  
DUMMY INJURY CRITERIA DATA (CONTINUED)**

Test Vehicle: 2019 BMW X5 5-DR SUV  
 Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
 Test Date: 7/9/2019

**NECK INJURY SUMMARY**

Injury Criteria	Value	Time (ms)
Upper Neck NTF	0.14	32.56
Upper Neck NTE	0.57	11.20
Upper Neck NCF	0.01	49.12
Upper Neck NCE	0.07	6.16
Peak Tension	559.70	9.84
Peak Compression	-73.96	6.16

**CHEST INJURY SUMMARY**

Injury Criteria	Value	Time (ms)
[Chest/Rib] Deflection		
Deflection Rate <sup>1</sup>		

<sup>1</sup>Deflection Rate was assessed by measuring compression from a rotary potentiometer

**RESEARCH INJURY SUMMARY**

Research Injury Criteria <sup>1</sup>	Value	Time (ms)
Upper Neck Lateral Moment		
Upper Neck Twist Moment		
Lower Neck Flexion Moment		
Lower Neck Extension Moment		
Lower Neck Lateral Moment		
Lower Neck Twist Moment		
Lower Neck Tension		
Lower Neck Compression		
Spine Acceleration		

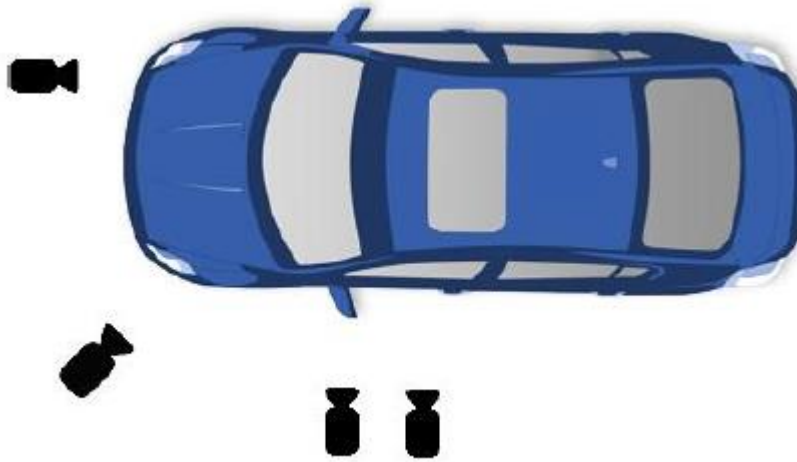
<sup>1</sup>These injury criteria are only monitored and not considered pass/fail

**DATA SHEET NO. 6  
CAMERA SETUP AND DESCRIPTION**

Test Vehicle: 2019 BMW X5 5-DR SUV  
 Test Program: Side Air Bag Out-of-Position Test

NHTSA No.: M20194105TWG3  
 Test Date: 7/9/2019

**CAMERA SETUP DIAGRAM FOR SAB OOP TESTS**



No.	Camera View	Location (mm) <sup>1</sup>			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Left View	-3417	-2357	-1470	20	1000
2	Oblique View	2111	-1927	-1527	20	1000
3	Front View	1758	1104	-751	20	1000
4	Real Time	--- <sup>2</sup>	--- <sup>2</sup>	--- <sup>2</sup>	--- <sup>2</sup>	--- <sup>2</sup>

<sup>1</sup>+X forward of vehicle, +Y right of vehicle, +Z into ground

<sup>2</sup>Camera omitted

**APPENDIX A**  
**PHOTOGRAPHS**

## TABLE OF PHOTOGRAPHS

<u>Figure</u>	<u>Photograph Title</u>	<u>Page</u>
Figure A-1	Right Front ¾ View of Test Vehicle as Delivered	A-3
Figure A-2	Vehicle Certification Label	A-3
Figure A-3	Pre-Test Vehicle Left Side View	A-4
Figure A-4	Post-Test Vehicle Left Side View	A-4
Figure A-5	Pre-Test Vehicle Location of Air Bag 1	A-5
Figure A-6	Pre-Test Vehicle Location of Air Bag 2	A-5
Figure A-7	Pre-Test Vehicle Location of Air Bag 3	A-6
Figure A-8	Pre-Test Vehicle Seat Back Angle	A-6
Figure A-9	Pre-Test Dummy Left Side View	A-7
Figure A-10	Post-Test Dummy Left Side View	A-7
Figure A-11	Pre-Test Dummy Left Side Close-up View	A-8
Figure A-12	Post-Test Dummy Left Side Close-up View	A-8
Figure A-13	Pre-Test Dummy Left ¾ Front View	A-9
Figure A-14	Post-Test Dummy Left ¾ Front View	A-9
Figure A-15	Pre-Test Dummy Left ¾ Front Close-up View	A-10
Figure A-16	Post-Test Dummy Left ¾ Front Close-up View	A-10
Figure A-17	Pre-Test Dummy Front View	A-11
Figure A-18	Post-Test Dummy Front View	A-11
Figure A-19	Pre-Test Dummy Front Close-up View	A-12
Figure A-20	Post-Test Dummy Front Close-up View	A-12
Figure A-21	Pre-Test Dummy Right ¾ Front View	A-13
Figure A-22	Post-Test Dummy Right ¾ Front View	A-13
Figure A-23	Pre-Test Dummy Right Side Front View	A-14
Figure A-24	Post-Test Dummy Right Side Front View	A-14
Figure A-25	Post-Test Dummy Right Side Front View	A-15
Figure A-26	Post-Test Curtain Air Bag Left Side View	A-15
Figure A-27	Post-Test Curtain Air Bag Left ¾ Front View	A-16
Figure A-28	Post-Test Curtain Air Bag Front View	A-16
Figure A-29	Post-Test Curtain Air Bag Right Side View	A-17



Figure A-1 Right Front 3/4 View of Test Vehicle as Delivered



**MFD BY BAYERISCHE MOTOREN WERKE AG**  
10/18  
GVWR 6162 lbs 2795 kg TIRE / RIM  
GAWR FRONT 2921 lbs 1325 kg WITH 265/50 R19 /9.0J x 19  
GAWR REAR 3616 lbs 1640 kg WITH 265/50 R19 /9.0J x 19  
THIS VEHICLE CONFORMS TO ALL APPLICABLE U. S. FEDERAL  
MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE  
OF MANUFACTURE SHOWN ABOVE.  
**5UXCR6C57KLK79699** TYPE: MPV  
C27M  
7 320 729

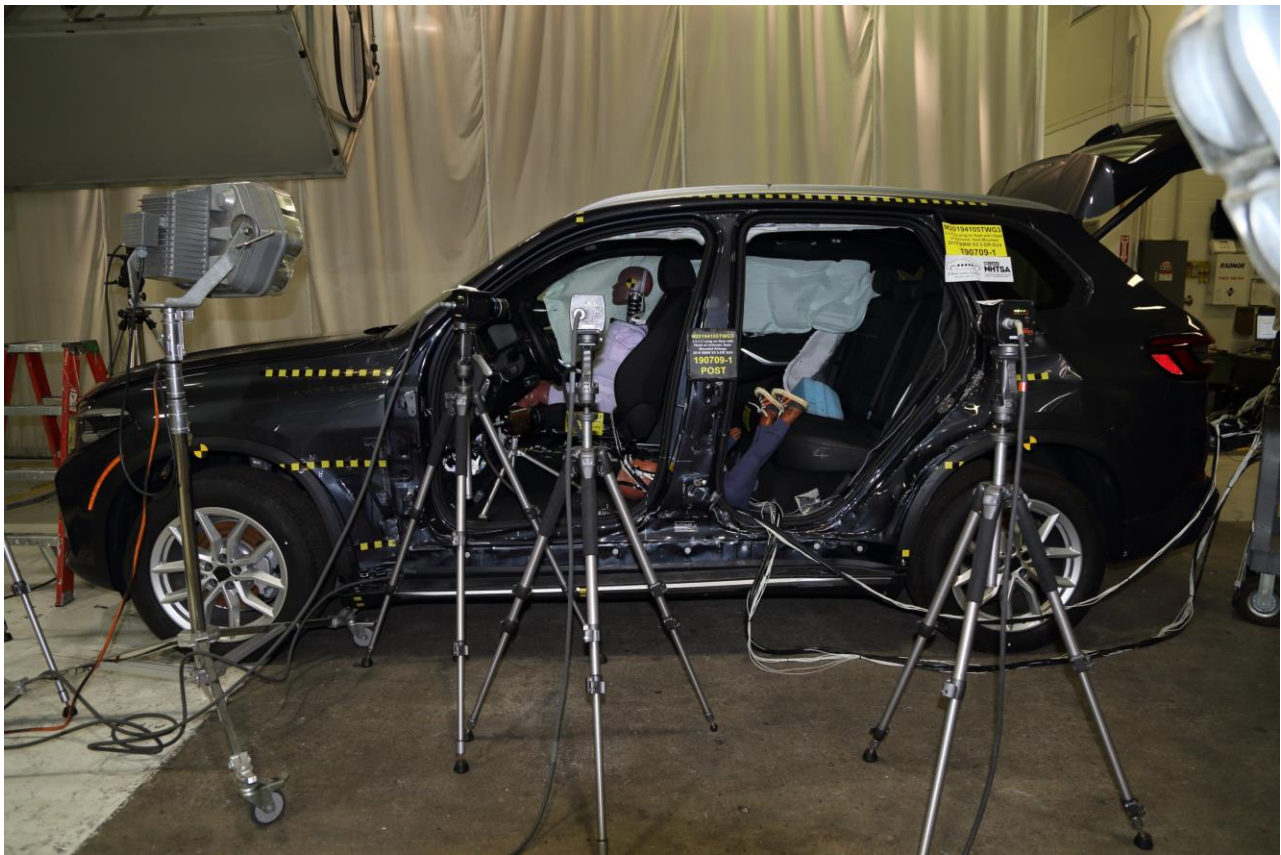
2019 BMW X5 5-DR Hatchback  
M20194105  
1/9/2019  
PRE-TEST

Figure A-2 Vehicle Certification Label

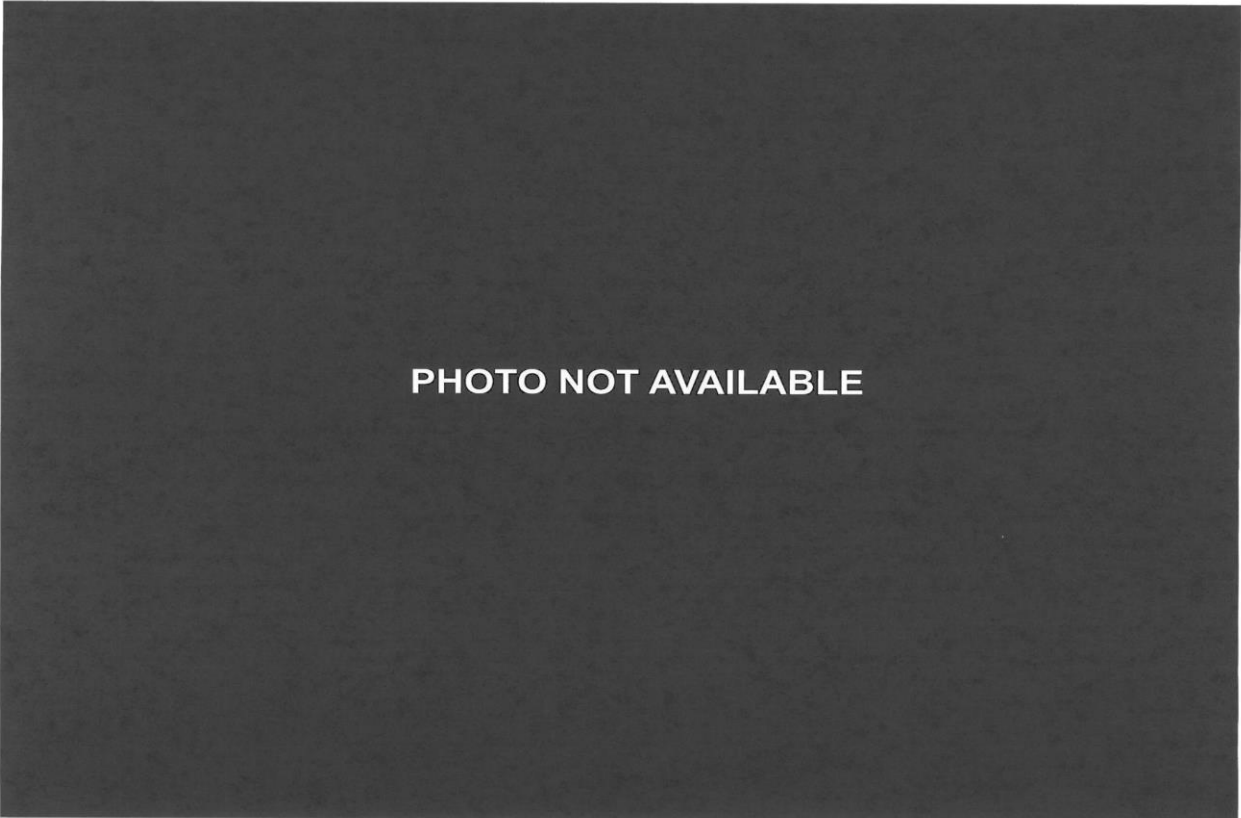




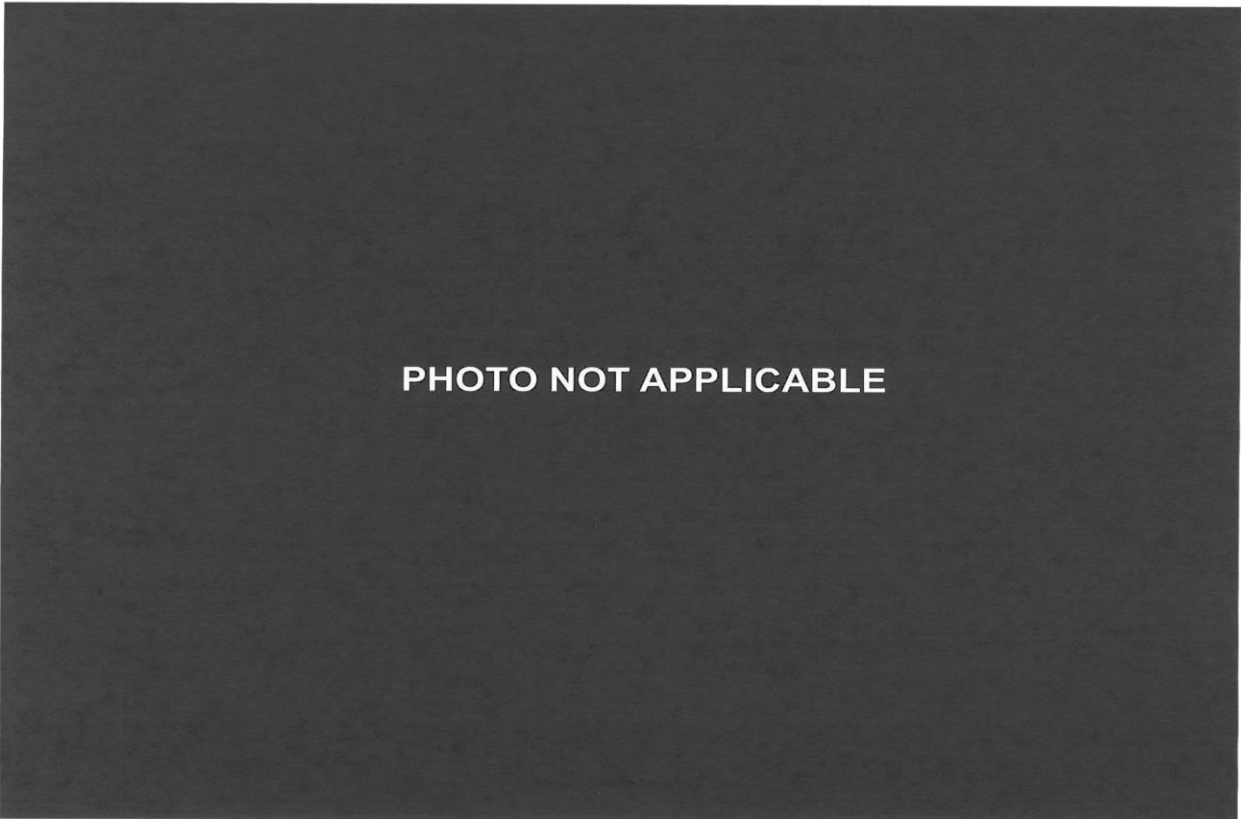
**Figure A-3 Pre-Test Vehicle Left Side View**



**Figure A-4 Post-Test Vehicle Left Side View**



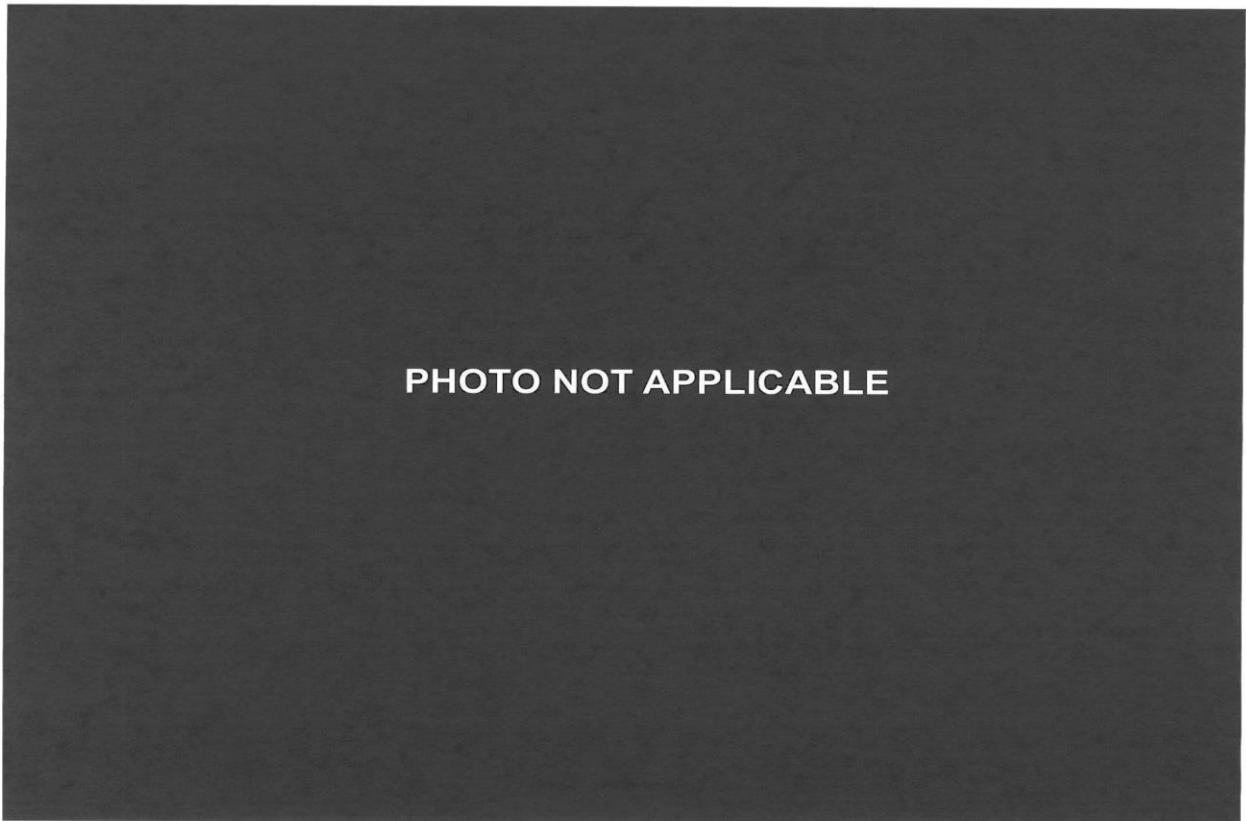
**Figure A-5 Pre-Test Vehicle Location of Air Bag 1**



**Figure A-6 Pre-Test Vehicle Location of Air Bag 2**



**Figure A-7 Pre-Test Vehicle Location of Air Bag 3**



**Figure A-8 Pre-Test Vehicle Seat Back Angle**



Figure A-9 Pre-Test Dummy Left Side View



Figure A-10 Post-Test Dummy Left Side View



Figure A-11 Pre-Test Dummy Left Side Close-up View



Figure A-12 Post-Test Dummy Left Side Close-up View



Figure A-13 Pre-Test Dummy Left  $\frac{3}{4}$  Front View



Figure A-14 Post-Test Dummy Left  $\frac{3}{4}$  Front View



Figure A-15 Pre-Test Dummy Left  $\frac{3}{4}$  Front Close-up View

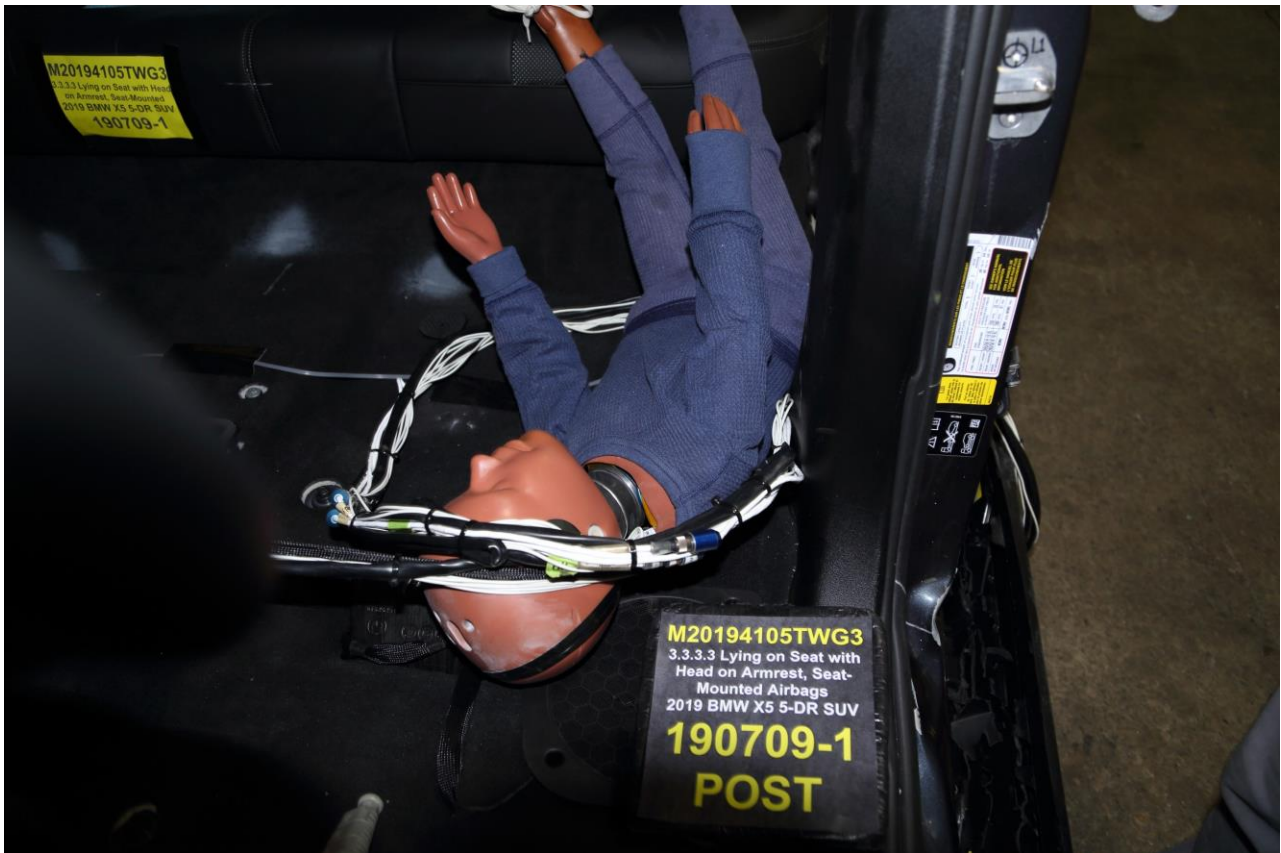


Figure A-16 Post-Test Dummy Left  $\frac{3}{4}$  Front Close-up View



**Figure A-17 Pre-Test Dummy Front View**



**Figure A-18 Post-Test Dummy Front View**





**Figure A-19 Pre-Test Dummy Front Close-up View**



**Figure A-20 Post-Test Dummy Front Close-up View**



Figure A-21 Pre-Test Dummy Right 3/4 Front View



Figure A-22 Post-Test Dummy Right 3/4 Front View

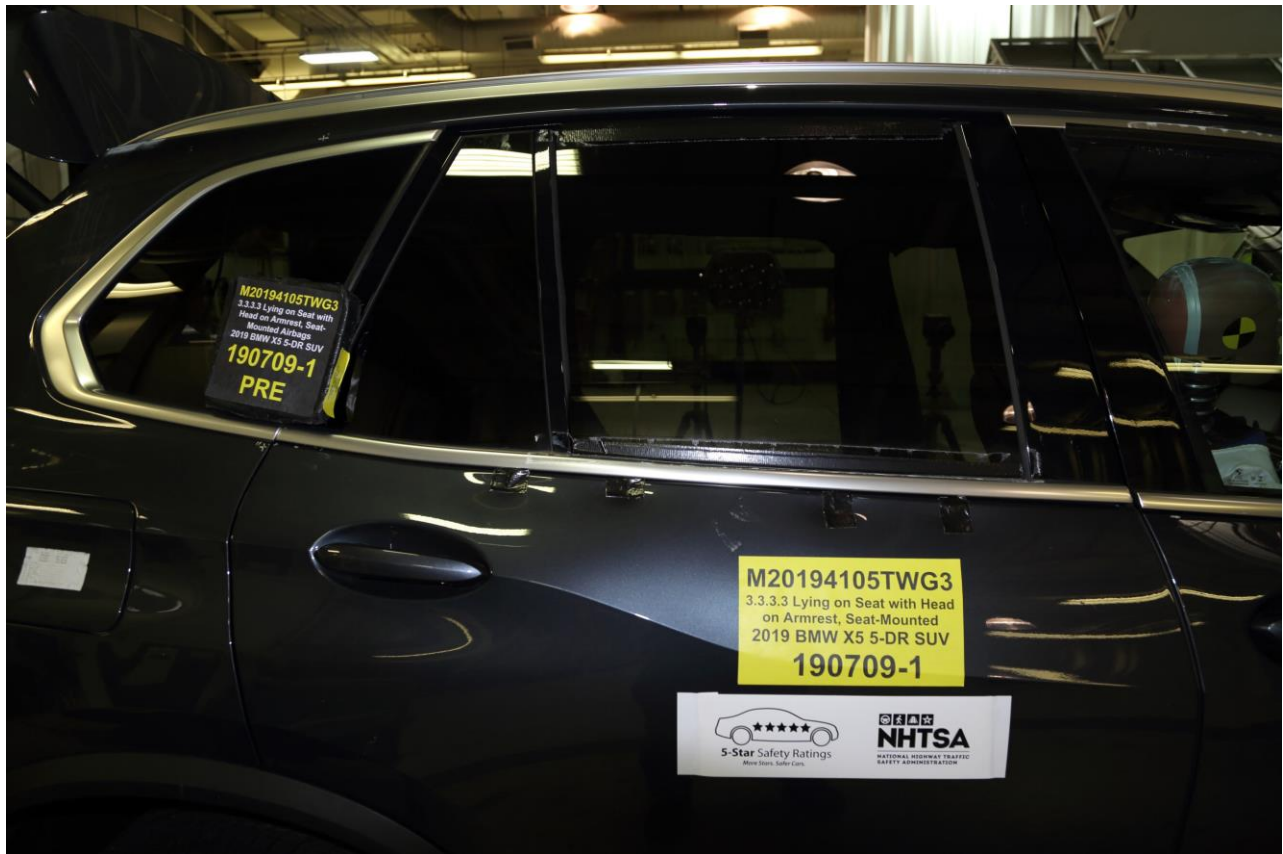


Figure A-23 Pre-Test Dummy Right Side Front View



Figure A-24 Post-Test Dummy Right Side Front View



**Figure A-25 Post-Test Dummy Right Side Front View**



**Figure A-26 Post-Test Curtain Air Bag Left Side View**



**Figure A-27 Post-Test Curtain Air Bag Left ¾ Front View**



**Figure A-28 Post-Test Curtain Air Bag Front View**



**Figure A-29 Post-Test Curtain Air Bag Right Side View**

**APPENDIX B**  
**DUMMY RESPONSE DATA PLOTS**

<u>No.</u>	<u>List of Data Plots Provided in the Test Report</u>	<u>Page</u>
1	Dummy Head Acceleration (X) Primary vs. Time	B-3
2	Dummy Head Acceleration (Y) Primary vs. Time	B-3
3	Dummy Head Acceleration (Z) Primary vs. Time	B-3
4	Dummy Head Resultant Acceleration Primary vs. Time	B-3
5	Dummy Head Acceleration (X) Redundant vs. Time	B-4
6	Dummy Head Acceleration (Y) Redundant vs. Time	B-4
7	Dummy Head Acceleration (Z) Redundant vs. Time	B-4
8	Dummy Head Resultant Acceleration Redundant vs. Time	B-4
9	Dummy Upper Neck Force X vs. Time	B-5
10	Dummy Upper Neck Force Y vs. Time	B-5
11	Dummy Upper Neck Force Z vs. Time	B-5
12	Dummy Upper Neck Force Resultant vs. Time	B-5
13	Dummy Upper Neck Moment X vs. Time	B-6
14	Dummy Upper Neck Moment Y vs. Time	B-6
15	Dummy Upper Neck Moment Z vs. Time	B-6
16	Dummy Upper Neck Moment Resultant vs. Time	B-6
17	Dummy Lower Neck Force X vs. Time	B-7
18	Dummy Lower Neck Force Y vs. Time	B-7
19	Dummy Lower Neck Force Z vs. Time	B-7
20	Dummy Lower Neck Force Resultant vs. Time	B-7
21	Dummy Lower Neck Moment X vs. Time	B-8
22	Dummy Lower Neck Moment Y vs. Time	B-8
23	Dummy Lower Neck Moment Z vs. Time	B-8
24	Dummy Lower Neck Moment Resultant vs. Time	B-8
25	NIJ vs. Time	B-9
26	Airbag Event Right Side Passenger Seat (V) vs. Time	B-10
27	Airbag Event Right Side Passenger Curtain (V) vs. Time	B-10
28	Airbag Event Right Side Passenger Seat (A) vs. Time	B-10
29	Airbag Event Right Side Passenger Curtain (A) vs. Time	B-10



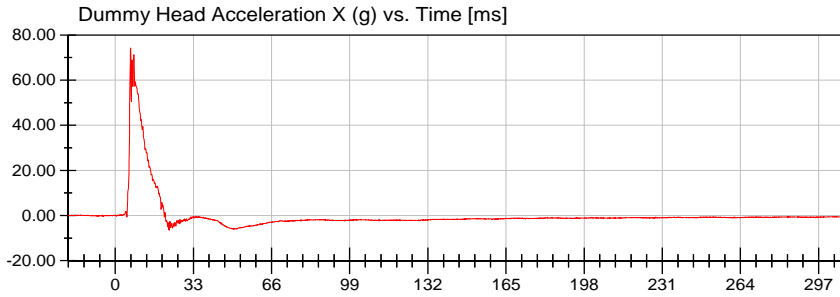
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



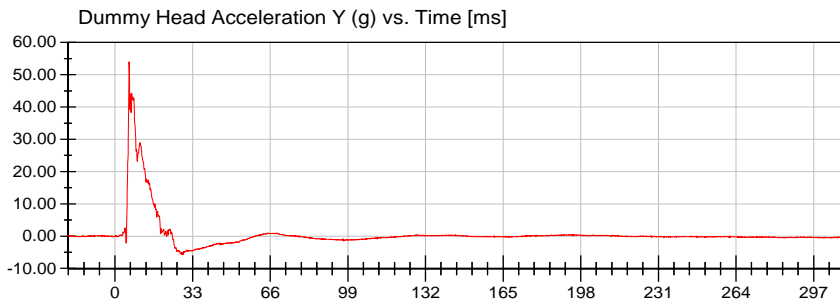
**<Max>**

74.22 g at 6.48 ms

**<Min>**

-6.58 g at 22.72 ms

CFC\_1000



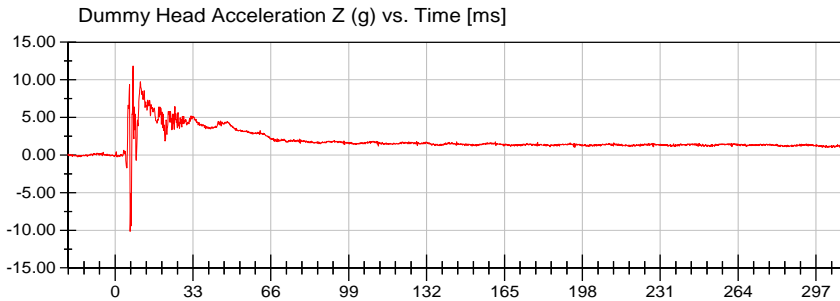
**<Max>**

53.99 g at 6.00 ms

**<Min>**

-5.78 g at 28.88 ms

CFC\_1000



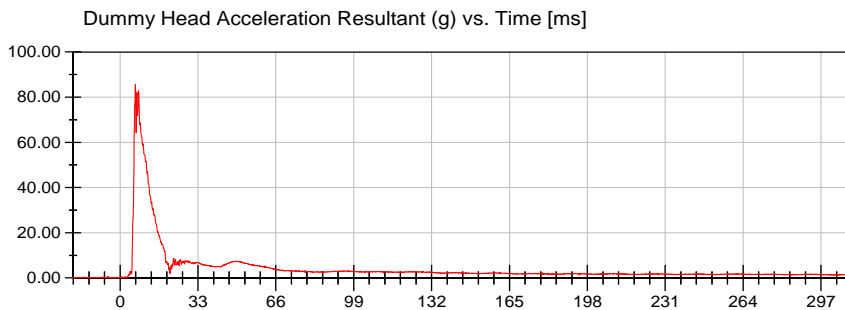
**<Max>**

11.83 g at 7.60 ms

**<Min>**

-10.13 g at 6.40 ms

CFC\_1000



**<Max>**

85.53 g at 6.48 ms

**<Min>**

0.03 g at -19.52 ms

CFC\_1000



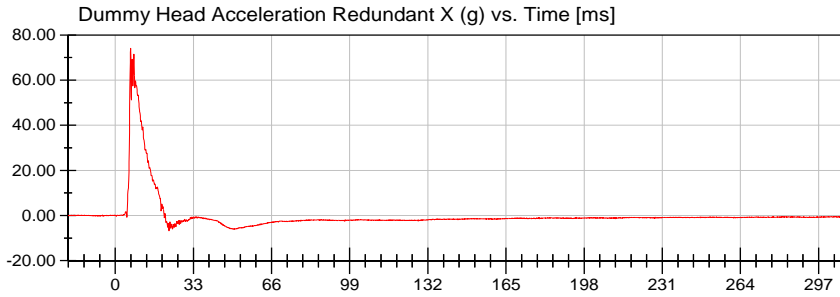
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



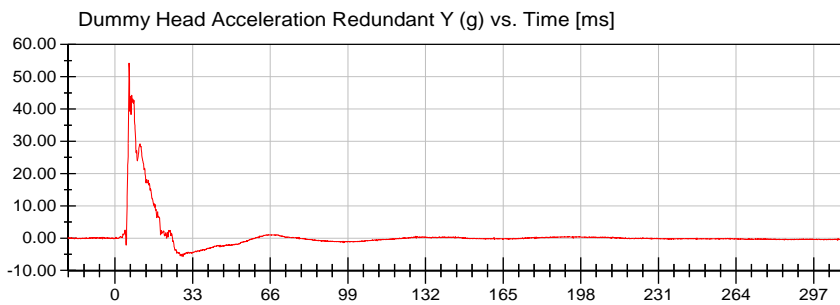
**<Max>**

74.13 g at 6.48 ms

**<Min>**

-6.81 g at 22.72 ms

CFC\_1000



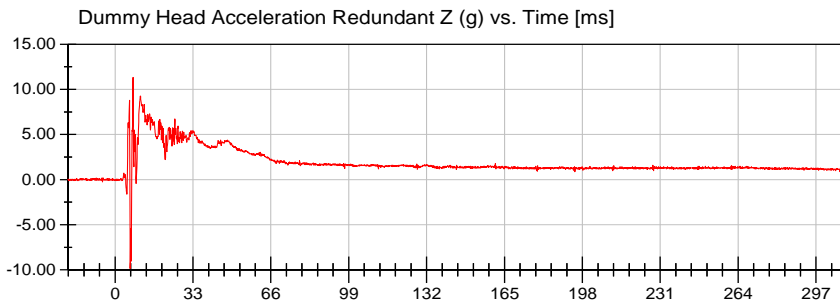
**<Max>**

54.18 g at 6.00 ms

**<Min>**

-5.70 g at 28.88 ms

CFC\_1000



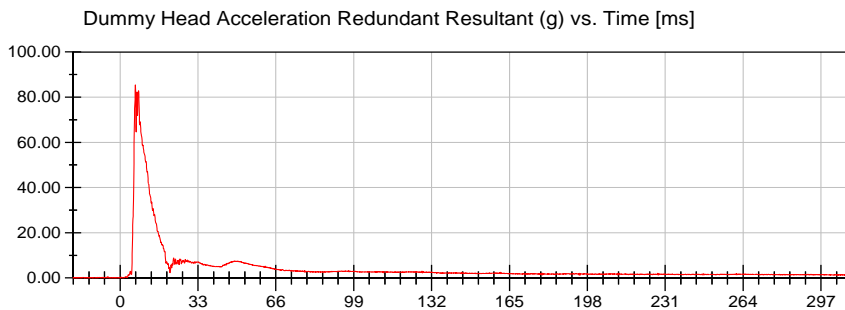
**<Max>**

11.32 g at 7.60 ms

**<Min>**

-9.84 g at 6.40 ms

CFC\_1000



**<Max>**

85.47 g at 6.48 ms

**<Min>**

0.04 g at -18.80 ms

CFC\_1000



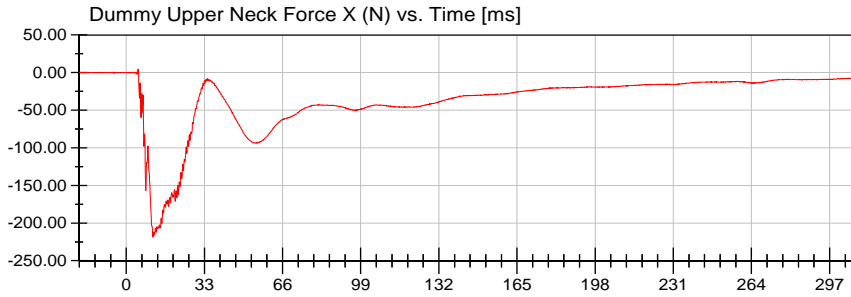
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



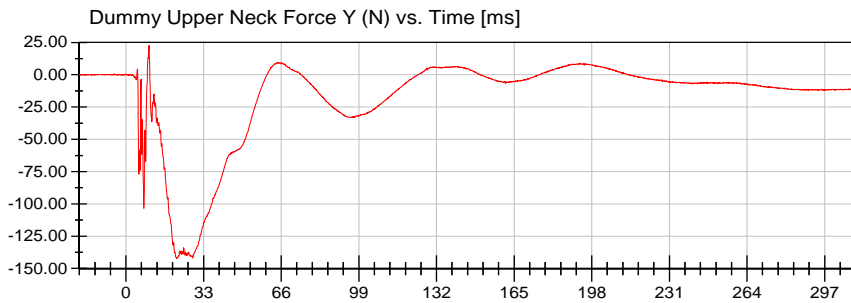
**<Max>**

4.35 N at 4.96 ms

**<Min>**

-218.68 N at 11.28 ms

CFC\_1000



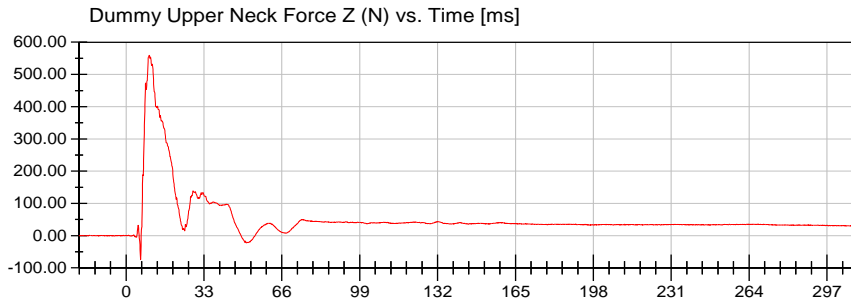
**<Max>**

22.72 N at 9.76 ms

**<Min>**

-142.41 N at 21.60 ms

CFC\_1000



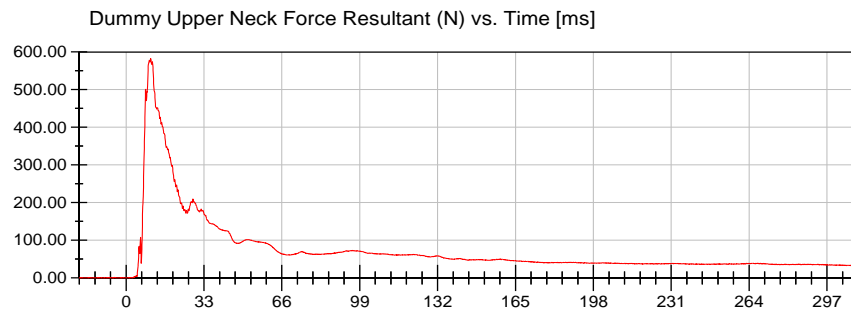
**<Max>**

559.70 N at 9.84 ms

**<Min>**

-73.96 N at 6.16 ms

CFC\_1000



**<Max>**

582.74 N at 10.40 ms

**<Min>**

0.09 N at -18.48 ms

CFC\_1000



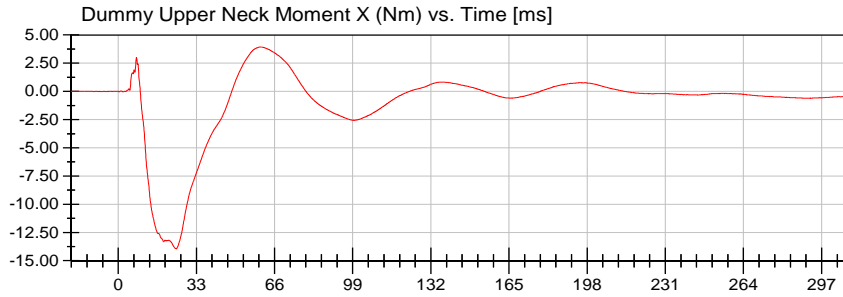
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



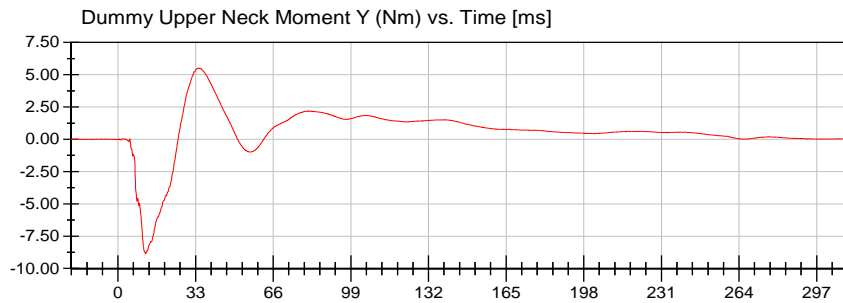
**<Max>**

3.93 Nm at 60.00 ms

**<Min>**

-13.94 Nm at 24.48 ms

CFC\_600



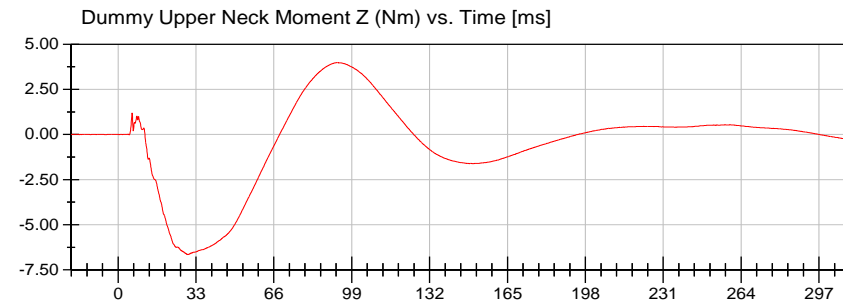
**<Max>**

5.52 Nm at 34.40 ms

**<Min>**

-8.84 Nm at 11.84 ms

CFC\_600



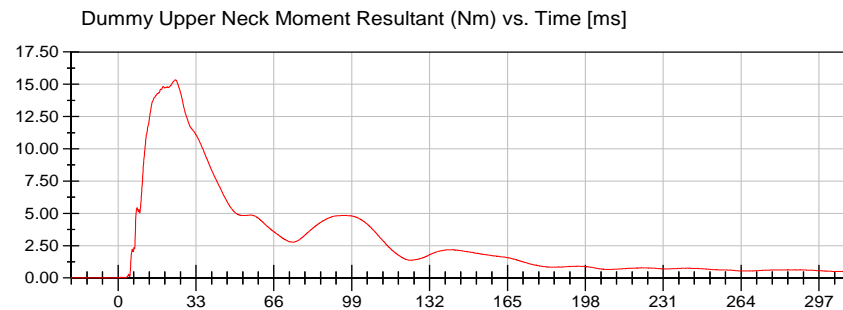
**<Max>**

3.98 Nm at 92.80 ms

**<Min>**

-6.65 Nm at 29.52 ms

CFC\_600



**<Max>**

15.34 Nm at 24.16 ms

**<Min>**

0.00 Nm at -20.00 ms

CFC\_600



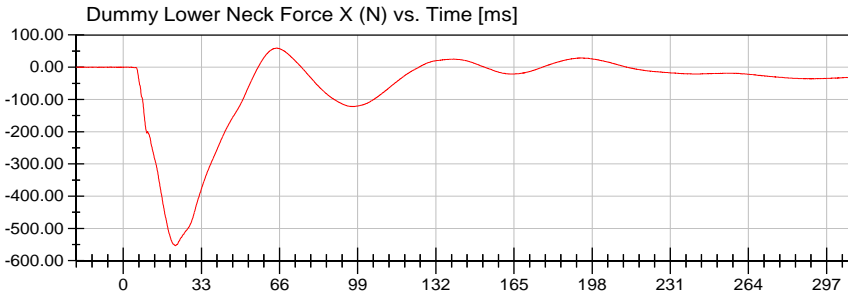
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



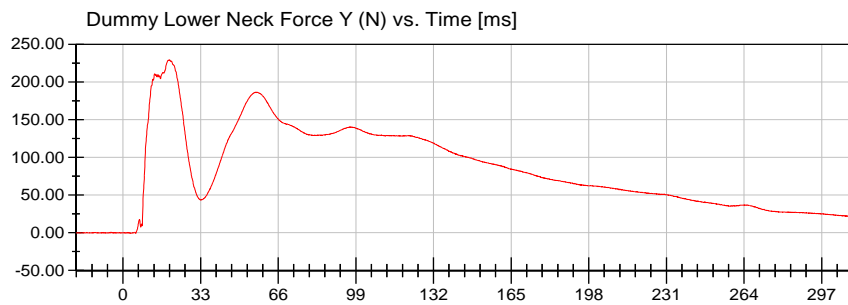
**<Max>**

59.26 N at 64.64 ms

**<Min>**

-553.53 N at 22.00 ms

CFC\_1000



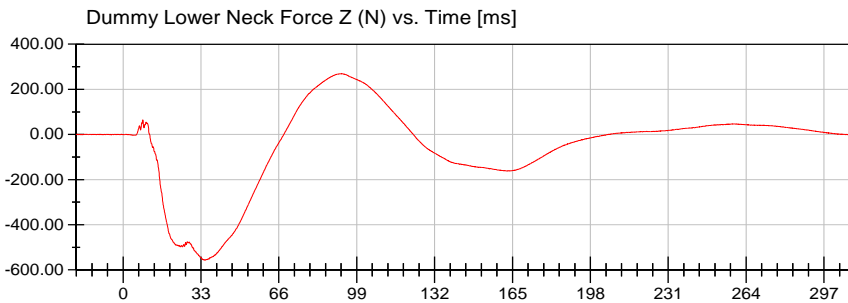
**<Max>**

229.57 N at 19.76 ms

**<Min>**

-0.71 N at 5.36 ms

CFC\_1000



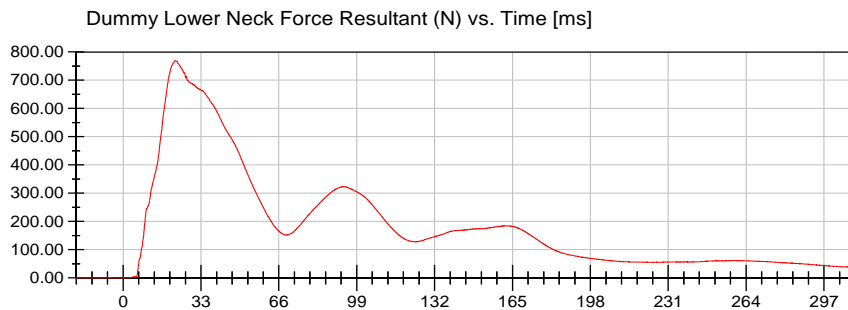
**<Max>**

269.36 N at 92.48 ms

**<Min>**

-556.67 N at 34.64 ms

CFC\_1000



**<Max>**

768.77 N at 22.24 ms

**<Min>**

0.07 N at -18.24 ms

CFC\_1000



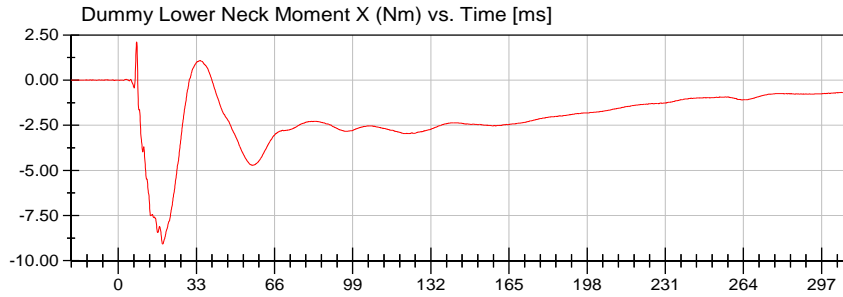
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



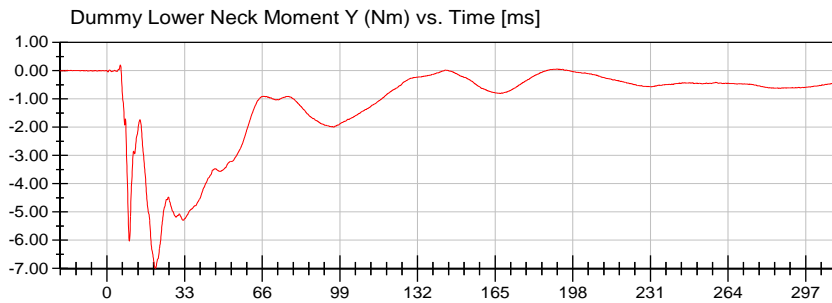
**<Max>**

2.11 Nm at 7.76 ms

**<Min>**

-9.08 Nm at 18.80 ms

CFC\_600



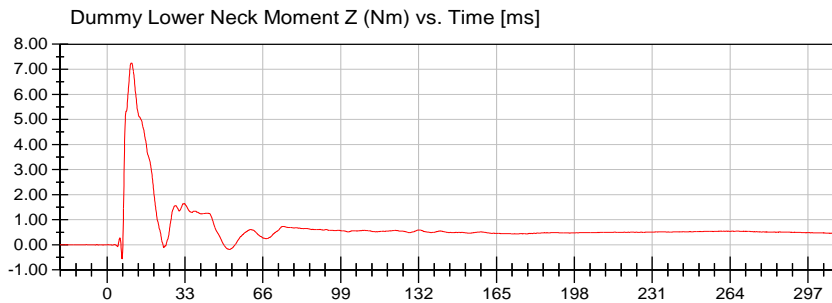
**<Max>**

0.20 Nm at 5.68 ms

**<Min>**

-6.99 Nm at 20.56 ms

CFC\_600



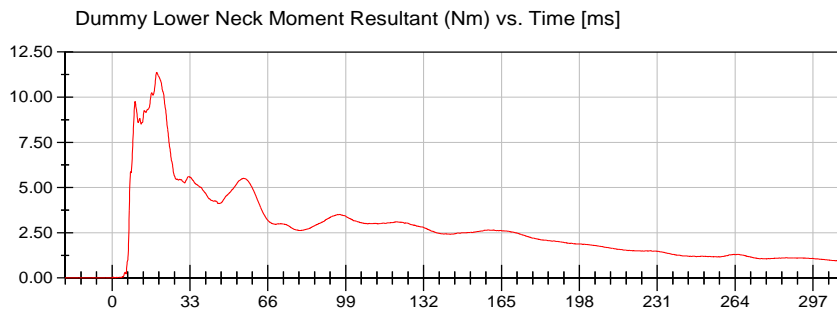
**<Max>**

7.24 Nm at 10.32 ms

**<Min>**

-0.56 Nm at 6.32 ms

CFC\_600



**<Max>**

11.36 Nm at 18.88 ms

**<Min>**

0.00 Nm at -0.08 ms

CFC\_600





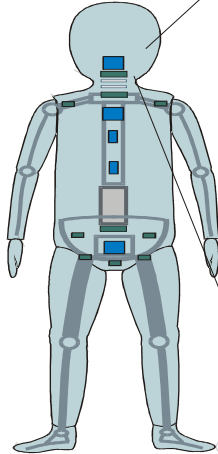
# 2019 BMW X5 5-DR SUV TWG OOP Test 3.3.3.3

Date: 07/09/2019  
Time: 13:25

## Neck Injury Predictor (NIJ)

**Customer: Alpha Technology**  
**Test Number: M20194105TWG3**

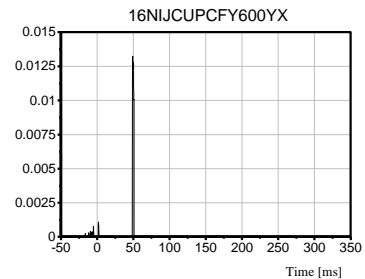
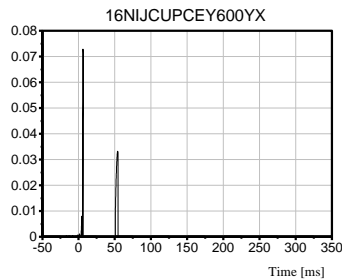
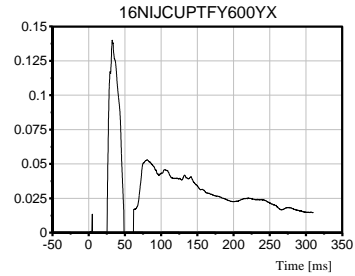
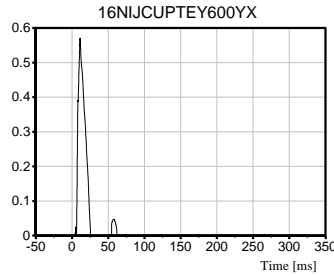
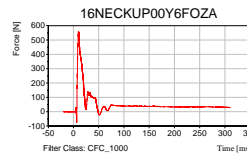
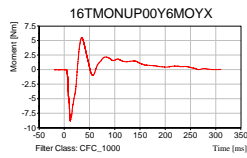
Test Orientation = Frontal  
Fzc(Tension) = 2120  
Fzc(Compression) = 2120  
Myc(Extension) = 27  
Myc(Flexion) = 68



Dummy: HIII 3 Year Old  
Seating Position:  
Right Rear Passenger

NIJ Source Code: (Fz/Fzc)+(Myc/Myc)

**TRC Inc. Test Lab: CTF**  
**Test Number: 190709-1**



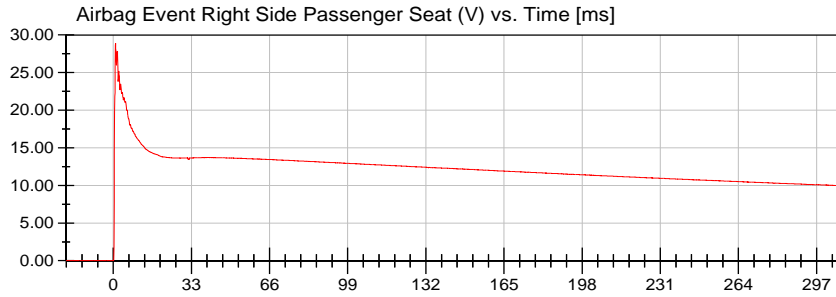
# Alpha Technology

Test Lab: CTF

Test Number: 190709-1 (M20194105TWG3)

Test Date: 07/09/2019

Position #3 Hybrid III 3 year old Dummy (Part 572 P) (16Y6)



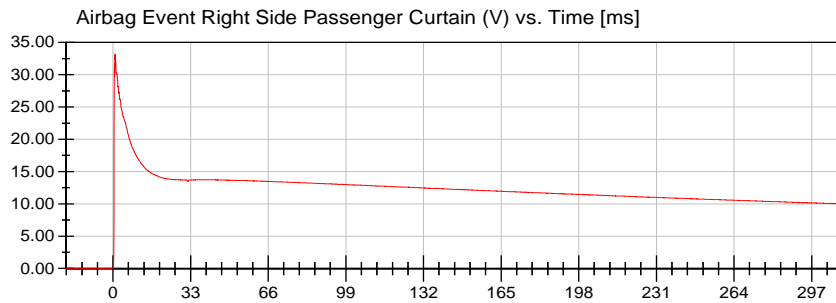
**<Max>**

28.88 V at 0.96 ms

**<Min>**

0.00 V at -20.00 ms

Unfiltered



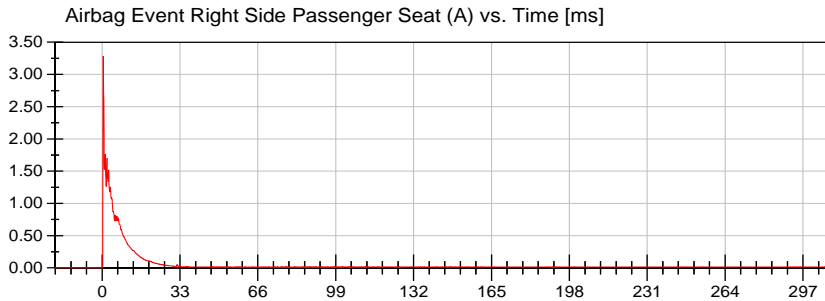
**<Max>**

33.18 V at 0.88 ms

**<Min>**

0.00 V at -20.00 ms

Unfiltered



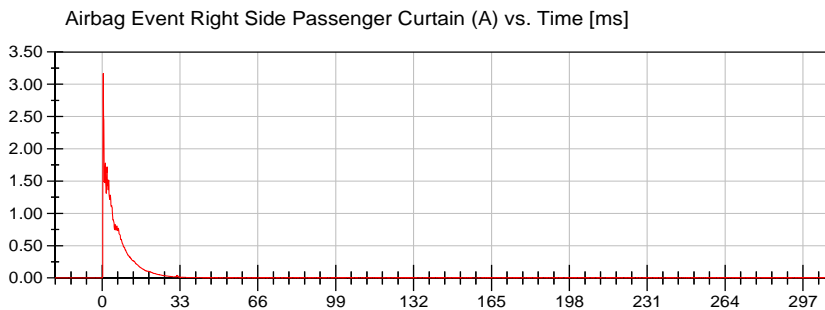
**<Max>**

3.28 A at 0.48 ms

**<Min>**

0.00 A at -20.00 ms

Unfiltered



**<Max>**

3.17 A at 0.48 ms

**<Min>**

0.00 A at -20.00 ms

Unfiltered





**APPENDIX C**  
**DUMMY QUALIFICATION DATA**

**Pre-Test Calibration Sheets**  
**Passenger S/N 040**

## Transportation Research Center Inc.

Front Head Drop  
HIII 3YO Serial No. 040 Certification No. 9-1  
Test Date: 6/26/2019

Test Parameter	Specification	Test Results	Pass
Temperature	18.9 - 25.6 °C	21.0 °C	Yes
Relative Humidity	10 - 70 %	59 %	Yes
Peak Head Resultant Acceleration	250 - 280 g	277.0 g	Yes
Peak Head Lateral Acceleration	(-15) - 15 g	-9.6 g	Yes
Is Acceleration Curve Unimodal?	< 10 %	5.07 %	Yes

**Test meets specifications.**

**Condition: Used**

**Comments:**

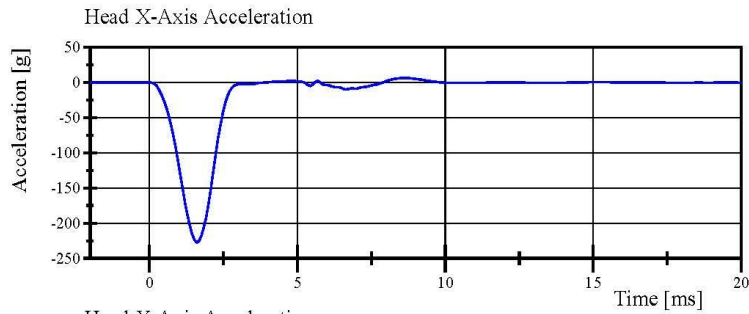
**Head Skin S/N: N/A**

# Transportation Research Center Inc.

Front Head Drop

HIII 3YO Serial No. 040 Certification No. 9-1

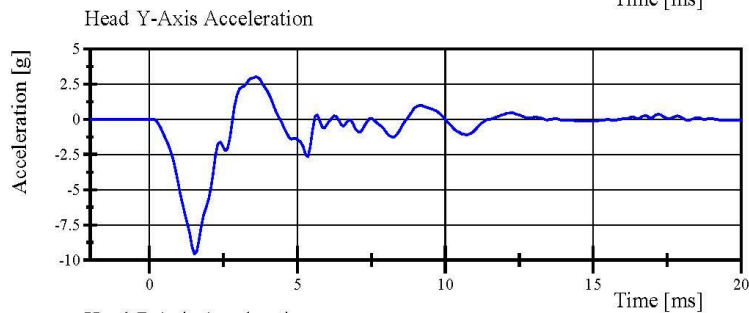
Test Date: 6/26/2019



Filter Class: CFC\_1000

Max: 6.6 g at 8.6 ms

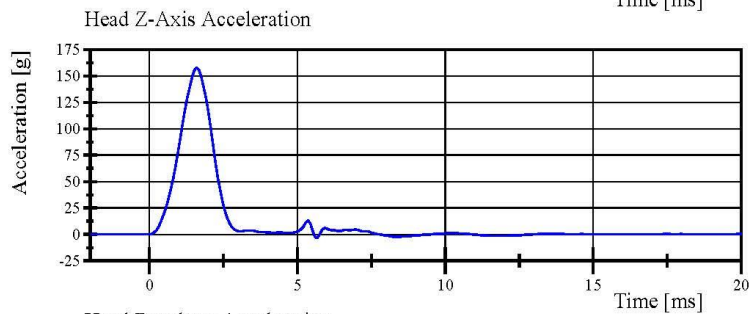
Min: -227.3 g at 1.6 ms



Filter Class: CFC\_1000

Max: 3.0 g at 3.6 ms

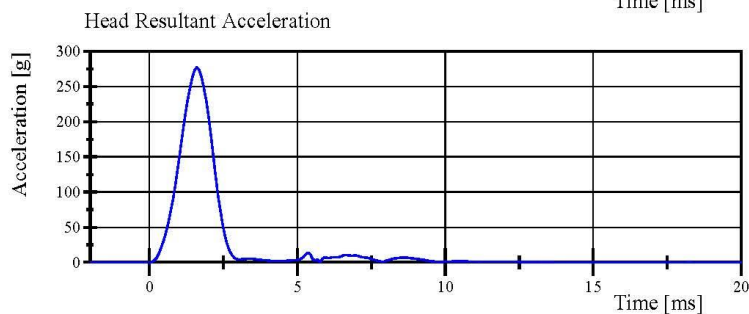
Min: -9.6 g at 1.5 ms



Filter Class: CFC\_1000

Max: 158.1 g at 1.6 ms

Min: -3.5 g at 5.7 ms



Filter Class: CFC\_1000

Max: 277.0 g at 1.6 ms

Min: 0.0 g at -2.0 ms

Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.26.2019 10:10:33 582



## Transportation Research Center Inc.

Neck Flexion

HIII 3YO Serial No. 040 Certification No. 9-2

Test Date: 6/27/2019

Test Parameter	Specification	Test Results	Pass
Temperature	20.6 - 22.2 °C	20.8 °C	Yes
Relative Humidity	10 - 70 %	58 %	Yes
Pendulum Impact Velocity	5.40 - 5.60 m/s	5.599 m/s	Yes
Pendulum Integrated Velocity Change at 10 ms	(-2.0) - (-2.7) m/s	-2.42 m/s	Yes
Pendulum Integrated Velocity Change at 15 ms	(-3.0) - (-4.0) m/s	-3.49 m/s	Yes
Pendulum Integrated Velocity Change at 20 ms	(-4.0) - (-5.1) m/s	-4.68 m/s	Yes
Total Headform D-Plane Rotation	(-70) - (-82) °	-79.2 °	Yes
Peak Neck Occipital Condyles Moment	42 - 53 Nm	44.4 Nm	Yes
Neck Occipital Condyles Moment Decay to 10 Nm	60 - 80 ms	74.6 ms	Yes

**Test meets specifications.**

**Condition: New**

**Comments:**

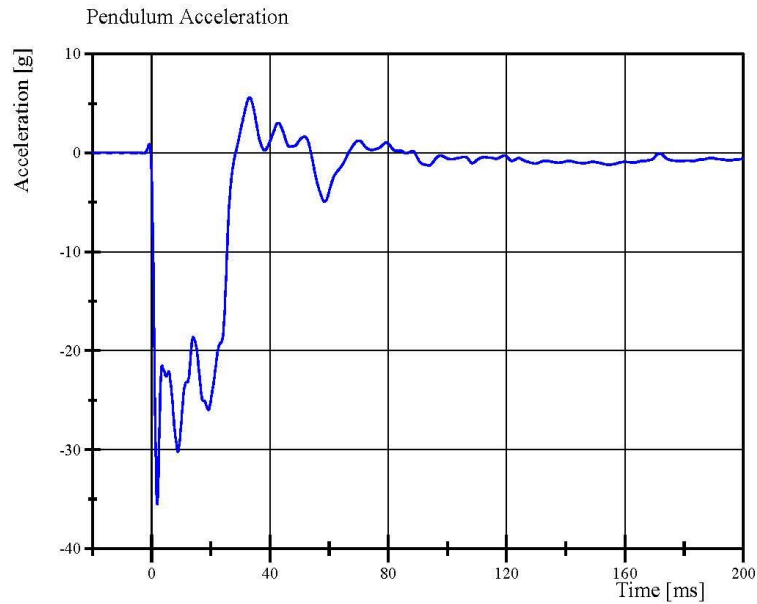
**Neck S/N: 160308**

# Transportation Research Center Inc.

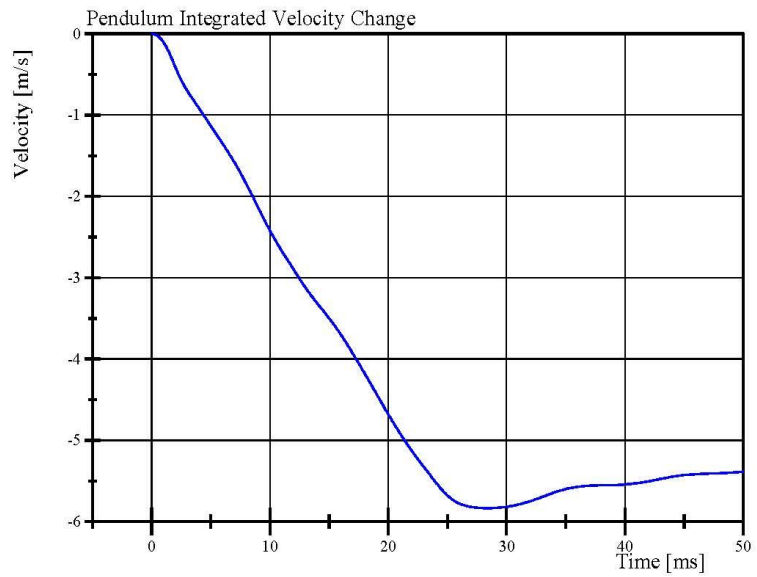
Neck Flexion

HIII 3YO Serial No. 040 Certification No. 9-2

Test Date: 6/27/2019



Filter Class: CFC\_180  
Max: 5.6 g at 33.1 ms  
Min: -35.5 g at 1.9 ms



Filter Class: CFC\_180  
Max: 0.0 m/s at 0.0 ms  
Min: -5.8 m/s at 28.4 ms

Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.27.2019 11:30:31 633

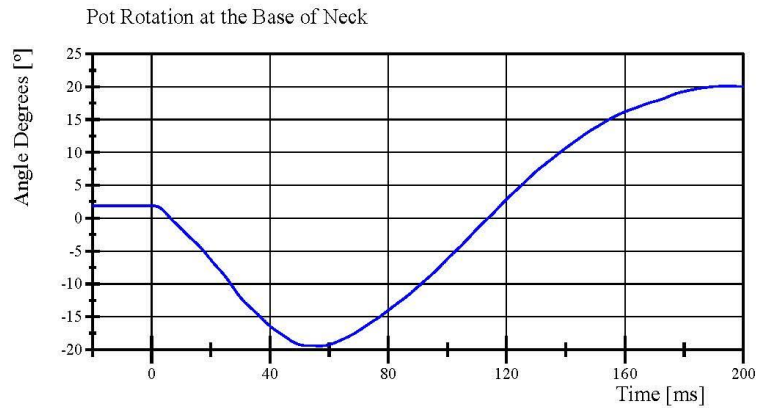


# Transportation Research Center Inc.

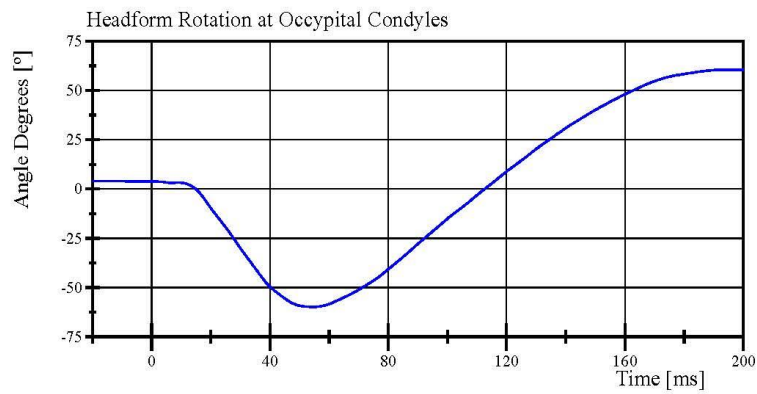
Neck Flexion

HIII 3YO Serial No. 040 Certification No. 9-2

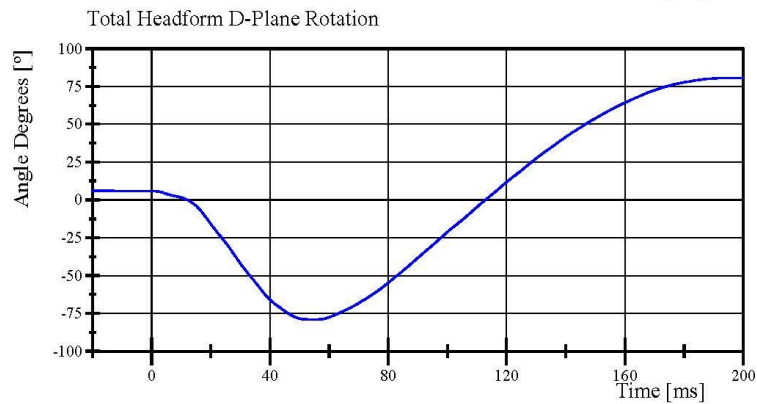
Test Date: 6/27/2019



Filter Class: CFC\_60  
Max: 20.1 ° at 194.2 ms  
Min: -19.5 ° at 56.7 ms



Filter Class: CFC\_60  
Max: 60.5 ° at 197.1 ms  
Min: -59.7 ° at 54.7 ms



Filter Class: CFC\_60  
Max: 80.6 ° at 195.0 ms  
Min: -79.2 ° at 55.0 ms

Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.27.2019 11:30:31 633

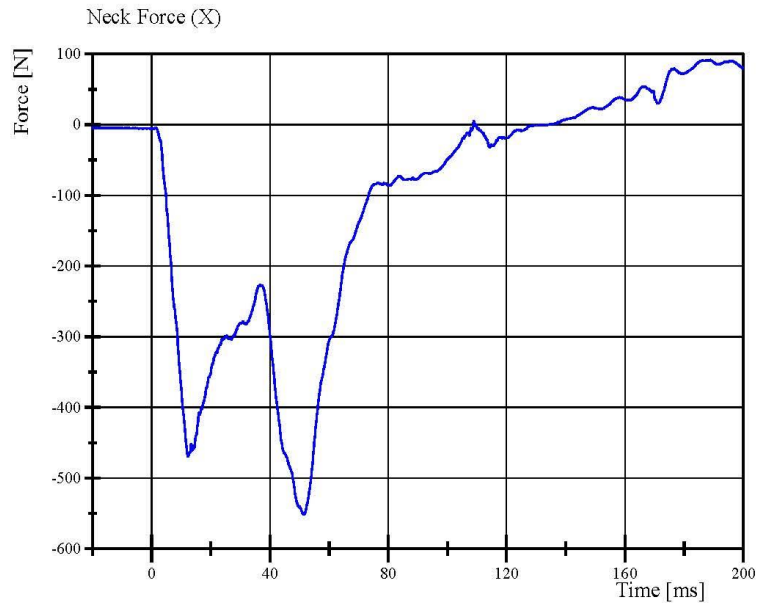


# Transportation Research Center Inc.

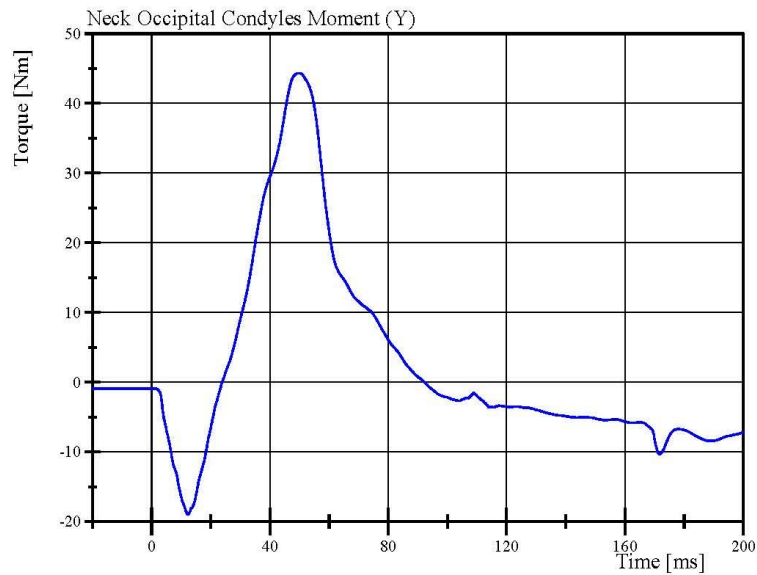
Neck Flexion

HIII 3YO Serial No. 040 Certification No. 9-2

Test Date: 6/27/2019



Filter Class: CFC\_1000  
Max: 91.5 N at 188.8 ms  
Min: -551.4 N at 51.4 ms



Filter Class: CFC\_600  
Max: 44.4 Nm at 49.8 ms  
Min: -19.0 Nm at 12.3 ms

Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.27.2019 11:30:32 633





## Transportation Research Center Inc.

Neck Extension

HIII 3YO Serial No. 040 Certification No. 9-1

Test Date: 6/27/2019

Test Parameter	Specification	Test Results	Pass
Temperature	20.6 - 22.2 °C	21.0 °C	Yes
Relative Humidity	10 - 70 %	60 %	Yes
Pendulum Impact Velocity	(-3.55) - (-3.75) m/s	-3.745 m/s	Yes
Pendulum Integrated Velocity Change at 6 ms	1.0 - 1.4 m/s	1.25 m/s	Yes
Pendulum Integrated Velocity Change at 10 ms	1.9 - 2.5 m/s	2.26 m/s	Yes
Pendulum Integrated Velocity Change at 14 ms	2.8 - 3.5 m/s	3.19 m/s	Yes
Total Headform D-Plane Rotation	83 - 93 °	88.6 °	Yes
Peak Neck Occipital Condyles Moment Neck Occipital Condyles Moment	(-43.7) - (-53.3) Nm	-45.39 Nm	Yes
Decay to 10 Nm	60 - 80 ms	70.2 ms	Yes

**Test meets specifications.**

**Condition: New**

**Comments:**

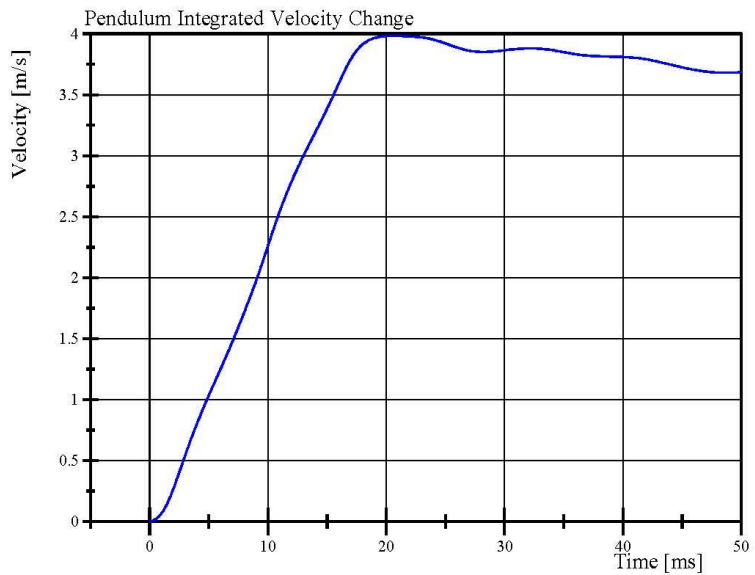
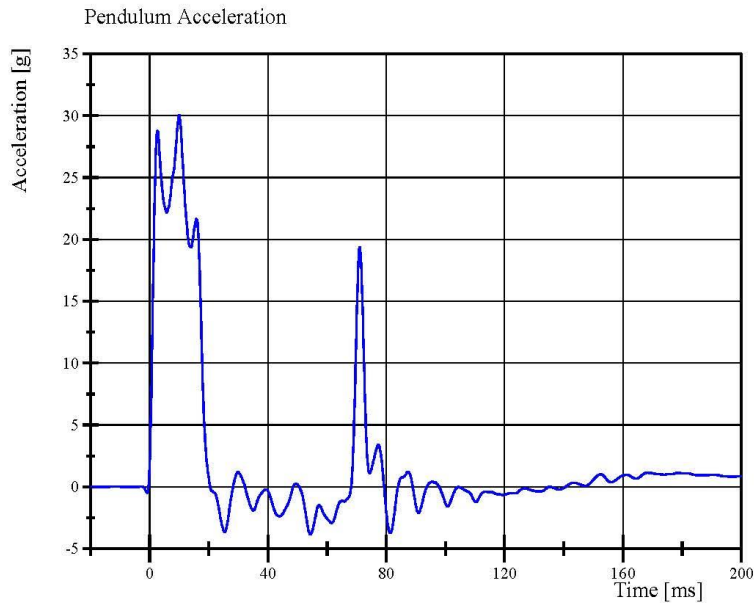
**Neck S/N: 160308**

# Transportation Research Center Inc.

Neck Extension

HIII 3YO Serial No. 040 Certification No. 9-1

Test Date: 6/27/2019



Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.27.2019 12:50:24 935

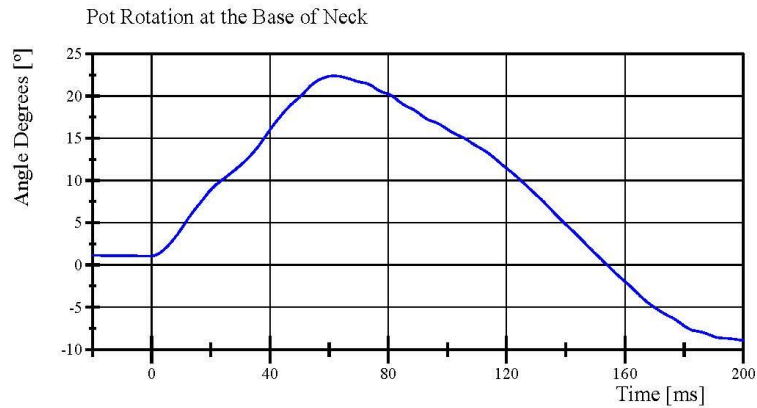


# Transportation Research Center Inc.

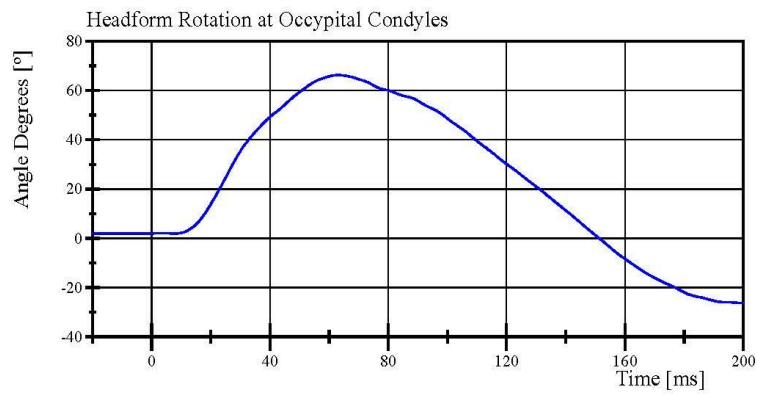
Neck Extension

HIII 3YO Serial No. 040 Certification No. 9-1

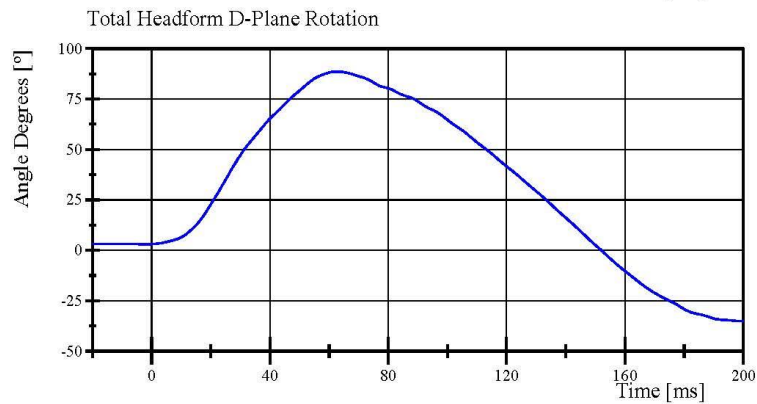
Test Date: 6/27/2019



Filter Class: CFC\_60  
Max: 22.4 ° at 61.7 ms  
Min: -8.9 ° at 200.0 ms



Filter Class: CFC\_60  
Max: 66.2 ° at 63.0 ms  
Min: -26.2 ° at 199.8 ms



Filter Class: CFC\_60  
Max: 88.6 ° at 62.6 ms  
Min: -35.1 ° at 200.0 ms

Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.27.2019 12:50:24 935

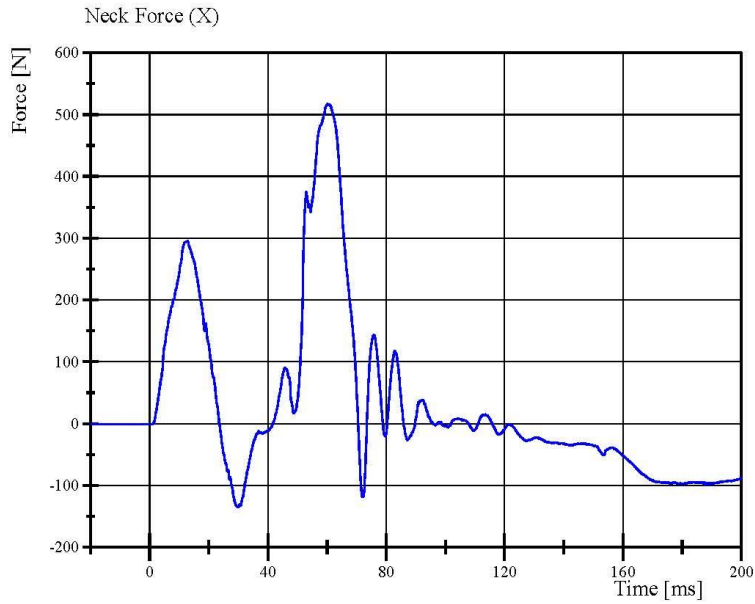


# Transportation Research Center Inc.

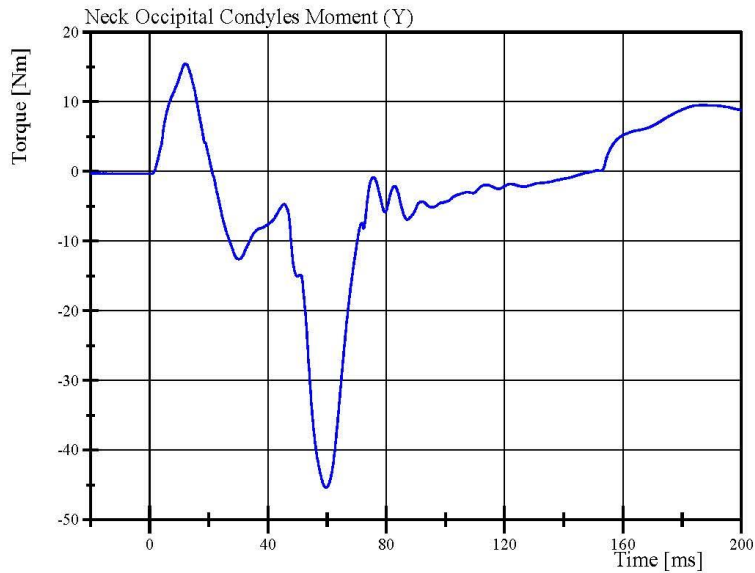
Neck Extension

HIII 3YO Serial No. 040 Certification No. 9-1

Test Date: 6/27/2019



Filter Class: CFC\_1000  
Max: 516.7 N at 60.2 ms  
Min: -134.7 N at 30.1 ms



Filter Class: CFC\_600  
Max: 15.4 Nm at 12.0 ms  
Min: -45.4 Nm at 59.7 ms

## Transportation Research Center Inc.

Front Thorax

HIII 3YO Serial No. 040 Certification No. 9-1

Test Date: 6/27/2019

Test Parameter	Specification	Test Results	Pass
Temperature	20.6 - 22.2 °C	21.4 °C	Yes
Relative Humidity	10 - 70 %	58 %	Yes
Probe Velocity	5.9 - 6.1 m/s	5.98 m/s	Yes
Probe Force Peak Between 32.0 mm and 38.0 mm Chest Deflection	(-680) - (-810) N	-743.3 N	Yes
Probe Force Peak Between 12.5 mm and 32.0 mm Chest Deflection	>= (-910) N	-738.7 N	Yes
Maximum Chest Compression	(-32) - (-38) mm	-34.7 mm	Yes
Internal Hysteresis	65 - 85 %	65.3 %	Yes

**Test meets specifications.**

**Condition: Used**

**Comments:**

**Torso Flesh S/N: 16312**

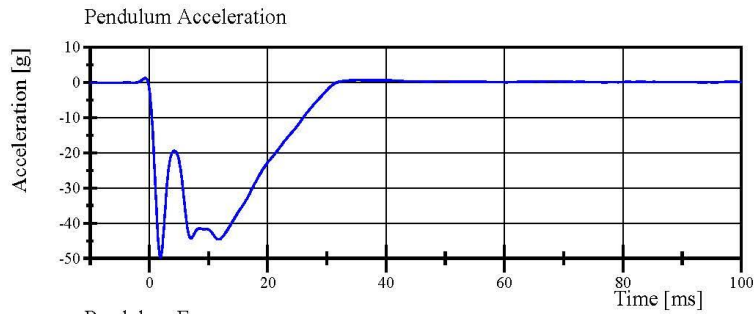
**Rib Set S/N: 16030071**

# Transportation Research Center Inc.

Front Thorax

HIII 3YO Serial No. 040 Certification No. 9-1

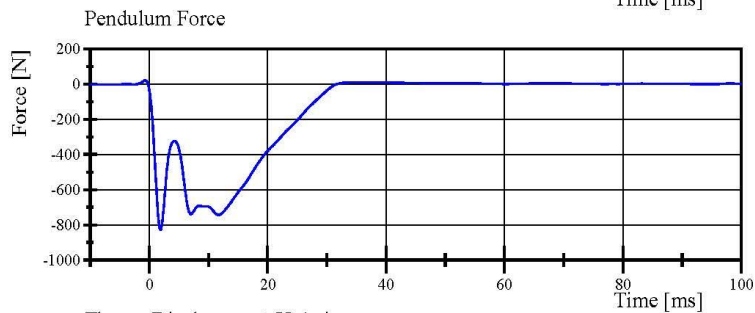
Test Date: 6/27/2019



Filter Class: CFC\_180

Max: 1.3 g at -0.7 ms

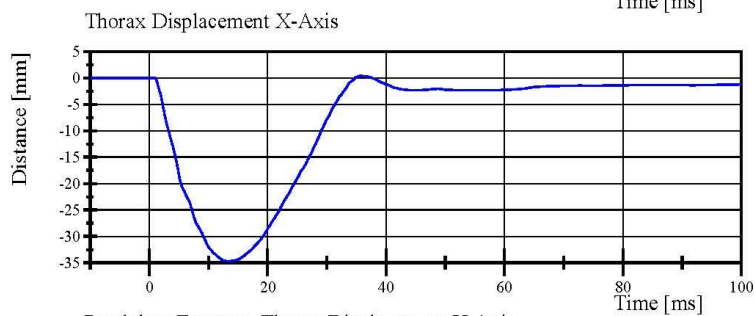
Min: -49.7 g at 1.9 ms



Filter Class: CFC\_180

Max: 20.9 N at -0.7 ms

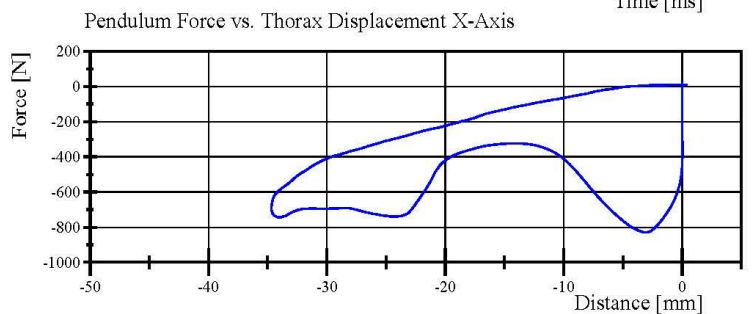
Min: -829.1 N at 1.9 ms



Filter Class: CFC\_600

Max: 0.4 mm at 35.6 ms

Min: -34.7 mm at 13.4 ms



Filter Class: CFC\_180

Max: 20.9 N at -0.0 mm

Min: -829.1 N at -3.2 mm

Specification Source: CFR49 Part 572 Subpart P  
with Polarity in accordance with J211

06.27.2019 15:19:56 416



**APPENDIX D**

**TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION**

			<b>Serial Number</b>	<b>Manufacturer and Model #</b>	<b>Calibration Date</b>	<b>Date Due</b>
ATD		N/A	040	FTSS	27-Jun-2019	
Head Accelerometers	Primary	X	P97685	Endevco	26-Jun-2019	26-Dec-2019
		Y	P97528	Endevco	26-Jun-2019	26-Dec-2019
		Z	P97862	Endevco	27-Jun-2019	27-Dec-2019
	Redundant	X	P97696	Endevco	26-Jun-2019	27-Dec-2019
		Y	P97533	Endevco	26-Jun-2019	26-Dec-2019
		Z	P97531	Endevco	26-Jun-2019	26-Dec-2019
Upper Neck Load Cell		Fx, Fy, Fz, Mx, My, Mz	214	Denton	26-Jun-2019	25-Jun-2020
Lower Neck Load Cell		Fx, Fy, Fz, Mx, My, Mz	210	Denton	26-Jun-2019	25-Jun-2020
Chest Potentiometer		Dx				
Sternum Accelerometer		X				
Spine Accelerometer		X				
Data System		N/A	223	Kayser-Threde	9-Jul-2019	
Inclinometer		N/A	DP-7	Mitutoyo Pro 360	19-Oct-2018	19-Oct-2019