REPORT NUMBER: NCAP-KAR-21-010

NEW CAR ASSESSMENT PROGRAM (NCAP)
FRONTAL BARRIER IMPACT TEST

BAYERISCHE MOTOREN WERKE AG
2021 BMW 330I XDRIVE 4-DOOR SEDAN

NHTSA NUMBER: M20214100

PREPARED BY:
APPLUS+ IDIADA KARCO ENGINEERING, LLC.
9270 HOLLY ROAD
ADELANTO, CA 92301

JUNE 28, 2021

FINAL REPORT

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
OFFICE OF CRASHWORTHINESS STANDARDS
1200 NEW JERSEY AVE, SE
ROOM W43-410
WASHINGTON, DC 20590

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Approval Date: June 28, 2021

FINAL REPORT ACCEPTANCE BY OCWS:

_____

Division Chief, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

Date: _____

_____

COTR, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

Date: _____

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Final Report of New Car Assessment Program Frontal Impact Testing of a 2021 BMW 330i xDrive 4-Door Sedan NHTSA No. M20214100	June 28, 2021 **6. Performing Organization Code** KAR
7. Authors Mr. Amjad A. Jadallah, Project Manager, Applus+ IDIADA KARCO Mr. Steven D. Matsusaka, Engineering Manager, Applus+ IDIADA KARCO	**8. Performing Organization Report No.** TR-P41056-01-NC
9. Performing Organization Name and Address Applus+ IDIADA KARCO Engineering, LLC. 9270 Holly Rd. Adelanto, CA 92301	**10. Work Unit No.** **11. Contract or Grant No.** 693JJ919D000004
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15. Supplementary Notes

16. Abstract

A 56.3 km/h NCAP Frontal Impact Test was conducted on a 2021 BMW 330i xDrive 4-Door Sedan in accordance with the specifications of the Office of Crashworthiness Standards Frontal NCAP Laboratory Test Procedure. The test was conducted at the Applus+ IDIADA KARCO Engineering, LLC. facility in Adelanto, California on March 17, 2021.

The impact velocity of the vehicle was 56.35 km/h and the ambient temperature at the barrier face at the time of impact was 16.7°C. The target vehicle's post-test maximum crush was 445mm at DPD2 to the left of the vehicle's centerline. The test vehicle's performance is as follows:

Measurement Description	Units	Driver ATD		Passenger ATD	
		Threshold	Result	Threshold	Result
Head Injury Criteria (HIC_{15})	N/A	700	145.4	700	251.8
Maximum Chest Compression	mm	63	-28	52	-14
Nij	N/A	1	0.23	1	0.33
Neck Tension	N	4170	922.3	2620	755.0
Neck Compression	N	4000	-140.2	2520	-331.3
Left Femur Force	N	10000	-895.0	6800	-887.6
Right Femur Force	N	10000	-1022.3	6800	-1502.7

17. Key Words	18. Distribution Statement
56.3 km/h (35 mph) Full Frontal Rigid Barrier Impact Test New Car Assessment Program (NCAP)	National Highway Traffic Safety Administration Technical Information Services Division 1200 New Jersey Ave, SE Washington, DC 20590

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SECTION 1
PURPOSE AND SUMMARY OF TEST

PURPOSE

This 56.3 km/h frontal barrier impact test is part of the Vehicle Barrier Impact Testing Program, sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number 693JJ919D000004. The purpose of this test was to obtain vehicle crashworthiness and occupant restraint system performance data for consumer information purposes.

The 56.3 km/h frontal barrier impact test was conducted in accordance with the Office of Crashworthiness Standards Laboratory Procedure dated May 2018 for NCAP Full Frontal Rigid Barrier Impact Testing.

SUMMARY

A load cell barrier consisting of 176 load cells was impacted by a 2021 BMW 330i xDrive 4-Door Sedan at a velocity of 56.35 km/h. The test was performed at Applus+ IDIADA KARCO Engineering, LLC. on March 17, 2021. Pre- and post-test photographs of the vehicle and dummies can be found in Appendix A of this report.

One (1) real-time cameras and sixteen (16) high-speed cameras were used to document the frontal barrier impact event. Camera locations and other pertinent camera information can be found in Data Sheet 6 of this report.

One Part HIII 50th percentile male anthropomorphic test device (ATD) was placed in the driver seating position and one Part HIII 5th percentile female ATD was placed in the right-front passenger seating position according to dummy placement instructions specified in the Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing.

Both ATDs were fully instrumented with head, chest and pelvis tri-axial accelerometers, chest displacement potentiometers, upper neck force transducers, right / left femur load cells, and lower leg instrumentation.

The driver (position 1) ATD (Serial No. 360) and the right-front passenger (position 2) ATD (Serial No. DH1644) were qualified prior to this test. Certification details, along with instrumentation calibration data, are found in Appendix C of this report.

The 106 channels of dummy and vehicle response data were recorded on an on-board data acquisition system. Appendix B contains the dummy response data traces. Appendix D contains a complete list of instrumentation used for dummies and the vehicle.

There was 100 percent windshield retention and intrusion into the protected zone of the windshield during the event. There was no Stoddard solvent leakage after the event or during any phase of the static rollover.

The maximum static crush of the test vehicle was 445 mm at DPD2 to the left of the vehicle's centerline. Both the driver and passenger side doors remained closed during the impact event and were operable after the impact.

The driver's visible contact points were as follows: the driver ATD's head contacted the frontal airbag, curtain airbag, and headrest. The upper and lower torso contacted the frontal airbag. The left knee contacted the knee airbag. The right knee contacted the knee airbag and steering wheel rim.

The passenger's visible contact points were as follows: the passenger ATD's head contacted the frontal airbag, curtain airbag, and headrest. The upper and lower torso contacted the frontal airbag. Both left and right knees contacted the knee airbag.

The occupant data is summarized below:

ATD Position	HIC_{15}	Nij	Neck Tension (N)	Neck Comp. (N)	3ms Chest Clip (g)	Chest Disp. (mm)	Left Femur (N)	Right Femur (N)
Driver (50th Male)	145.4	0.23	922.3	-140.2	43	-28	-895.0	-1022.3
Passenger (5th Female)	251.8	0.33	755.0	-331.3	42	-14	-887.6	-1502.7

GENERAL COMMENTS:

- Left Rear Sill Ax, Channel Failed, No Data
- Barrier A-01 FX, MY, MZ, Channels Failed, No Data

SECTION 2

OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

CONVERSION FACTORS

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	miles/hr	km/hr	1.609344
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.574
Pressure	Tire Pressures	lbf/in^2	kPa	6.895
Temperature	General Use	^oF	^oC	=(Tf -32)/1.8
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET NO. 1

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA Number	M20214100
Model Year	2021
Make	BMW
Model	330i xDrive
Body Style	4-Door Sedan
VIN	WBA5R7C02MFK51022
Body Color	Mineral Grey Metallic
Odometer Reading (km / mi)	29 / 18
Engine Displacement (L)	2.0
Type / No. of Cylinders	Inline 4-Cylinder
Engine Placement	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
Automatic Door Locks (ADLs)	Yes

Traction Control System	Yes
Power Steering	Yes
Power Window Auto-Reverse	Yes
Driver Frontal 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
Front Pass. Frontal Airbag	Yes
Front Pass. Curtain Airbag	Yes
Front Pass. Head/Torso Airbag	No
Front Pass. Torso Airbag	No
Front Pass. Torso/Pelvis Airbag	Yes
Front Pass. Pelvis Airbag	No
Front Pass. Knee Airbag	Yes
Driver Seat Belt Pretensioner	Yes
Driver Load Limiter	Yes
Front Pass. Seat Belt Pretensioner	Yes
Front Pass. Load Limiter	Yes
Other Safety Restraint	No

Does Owner's Manual provide instructions to turn off automatic door locks?	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Bayerische Motoren Werke AG
Date of Manufacture	Oct-20

GVWR (kg)	2165
GAWR Front (kg)	1055
GAWR Rear (kg)	1180

VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

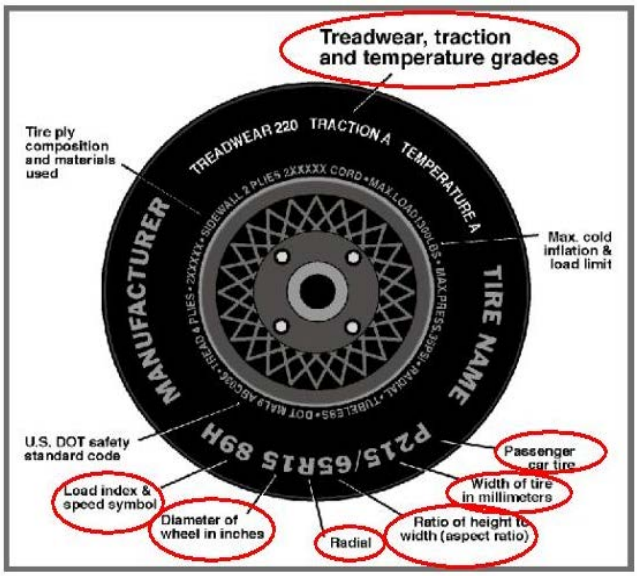
Measured Parameter	Front	Rear	Third	Total	
Type of Seats	Bucket	Split Bench			
Designated Seating Capacity	2	3		5	
Capacity Weight (VCW) (kg)				398.0	*A*
DSC x 68.04 (kg)				340.2	*B*
Cargo Weight (RCLW) (kg)				57.8	*A-B*

DATA SHEET NO. 1 … (CONTINUED)

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21



VEHICLE TIRE INFORMATION

Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	220	270
Recommended Tire Size	P225/45 R18	P225/45 R18
Tire Size on Vehicle	P225/45 R18	P225/45 R18
Tire Manufacturer	Continental	Continental
Tire Model	ProContact GX SSR	ProContact GX SSR
Treadwear	500	500
Traction	A	A
Temperature Grades	A	A
Tire Plies Sidewall	2 Polyester	2 Polyester
Tire Plies Body	1 Polyester, 2 Steel, 1 Polyamide	1 Polyester, 2 Steel, 1 Polyamide
Load Index / Speed Symbol	95H	95H
Tire Material	Polyester, Steel, Polyamide	Polyester, Steel, Polyamide
DOT Safety Code Left	6Y4F D8K5 1919	6Y4F D8K5 1919
DOT Safety Code Right	6Y4F D8K5 1919	6Y4F D8K5 1919

DATA SHEET NO. 1 … (CONTINUED)

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

TEST VEHICLE WEIGHTS

	Units	As Delivered Weights (UVW)			As Tested Weights (ATW)		
		Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total
Left	kg	414.5	412.0		458.5	474.5	
Right	kg	456.0	375.0		456.5	461.5	
Ratio	%	52.5%	47.5%	100.0%	49.4%	50.6%	100.0%
Total	kg	870.5	787.0	1657.5	915.0	936.0	1851.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total Delivered Weight (UVW)	kg	1657.5	A
Weight of 1 P572E ATD & 1 P572O ATD	kg	141.0	B
Rated Cargo/Luggage Weight (RCLW)	kg	57.8	C
Calculated Vehicle Target Weight (TVTW)	kg	1856.3	A+B+C

TEST VEHICLE ATTITUDES

Condition	Units	LF	RF	LR	RR	CG Aft of Front Axle
As Delivered	mm	725	725	720	725	1353
As Tested	mm	714	716	689	698	1441
Post-Test	mm	786	797	685	702	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheelbase	mm	2850
Total Vehicle Length at Left Side	mm	4070
Total Vehicle Length at Centerline	mm	4710
Total Vehicle Length at Right Side	mm	4070
Weight of Ballast in Cargo Area	kg	51.3
Weight of Vehicle Components Removed	kg	12.0
Amount of Stoddard Solvent in Fuel Tank	L	54.89

VEHICLE COMPONENTS REMOVED TO MEET TEST WEIGHT:

Rear trunk trim (3.0 kg), Rear Seat Cushion (6.0 kg), Taillights (1.0 kg), Rear Headrest (2.0 kg)

DATA SHEET NO. 1 … (CONTINUED)

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

TARGET VEHICLE STRUCTURAL MEASUREMENTS

No.	Description	Pre-Test
1	Total Length	4710
2	Total Width	1828
3	Bumper Top Height	533
4	Bumper Bottom Height	403
5	Longitudinal Member Top Height	510
6	Distance Between Longitudinal Members	790
7	Longitudinal Member Width	70
8	Engine Top Height	875
9	Engine Bottom Height	215
10	Engine and Gearbox Width	630
11	Front Bumper to Engine Distance	660
12	Front Shock Absorber Fixing Height	840
13	Bonnet Leading Edge Height	725
14	Front Shock Absorber Fixing Width	1173
15	Front Bumper to Front Axle Distance	790
16	Front Axle to A-Pillar Distance	674
17	A-Pillar to B-Pillar Distance	969
18	B-Pillar to Rear Axle Distance	1113
19	B-Pillar to C-Pillar Distance	786
20	Roof Sill Bottom Height	1295
21	Roof Sill Top Height	1415
22	Floor Sill Bottom Height	203
23	Floor Sill Top Height	410

All measurements in millimeters.

DATA SHEET NO. 2

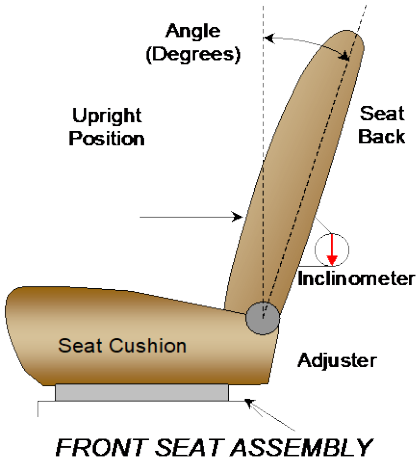
SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

NOMINAL DESIGN RIDING POSITION

The procedure for the driver is as follows: the seat back is set to the manufacturer's designated angle. The procedure for the passenger is as follows: the seat back is set to position the transverse instrumentation platform of the dummy's head at 0° ± 0.5°. Seat back angle is measured with a flat edge along the seat back.



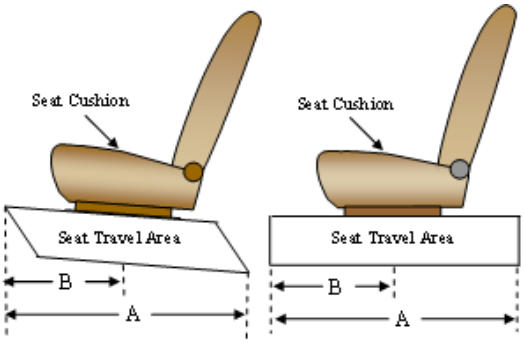
FRONT SEAT ASSEMBLY

SEAT BACK ANGLE

Seating Position	Degrees
Driver Seat Back Angle	25.5
Passenger Seat Back Angle	18.1

SEAT FORE / AFT POSITIONING

The total seat travel is measured from the forward most possible position to the rear most possible position. The driver's seat is set to the middle of the fore-aft travel. The passenger's seat is set to the forward most position where the ATD will not contact any interior panels.



SEAT FORE/AFT POSITIONS

Seating Position	Total Fore-Aft Travel	Placed in Position
Driver Seat	304 mm	152 mm
Passenger Seat	250 mm	0 mm

SEAT BELT UPPER ANCHORAGE

The seat belt upper anchorage is positioned to the manufacturer's design position for a 50th percentile adult male ATD for the driver, and a 5th percentile adult female ATD for the passenger. Position "L" is the lowermost position, followed by position "M1". Position "H" is the uppermost position.

SEAT BELT UPPER ANCHORAGES

Seating Position	Total No. of Positions	Placed in Position
Driver Seat	Fixed	Fixed
Passenger Seat	Fixed	Fixed

DATA SHEET NO. 2 … (CONTINUED)

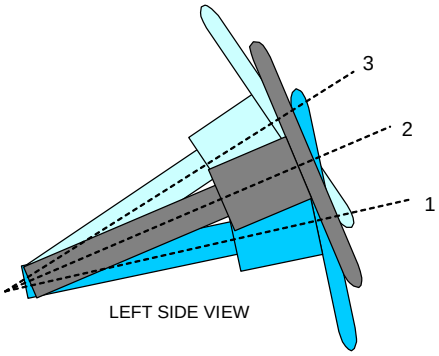
SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. A digital inclinometer is used to measure a plate which is placed across the rim of the steering wheel for angular measurements.



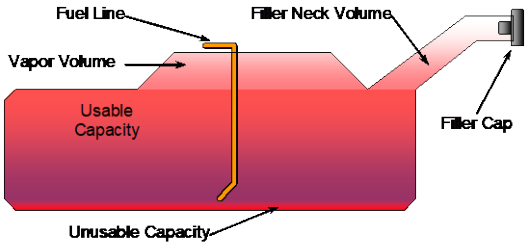
STEERING COLUMN ASSEMBLY

STEERING COLUMN POSITIONING

	Degrees	Fore-Aft Position (mm)
Lowermost Position, No. 1	18.4	70
Geometric Center Position, No. 2	20.1	99
Uppermost Position, No. 3	21.8	128
Telescoping Steering Wheel Travel		58
Test Position	20.1	99

FUEL PUMP

The vehicle is equipped with an electric fuel pump. The pump will work at “ignition on” until pressure in the system has reached working pressure in the system; then it will stop pumping fuel until the engine has been started.



VEHICLE FUEL TANK ASSEMBLY

FUEL TANK CAPACITY

Description	Liters
Usable Capacity of "Standard Tank" (see Form No. 1)	59.01
Usable Capacity of "Optional Tank" (see Form No. 1)	
Usable Capacity of "Standard Tank" (see Owner's Manual)	59.01
Usable Capacity of "Optional Tank" (see Owner's Manual)	
93% of Usable Capacity	54.88
Actual amount of Solvent Used in Test	54.88
1/3 of Usable Capacity	19.67

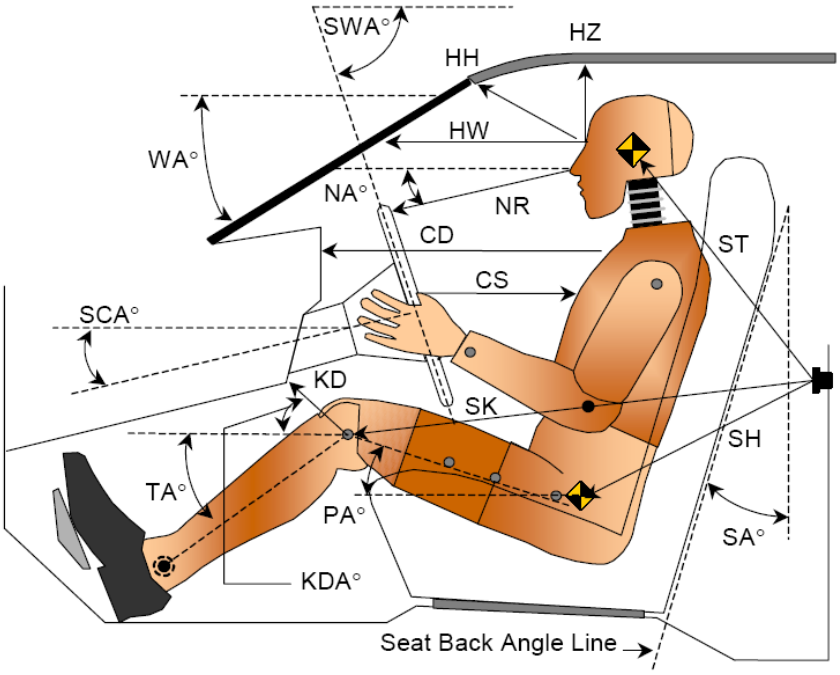
Is the Actual Amount of Solvent Used in the test equal to 93% ± 1% of the Usable Capacity stated in the Form No. 1? ☒ **Yes** ☐ **No**

DATA SHEET NO. 3

DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21



LEFT SIDE VIEW

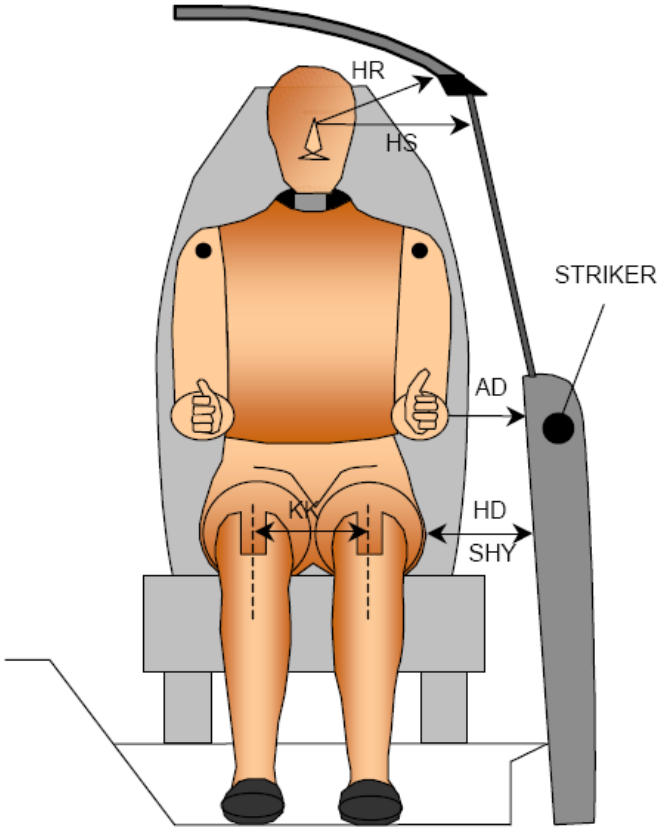
Code	Measurement Description	Driver		Passenger	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		29.3		
SWA°	Steering Wheel Angle		68.8		
SCA°	Steering Column Angle		21.2		
SA°	Seat Back Angle (On Headrest Post)		25.5		18.1
HZ	Head to Roof	187	90.0	186	90.0
HH	Head to Header	358	23.8	276	46.8
HW	Head to Windshield	603	0.0	612	0.0
NR	Nose to Rim	400	9.2	435	27.0
CD	Chest to Dash	530	15.1	386	11.9
CS	Chest to Steering Hub	323	3.2		
RA	Rim to Abdomen	222	0.0		
KDL	Left Knee to Dash	223	33.1	95	48.9
KDR	Right Knee to Dash	208	25.9	135	35.2
PA°	Pelvic Angle		23.0		21.6
TA°	Tibia Angle		47.5		42.2
SK	Striker to Knee	553	15	642	10
ST	Striker to Head	380	86	372	64
SH	Striker to H-Point	309	59	315	10

DATA SHEET NO. 4

DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21



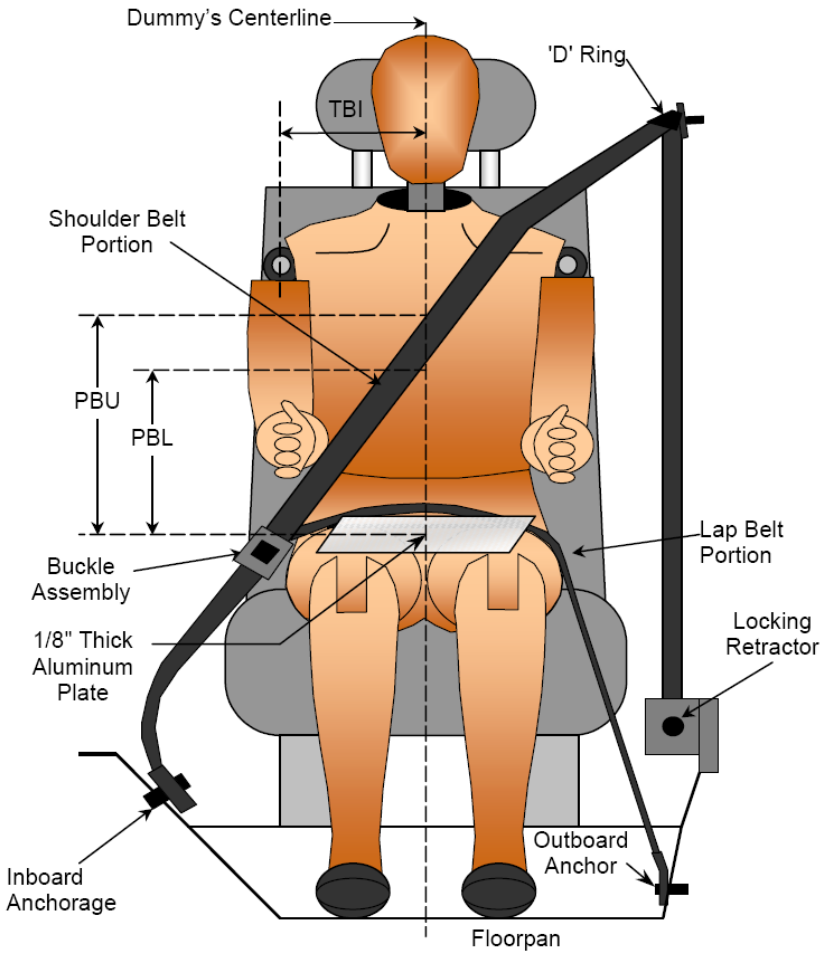
Code	Description	Driver (mm)	Passenger (mm)
AD	Arm to Door	36	87
HD	H-Point to Door	158	175
HR	Head to Side Header	203	217
HS	Head to Side Window	323	346
KK	Knee to Knee	303	160
SHY	Striker to H-Point (Y-Direction)	211	254
AA	Ankle to Ankle	322	170

DATA SHEET NO. 5

SEAT BELT POSITIONING DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Code	Measurement Description	Units	Driver	Passenger
PBU	Top Surface of Aluminum Plate to Belt Upper Edge	mm	322	240
PBL	Top Surface of Aluminum Plate to Belt Lower Edge	mm	247	165

BELT LENGTH DATA

Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as Measured on ATD	mm	865	946
Lap Belt Length as Measured on ATD	mm	638	681
Remainder of Belt on Reel	mm	1187	1080
Total Belt Length for Continuous Webbing Systems	mm	2690	2707

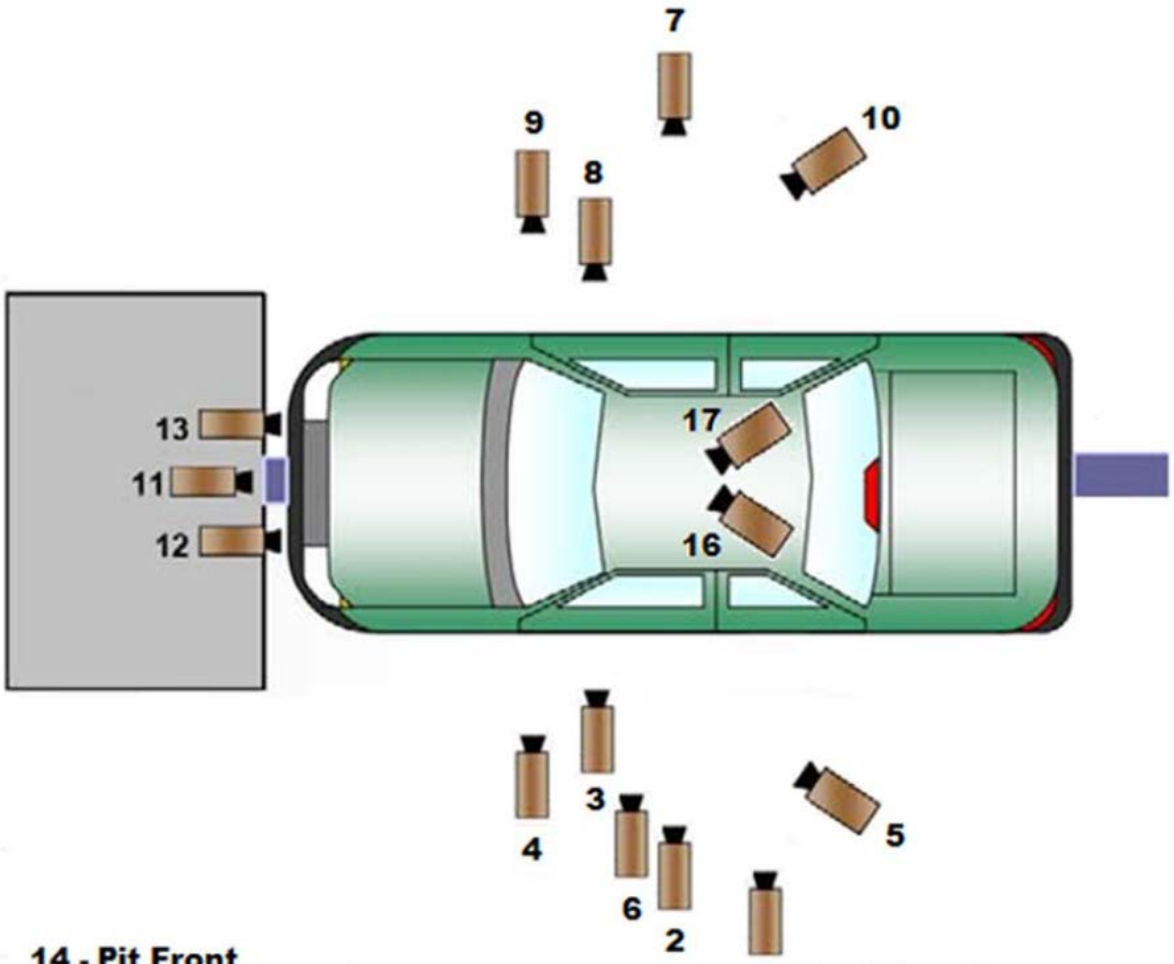
DATA SHEET NO. 6

HIGH-SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

CAMERA POSITIONS FOR FRONTAL IMPACTS



***Camera locations are approximate and not to scale*

DATA SHEET NO. 6 … (CONTINUED)

HIGH-SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

CAMERA LOCATIONS

No.	Description	Location (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Overall	-11412	-8150	-1484		30
2	Left Overall	-2456	-7975	-1025	20	1000
3	Driver Close-Up	-2590	-7950	-1371	50	1000
4	Left Front Half	-1701	-6197	-1701	35	1000
5	Left Angle	-6696	-10308	-3211	105	1000
6	Steering Column	-1966	-10412	-3688	35	1000
7	Right Overall	-2336	7569	-1012	20	1000
8	Passenger Close-Up	-1733	7581	-1408	50	1000
9	Right Front Half	-1600	8214	-1811	35	1000
10	Right Angle	-6217	9516	-4830	85	1000
11	Windshield	-354	0	-5749	28	1000
12	Driver Windshield	297	-366	-2460	24	1000
13	Passenger Windshield	297	366	-2460	24	1000
14	Pit Front	-756	0	1495	21	1000
15	Pit Rear	-3398	0	1495	14	1000
16	Driver Onboard	-1660	-265	-1340	6	1000
17	Passenger Onboard	-1660	265	-1340	6	1000

Coordinates: +X = forward impact plane

+Y = right of monorail center

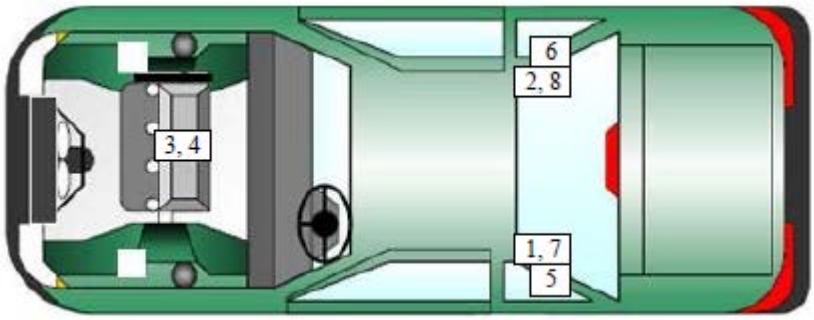
+Z = into ground

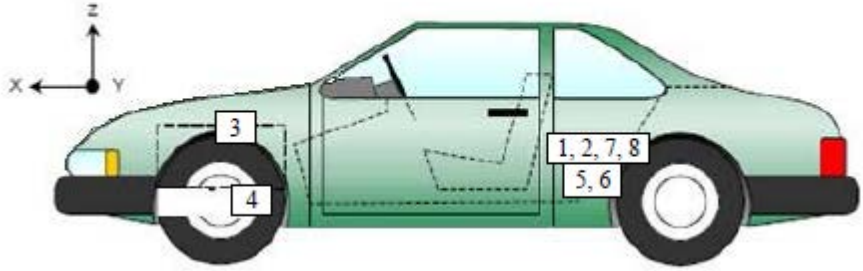
DATA SHEET NO. 7

VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21





VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Description	Location		
		X	Y	Z
1	Left Rear Accelerometer X-Direction	3000	-720	350
2	Right Rear Accelerometer X-Direction	3010	730	360
3	Engine Top X	600	110	820
4	Engine Bottom X	800	120	200
5	Left Rear Accelerometer Z-Direction	3000	-720	350
6	Right Rear Accelerometer Z-Direction	3010	730	360
7	Left Rear Accelerometer X-Direction Redundant	3000	-720	350
8	Right Rear Accelerometer X-Direction Redundant	3010	730	360

Reference Points: X – Rear Surface of Vehicle (+ forward)

Y – Vehicle Centerline (+ to right)

Z – Ground Plane (+ down)

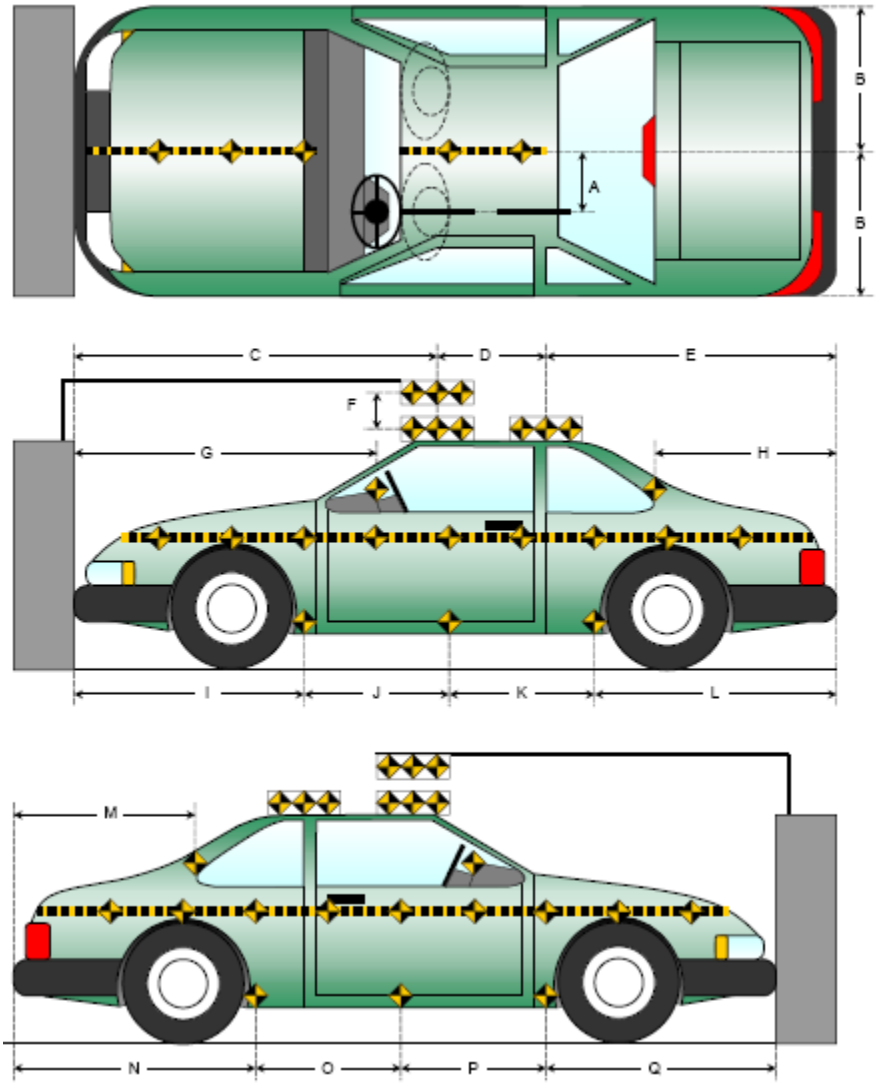
DATA SHEET NO. 8

PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

Item	Value
A	N/A
B	914
C	2275
D	610
E	1820
F	305
G	1850
H	867
I	1235
J	988
K	988
L	1499
M	867
N	1499
O	988
P	988
Q	1235



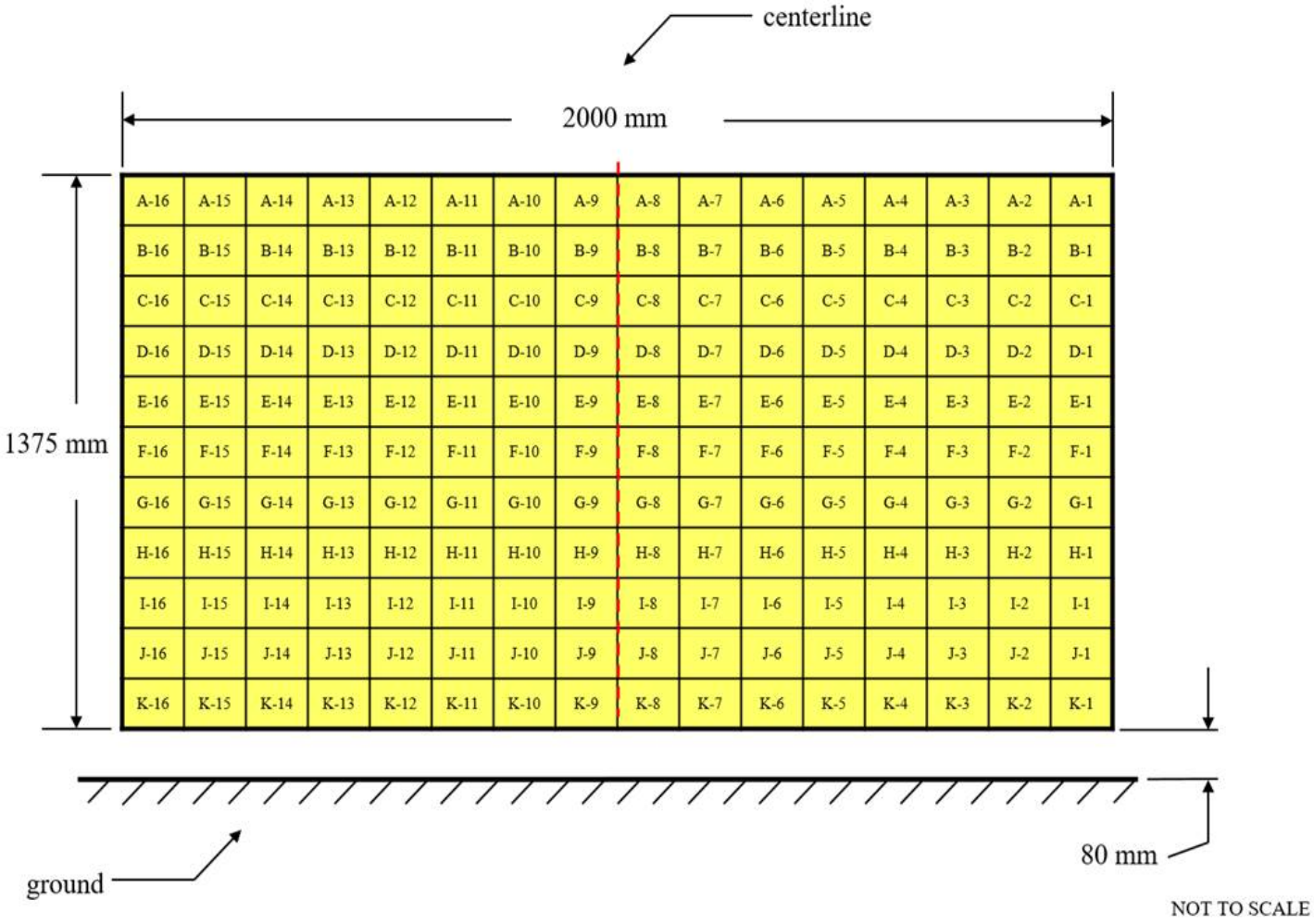
All measurements in millimeters.

DATA SHEET NO. 9

LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21



DATA SHEET NO. 10

TEST VEHICLE SUMMARY OF RESULTS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

INSTRUMENTATION

Driver Dummy Accelerometers	49
Passenger Dummy Accelerometers	49
Vehicle Structure Accelerometers	8
Load Cell Barrier	528
Total	634

CAMERA COVERAGE

High-Speed Vehicle On Board	2
High-Speed Off Board	14
Real Time	1
Total	17

DATA SHEET NO. 11

POST-TEST OBSERVATIONS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Passenger
Dummy Type/Serial No.	HIII 50th Percentile Male ATD / 360	HIII 5th Percentile Female ATD / DH1644
Head Contact	Frontal Airbag, Curtain Airbag, Headrest	Frontal Airbag, Curtain Airbag, Headrest
Upper Torso Contact	Frontal Airbag	Frontal Airbag
Lower Torso Contact	Frontal Airbag	Frontal Aibag
Left Knee Contact	Knee Airbag	Knee Airbag
Right Knee Contact	Knee Airbag, Steering Wheel Rim	Knee Airbag

DOOR OPENING, TRUNK OPENING, AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Locked / Unlocked Doors	Unlocked	Unlocked
Front Door Opening	Remained closed, latched, and operational	Remained closed, latched, and operational
Rear Door Opening	Remained closed, latched, and operational	Remained closed, latched, and operational
Trunk/Hatch/Tailgate Opening	Trunk Opened	
Seat Track Shift (mm)	0	0
Seat Back Movement from Initial Position	None	None

OTHER VEHICLE POST-TEST OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Windshield Damage	None
Window Damage	None
Other Notable Effects	None

VEHICLE REBOUND FROM BARRIER

Measured Parameter	Units	Value
Left Side	mm	996
Center	mm	934
Right Side	mm	832
Average	mm	921

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

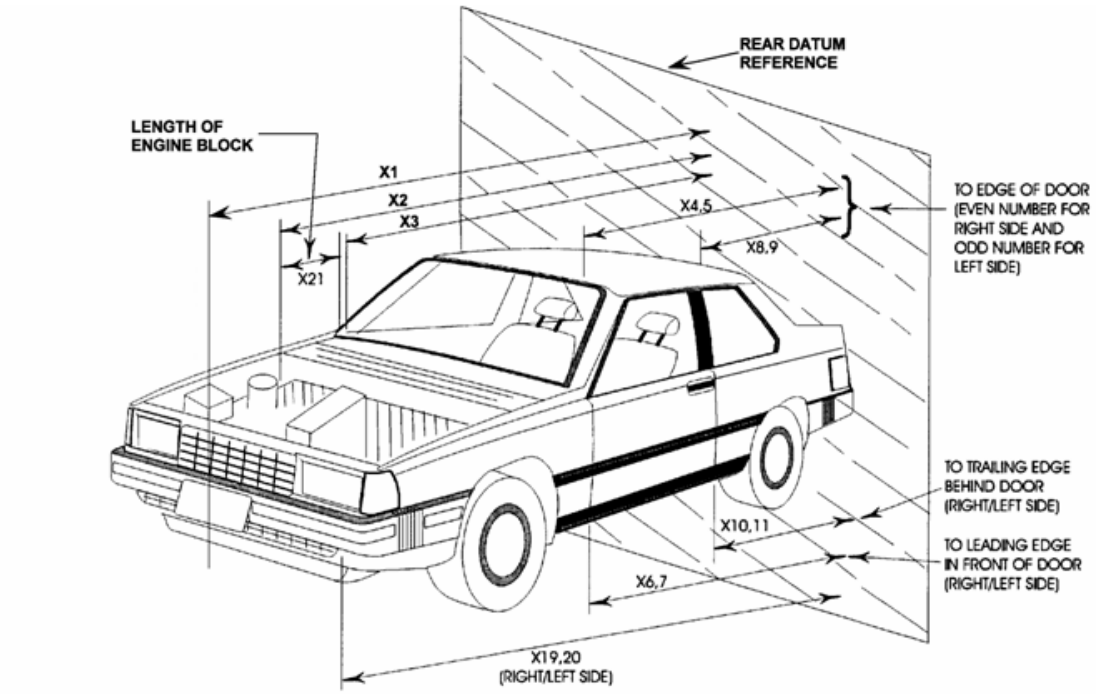
Restraint Type	Driver		Passenger	
	Installed	Operated	Installed	Operated
Front Airbag	Yes	Yes	Yes	Yes
Side Airbag 1 (Curtain)	Yes	Yes	Yes	Yes
Side Airbag 2 (Torso/Pelvis)	Yes	No	Yes	No
Knee Airbag	Yes	Yes	Yes	Yes
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes	Yes	Yes	Yes

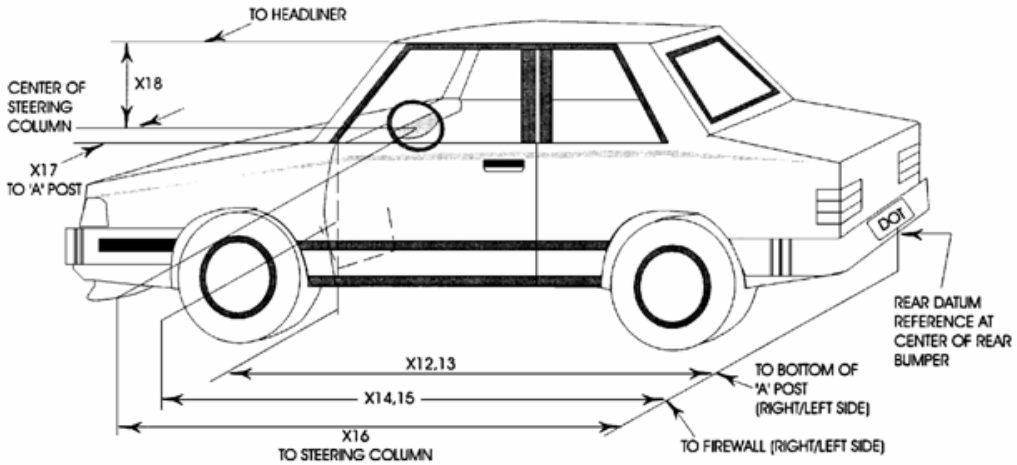
DATA SHEET NO. 12

VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21





DATA SHEET NO. 12 … (CONTINUED)

VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

No.	Description	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	4710	4300	-410
2	Rear Surface of Vehicle to Front of Engine	4050	4041	-9
3	RSOV to Firewall	3565	3556	-9
4	RSOV to Upper Leading Edge of Right Door	3220	3228	8
5	RSOV to Upper Leading Edge of Left Door	3220	3223	3
6	RSOV to Lower Leading Edge of Right Door	3230	3228	-2
7	RSOV to Lower Leading Edge of Left Door	3230	3233	3
8	RSOV to Upper Trailing Edge of Right Door	2095	2099	4
9	RSOV to Upper Trailing Edge of Left Door	2095	2101	6
10	RSOV to Lower Trailing Edge of Right Door	2170	2172	2
11	RSOV to Lower Trailing Edge of Left Door	2170	2178	8
12	RSOV to Bottom of A-Pillar, Right Side	3150	3152	2
13	RSOV to Bottom of A-Pillar, Left Side	3150	3152	2
14	RSOV to Firewall, Right Side	3932	3940	8
15	RSOV to Firewall, Left Side	3932	3940	8
16	RSOV to Steering Column	2710	2770	60
17	Center of Steering Column to A-Pillar	410	409	-1
18	Center of Steering Column to Headliner	387	378	-9
19	RSOV to Right Side of Front Bumper	4070	4125	55
20	RSOV to Left Side of Front Bumper	4070	4165	95
21	Length of Engine Block	610	610	0
RD	RSOV to Right Side of Dash Panel	2870	2876	6
CD	RSOV to Center of Dash Panel	2780	2801	21
LD	RSOV to Left Side of Dash Panel	2870	2874	4

All measurements in millimeters.

DATA SHEET NO. 13

ACCIDENT INVESTIGATION DIVISION DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

VEHICLE INFORMATION

VIN: WBA5R7C02MFK51022 Wheelbase (mm): 2850

Vehicle Size Category: Passenger Car Test Weight (kg): 1851.0

ACCELEROMETER DATA

Accelerometer Locations: Left Rear Crossmember

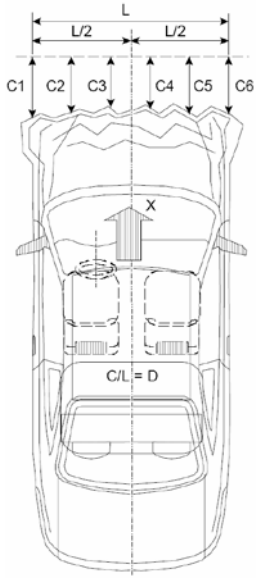
Cal. Procedure/Interval: Vibration Test / 6 months

Integration Algorithm: NHTSA Standard Linearity: Good

Impact Velocity (km/h): 56.35

Velocity Change (km/h): 69.4

Time of Separation (msec): 65.1



CRUSH PROFILE

Collision Deformation Classification: 12FDEW2

Midpoint of Damage: Vehicle Centerline

Damage Region Length (mm): 1270

Impact Mode: Full Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush Zone 1 at Left Side	mm	155	420	265
C2	Crush Zone 2 at Left Side	mm	50	495	445
C3	Crush Zone 3 at Left Side	mm	10	435	425
C4	Crush Zone 4 at Right Side	mm	10	380	370
C5	Crush Zone 5 at Right Side	mm	50	350	300
C6	Crush Zone 6 at Right Side	mm	155	345	190
L	C1 to C6	mm	1270		

DATA SHEET NO. 14

VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

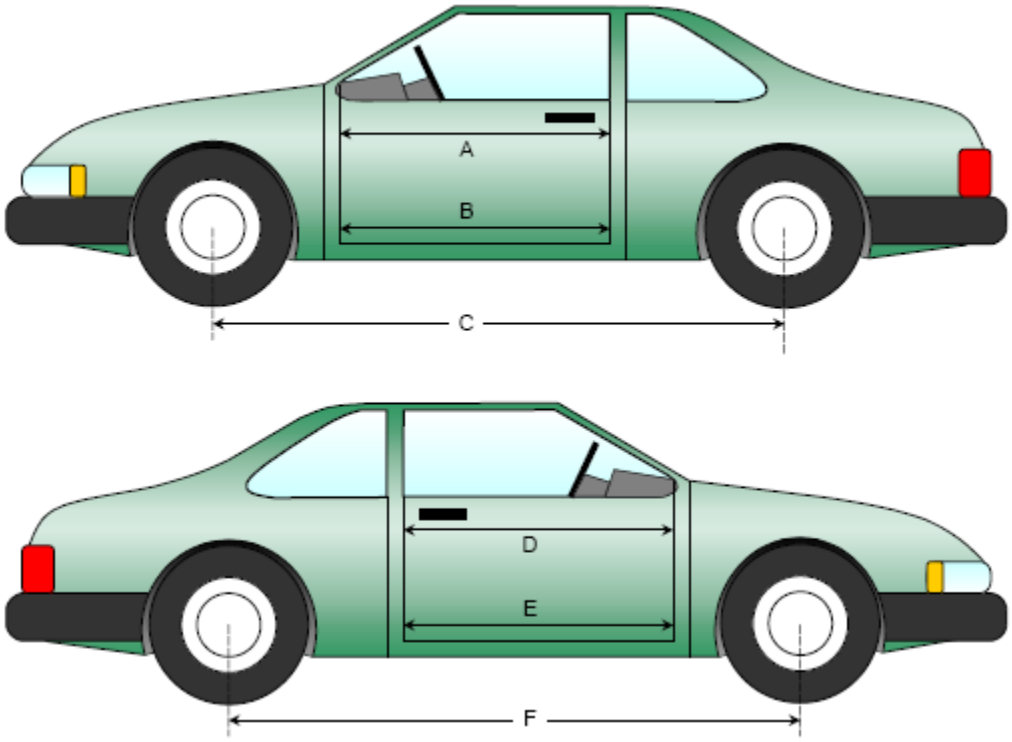
Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	969	968	1
B	Left Side Lower	mm	842	843	-1
D	Right Side Upper	mm	968	970	-2
E	Right Side Lower	mm	873	870	3

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2850	2740	110
F	Right Side Wheelbase	mm	2850	2737	113



DATA SHEET NO. 14 … (CONTINUED)

VEHICLE INTRUSION MEASUREMENTS

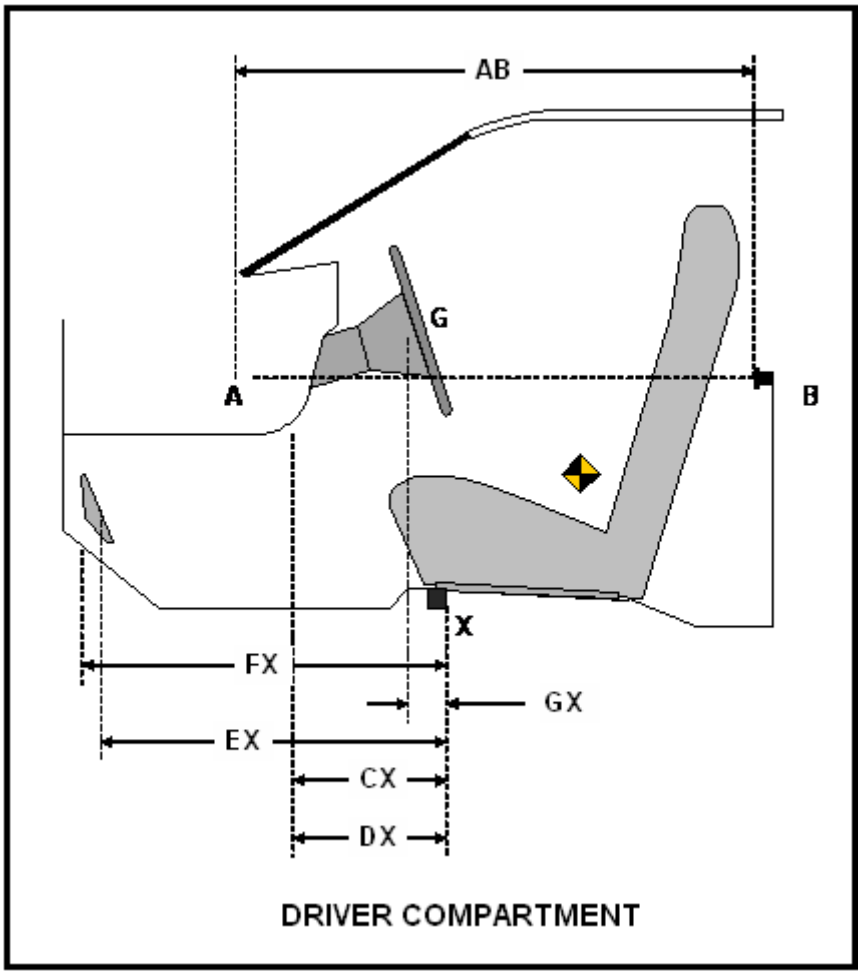
Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	792	794	-2
CX	Left Knee Bolster to X	mm	312	311	1
DX	Right Knee Bolster to X	mm	310	311	-1
EX	Brake Pedal to X	mm	563	565	-2
FX	Foot Rest to X	mm	616	618	-2
GX	Center of Steering Wheel Hub to X	mm	25	35	-10

X = Front of Seat Track (Stationary)



DATA SHEET NO. 15

SUMMARY OF INDICANT FMVSS 212 AND 219 (PARTIAL) DATA

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

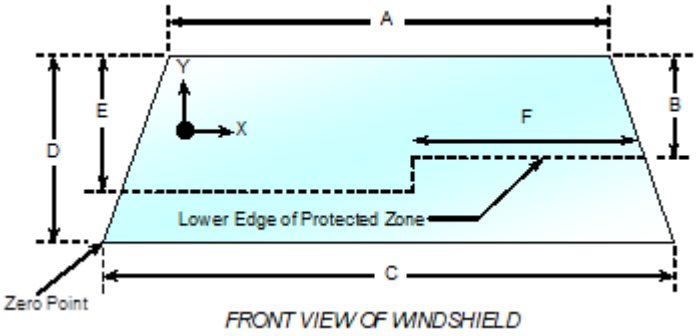
Windshield Mounting Details: Windshield glass is secured to the vehicle frame with rubber molding and rubber cement.

The standard requires that the post-test retention measurement be a minimum of 75% of the pre-test total periphery measurement for vehicles not equipped with occupant passive restraints and 50% for each side of the windshield for vehicles which are equipped with occupant passive restraints.

Temperature of windshield molding during test: 21.4° C

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% Retention
Left Side	2135	2135	100.0%
Right Side	2135	2135	100.0%
Total	4270	4270	100.0%



FRONT VIEW OF WINDSHIELD

Item	Units	Value
A	mm	1160
B	mm	305
C	mm	1440
D	mm	835
E	mm	450
F	mm	530

AREAS OF PROTECTED ZONE FAILURES

A. Provide Coordinates of the area that the protected zone was penetrated more than 0.25 inches by a vehicle component other than one that is normally in contact with the windshield.

X	Y

B. Provide coordinates of the area beneath the protected zone that the inner surface of the windshield was penetrated by a vehicle component.

X	Y

DATA SHEET NO. 16

FMVSS 301 BARRIER IMPACT AND STATIC ROLLOVER RESULTS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Temperature at Time of Impact: 16.7°C Test Time: 2:05 PM

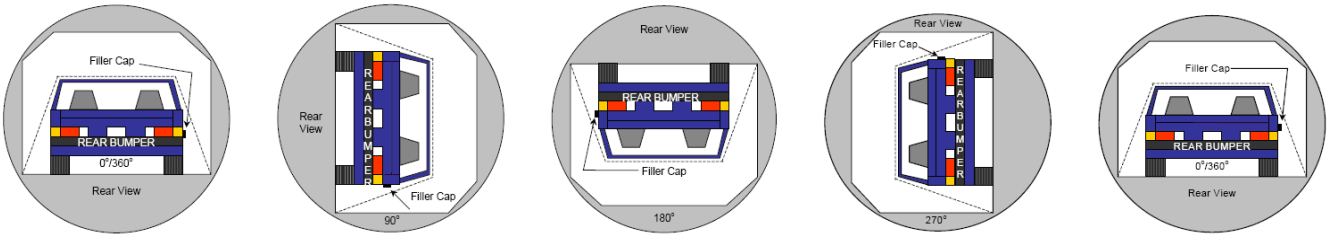
Stoddard Solvent Spillage Measurements

A. From impact until vehicle motion ceases: N/A oz.
(Maximum allowable = 1 oz.)

B. For the 5 minute period after motion ceases: N/A oz.
(Maximum allowable = 5 oz.)

C. For the following 25 minutes: N/A oz.
(Maximum allowable = 1 oz./minute)

D. Spillage: _____



0° TO 90° 90° TO 180° 180° TO 270° 270° TO 360°

1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.
2. The position hold time at each position is 300 seconds (minimum).
3. Details of Stoddard solvent spillage: N/A

SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° To 90°	83	300	383
90° To 180°	79	300	379
180° To 270°	83	300	383
270° To 360°	83	300	383

DATA SHEET NO. 16 … (CONTINUED)

FMVSS 301 BARRIER IMPACT AND STATIC ROLLOVER RESULTS

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21

FMVSS 301 SPILLAGE TABLE

Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eighth Minute
0° To 90°				
90° To 180°				
180° To 270°				
270° To 360°				

SOLVENT SPILLAGE LOCATION TABLE

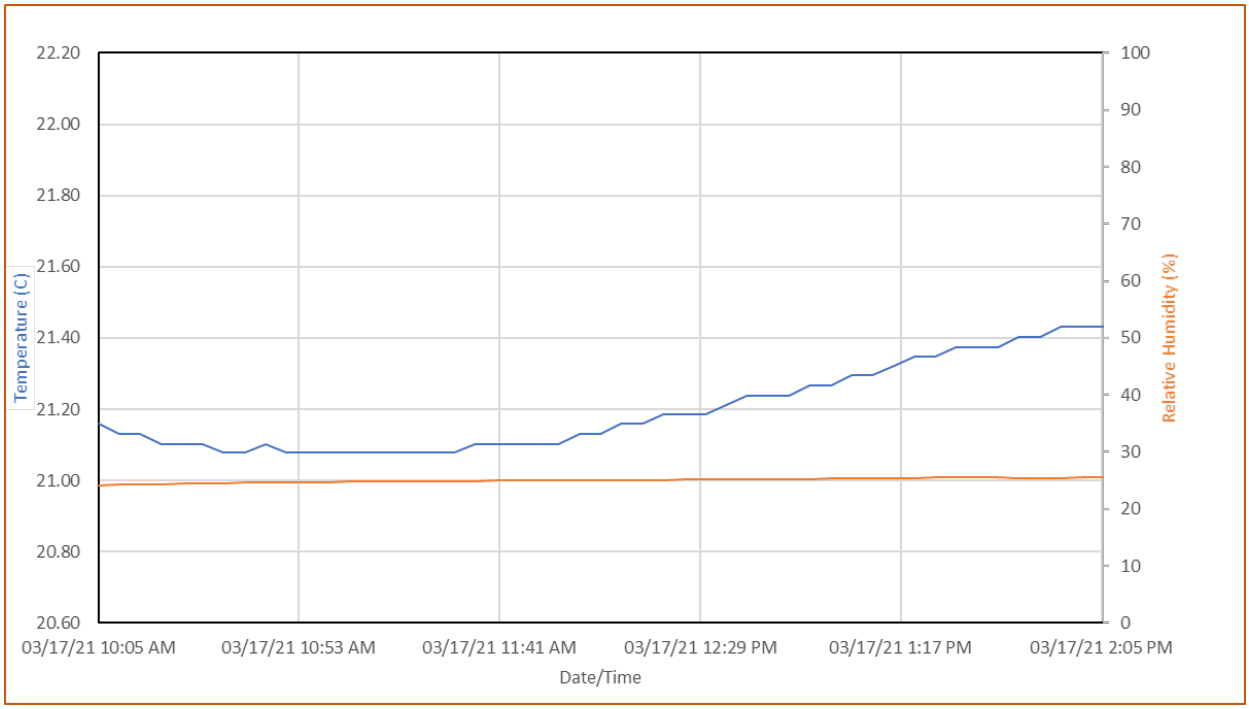
Test Phase	Spillage Location
0° To 90°	
90° To 180°	
180° To 270°	
270° To 360°	

DATA SHEET NO. 17

DUMMY / VEHICLE TEMPERATURE STABILIZATION CHART

Test Vehicle: 2021 BMW 330i xDrive 4-Door Sedan NHTSA No.: M20214100

Test Program: 56.3 km/h Frontal Impact NCAP Test Test Date: 03/17/21



APPENDIX A
PHOTOGRAPHIC DOCUMENTATION

TABLE OF PHOTOGRAPHS

TABLE OF PHOTOGRAPHS … (CONTINUED)

TABLE OF PHOTOGRAPHS … (CONTINUED)

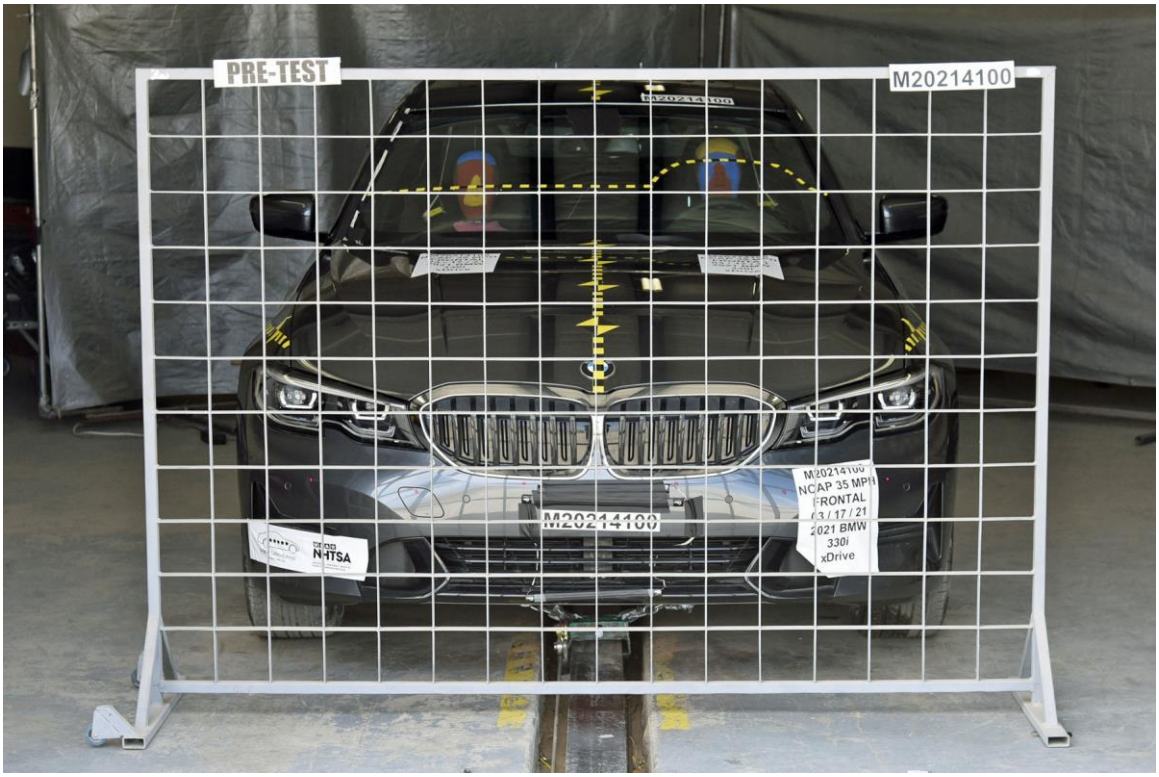


FIGURE 1. Load Cell Location

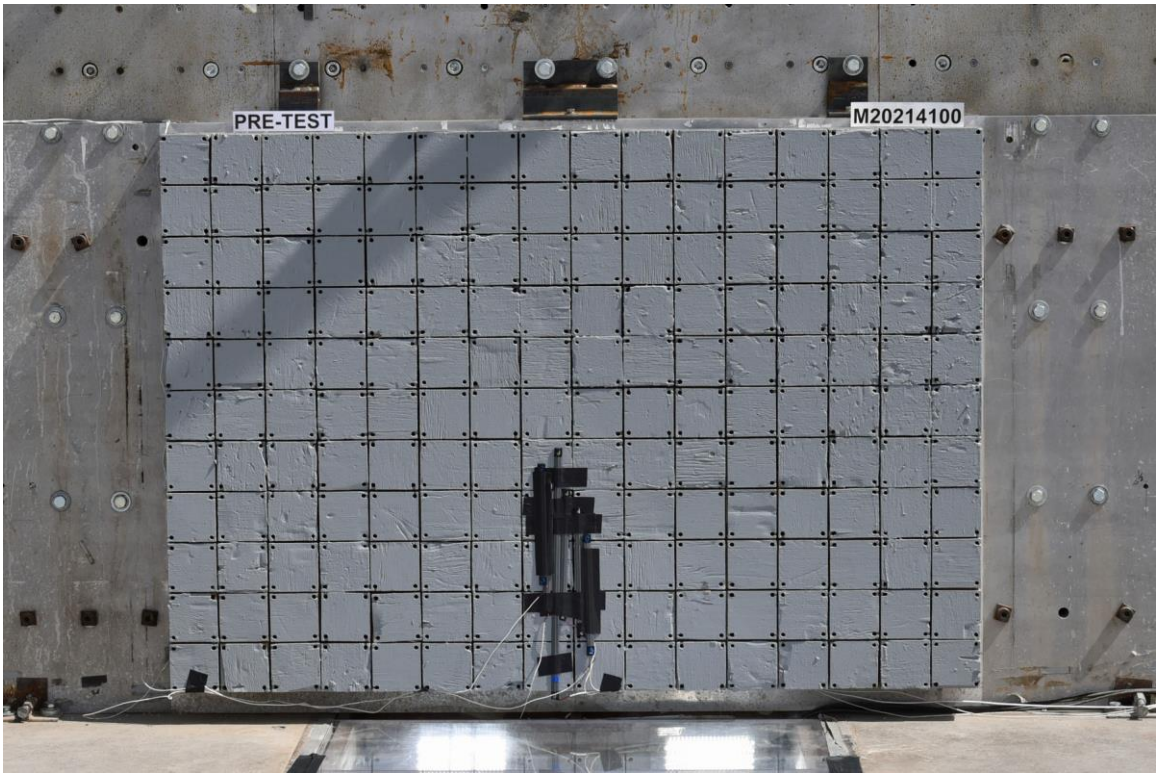


FIGURE 2. Pre-Test Load Cell Wall

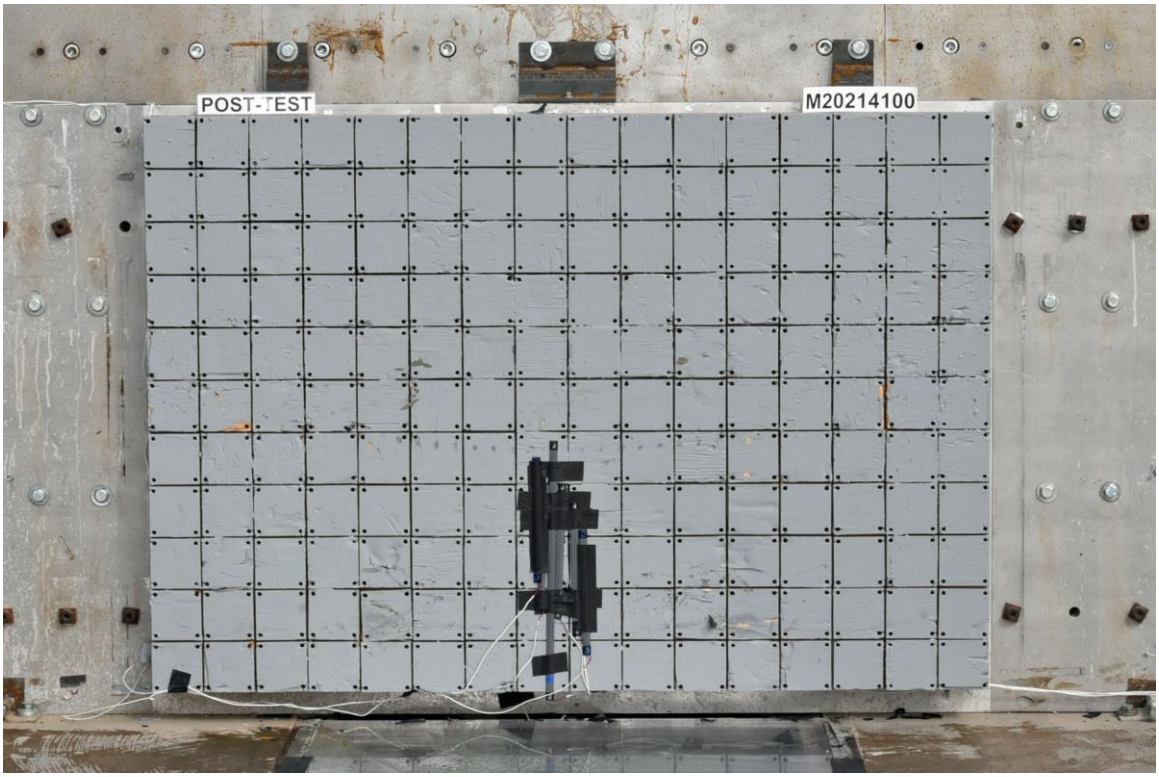


FIGURE 3. Post-Test Load Cell Wall

FIGURE 4. Manufacturer's Label

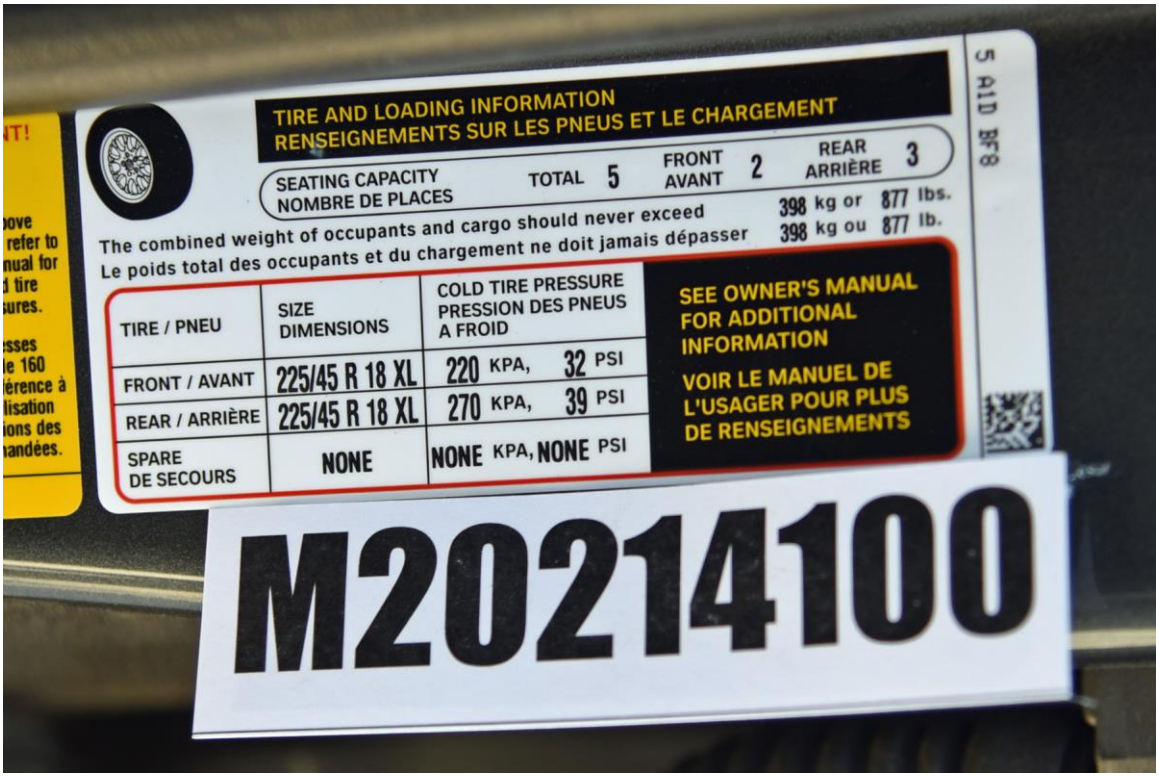


FIGURE 5. Tire Placard

FIGURE 6. 2021 BMW 330i xDrive Frontal as Delivered

FIGURE 7. Left Rear ¾ View, as Received

FIGURE 8. Pre-Test Front View of Test Vehicle

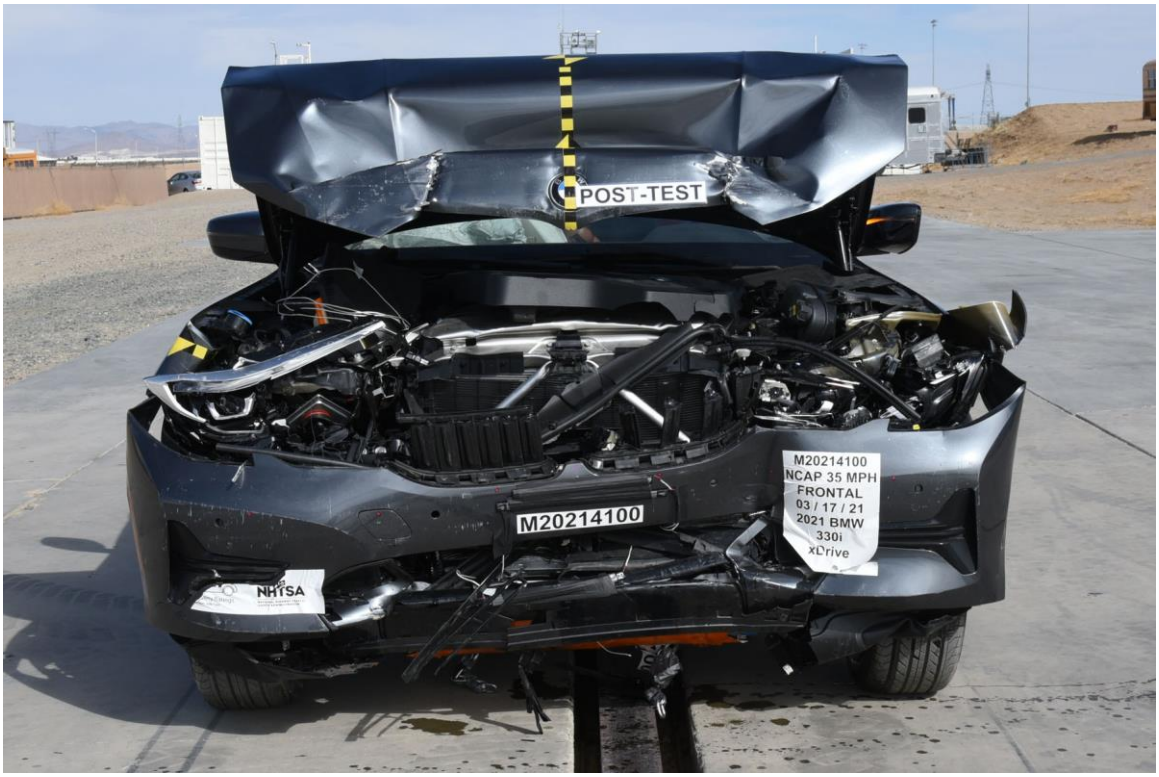


FIGURE 9. Post-Test Front View of Test Vehicle

FIGURE 10. Pre-Test Left View of Test Vehicle

FIGURE 11. Post-Test Left View of Test Vehicle

FIGURE 12. Pre-Test Right View of Test Vehicle

FIGURE 13. Post-Test Right View of Test Vehicle

FIGURE 14. Pre-Test Right Front ¾ View

FIGURE 15. Post-Test Right Front ¾ View

FIGURE 16. Pre-Test Left Rear ¾ View

FIGURE 17. Post-Test Left Rear ¾ View

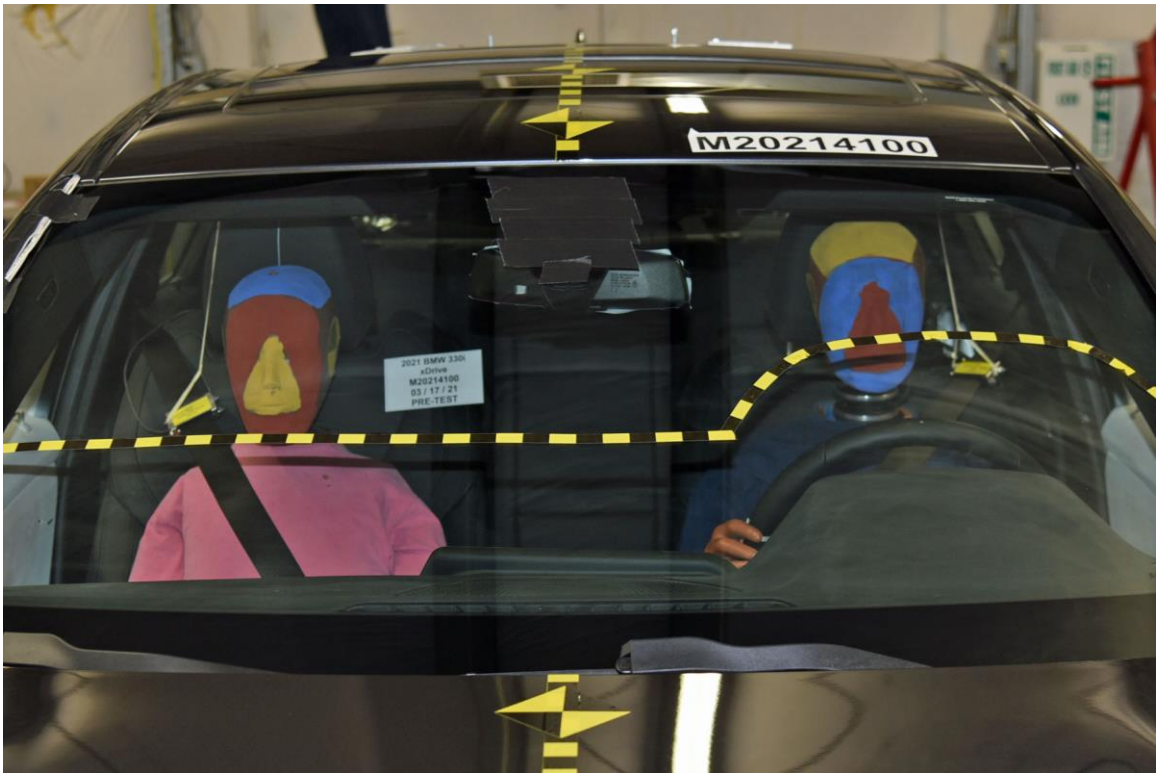


FIGURE 18. Pre-Test Windshield View

FIGURE 19. Post-Test Windshield View

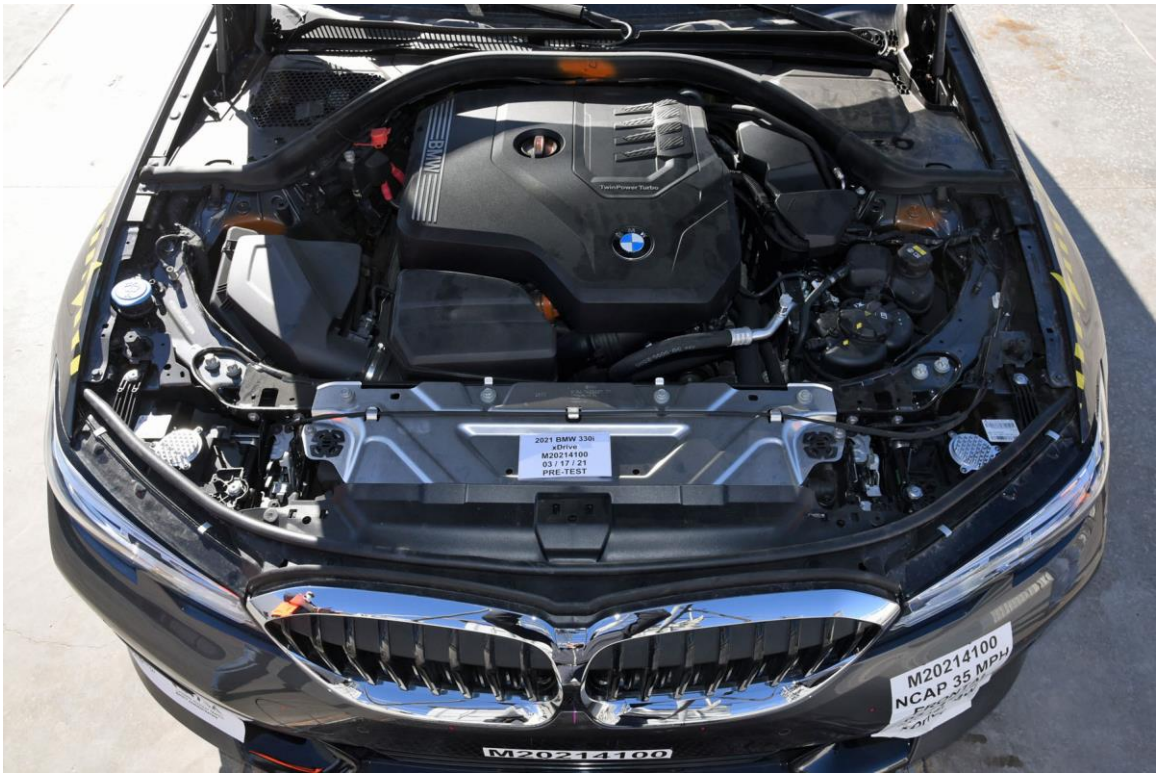


FIGURE 20. Pre-Test Engine Compartment View

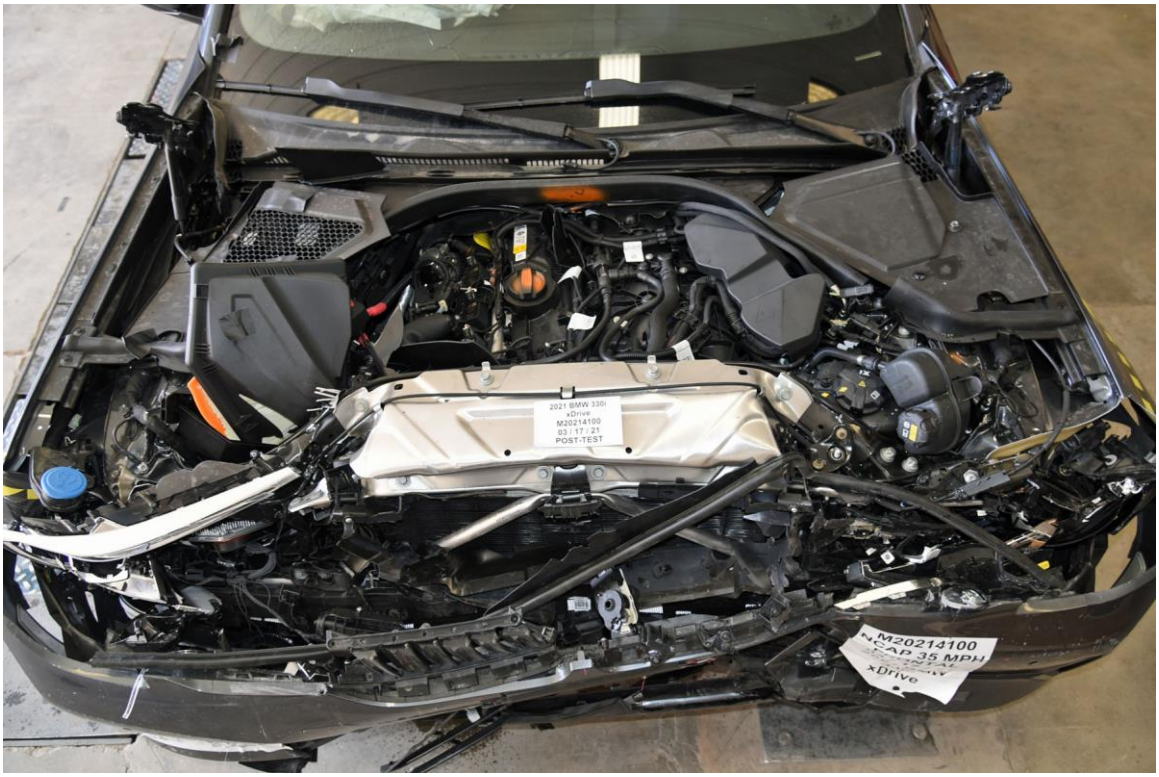


FIGURE 21. Post-Test Engine Compartment View

FIGURE 22. Pre-Test Fuel Filler Cap View

FIGURE 23. Post-Test Fuel Filler Cap View

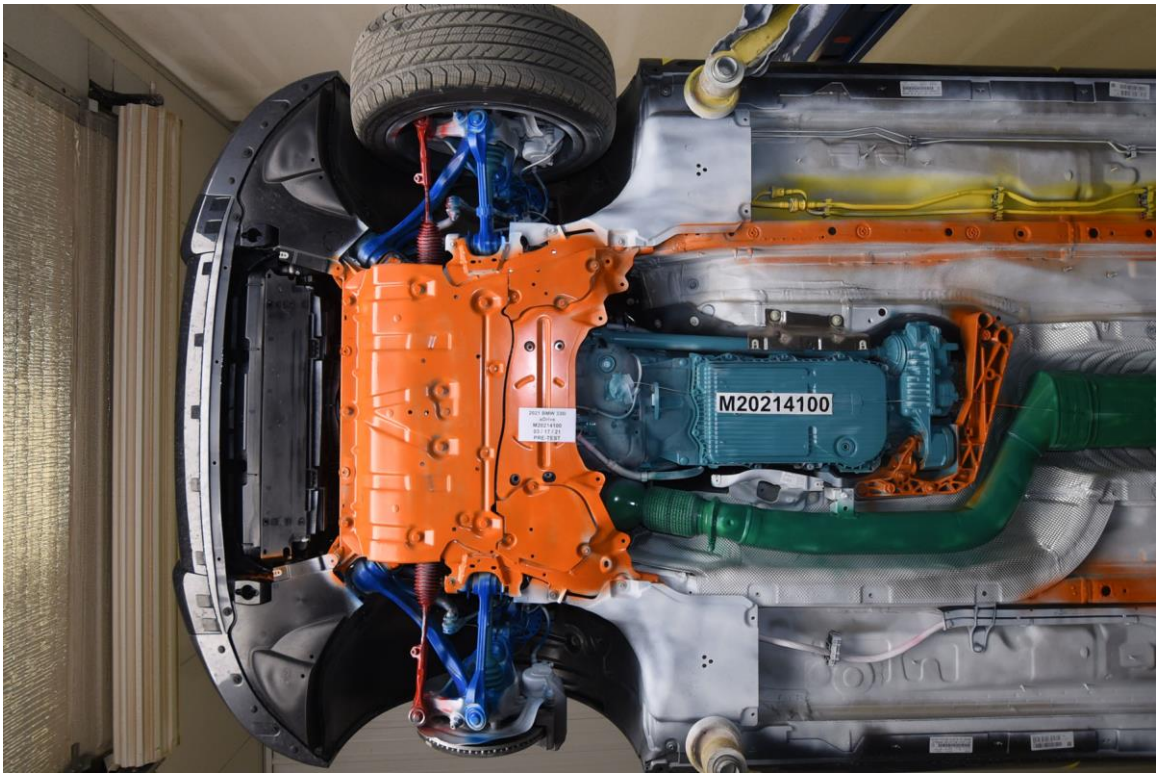


FIGURE 24. Pre-Test Front Underbody View

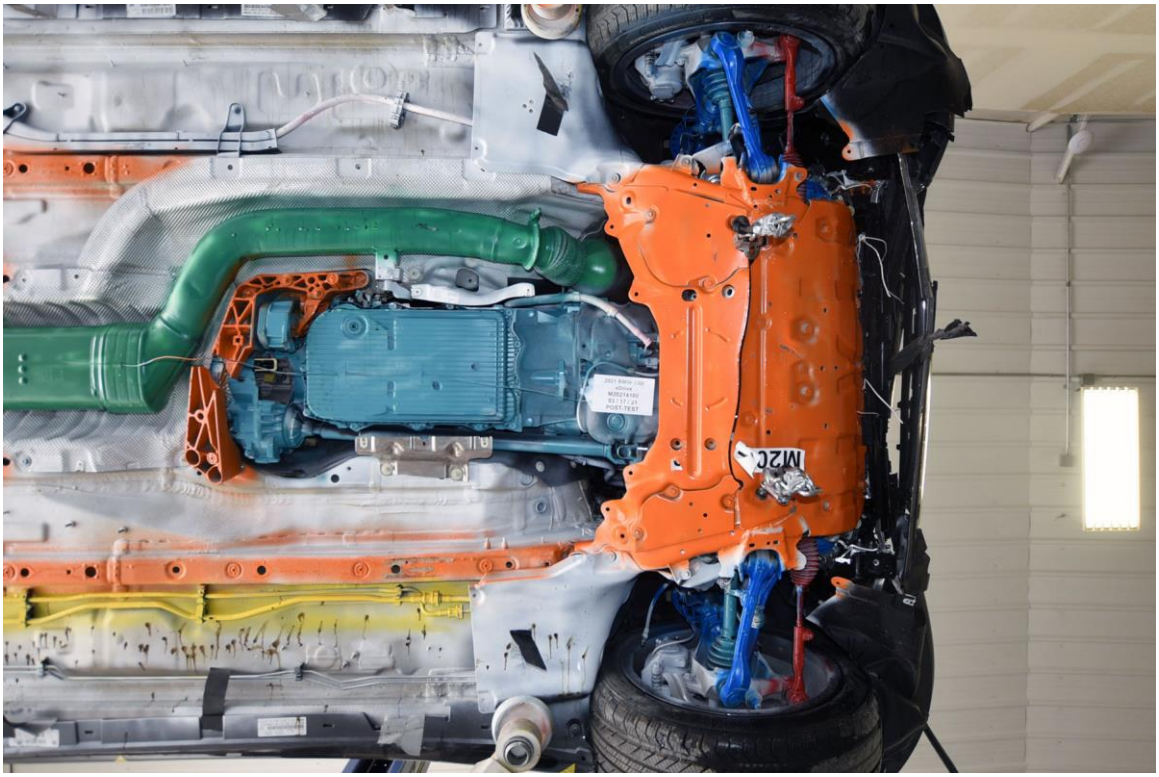


FIGURE 25. Post-Test Front Underbody View

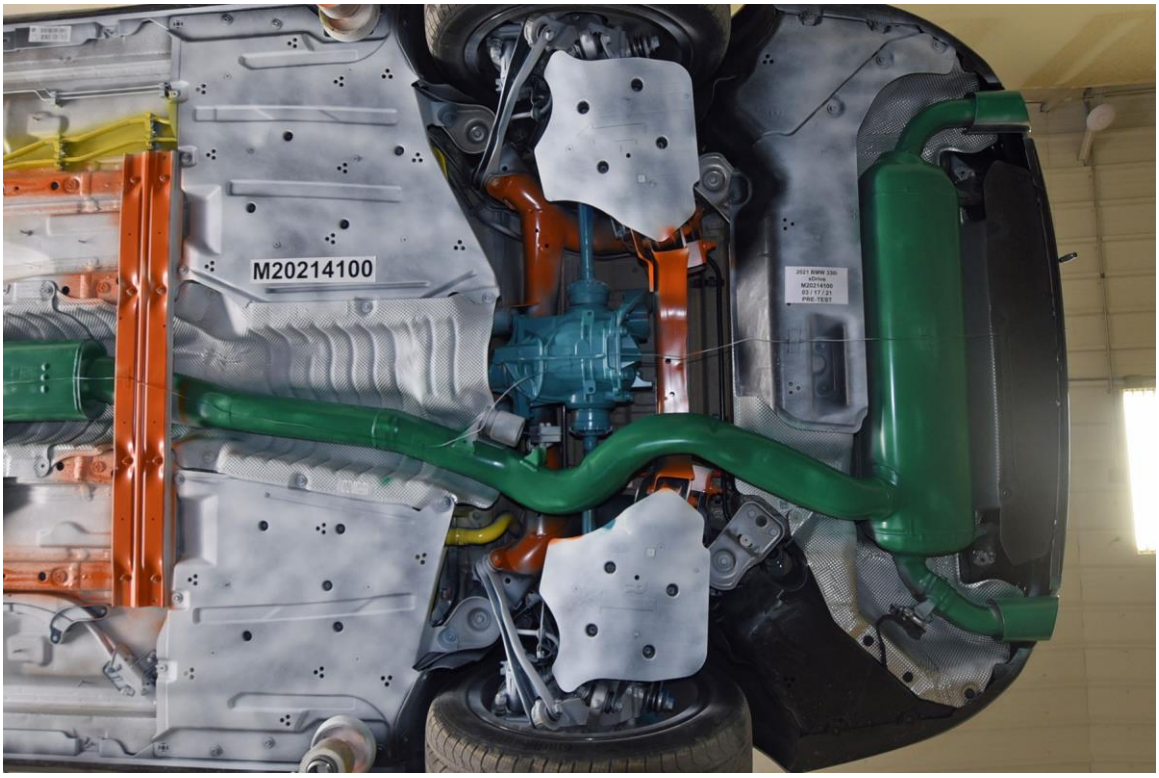


FIGURE 26. Pre-Test Rear Underbody View

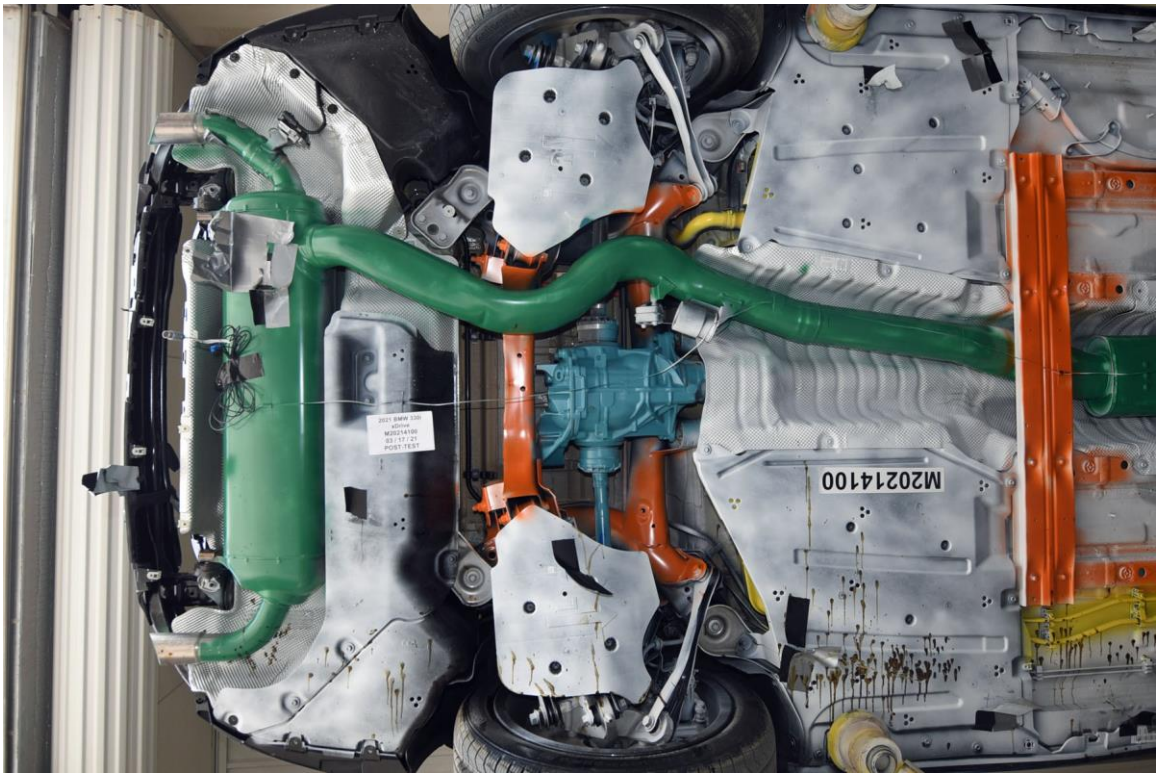


FIGURE 27. Post-Test Rear Underbody View

FIGURE 28. Pre-Test Dummy Cable Routing

FIGURE 29. Post-Test Dummy Cable Routing

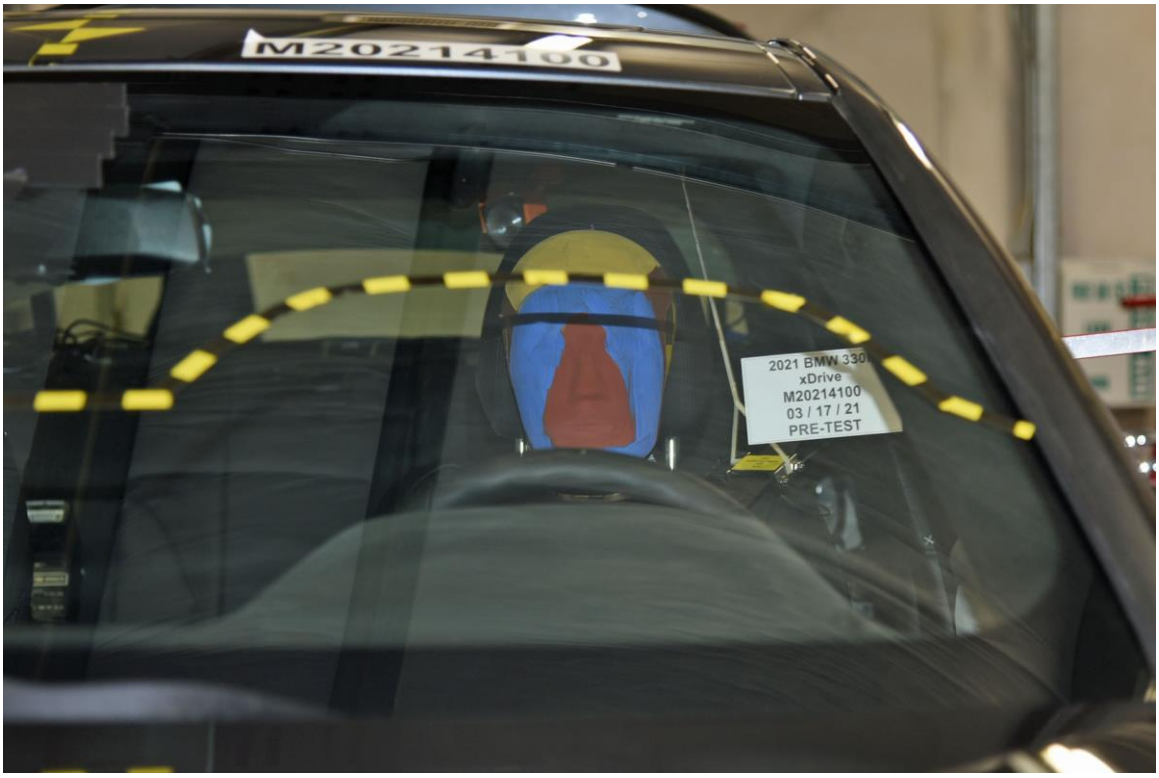


FIGURE 30. Pre-Test Driver Dummy Front View

FIGURE 31. Post-Test Driver Dummy Front View

FIGURE 32. Pre-Test Driver Dummy Window View

FIGURE 33. Post-Test Driver Dummy Window View

FIGURE 34. Pre-Test Driver Dummy and Vehicle Interior View

FIGURE 35. Post-Test Driver Dummy and Vehicle Interior View

FIGURE 36. Pre-Test Driver's Seat Fore-Aft Markings

FIGURE 37. Post-Test Driver's Seat Fore-Aft Markings

FIGURE 38. Pre-Test View of Belt Anchorage for Driver Dummy

FIGURE 39. Post-Test View of Belt Anchorage for Driver Dummy

FIGURE 40. Pre-Test View of Belt Buckle and Latch Plate for Driver Dummy

FIGURE 41. Post-Test View of Belt Buckle and Latch Plate for Driver Dummy

FIGURE 42. Pre-Test Driver Dummy Feet

FIGURE 43. Post-Test Driver Dummy Feet

FIGURE 44. Pre-Test Driver's Side Knee Bolster

FIGURE 45. Post-Test Driver's Side Knee Bolster

FIGURE 46. Pre-Test Driver's Side Floorpan

FIGURE 47. Post-Test Driver's Side Floorpan

FIGURE 48. Post-Test Driver Dummy Face

FIGURE 49. Post-Test Driver Dummy Contact with Airbag

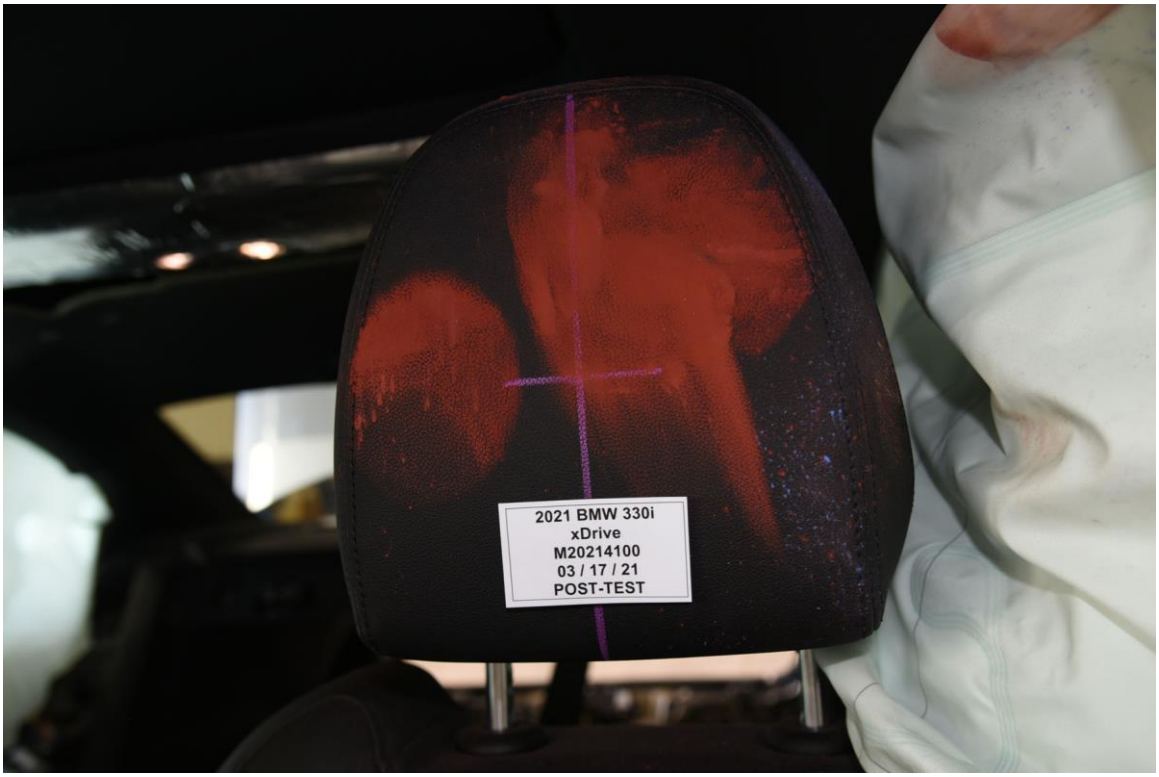


FIGURE 50. Post-Test Driver Dummy Contact with Headrest

FIGURE 50a. Post-Test Driver Dummy Contact with Knee Airbag

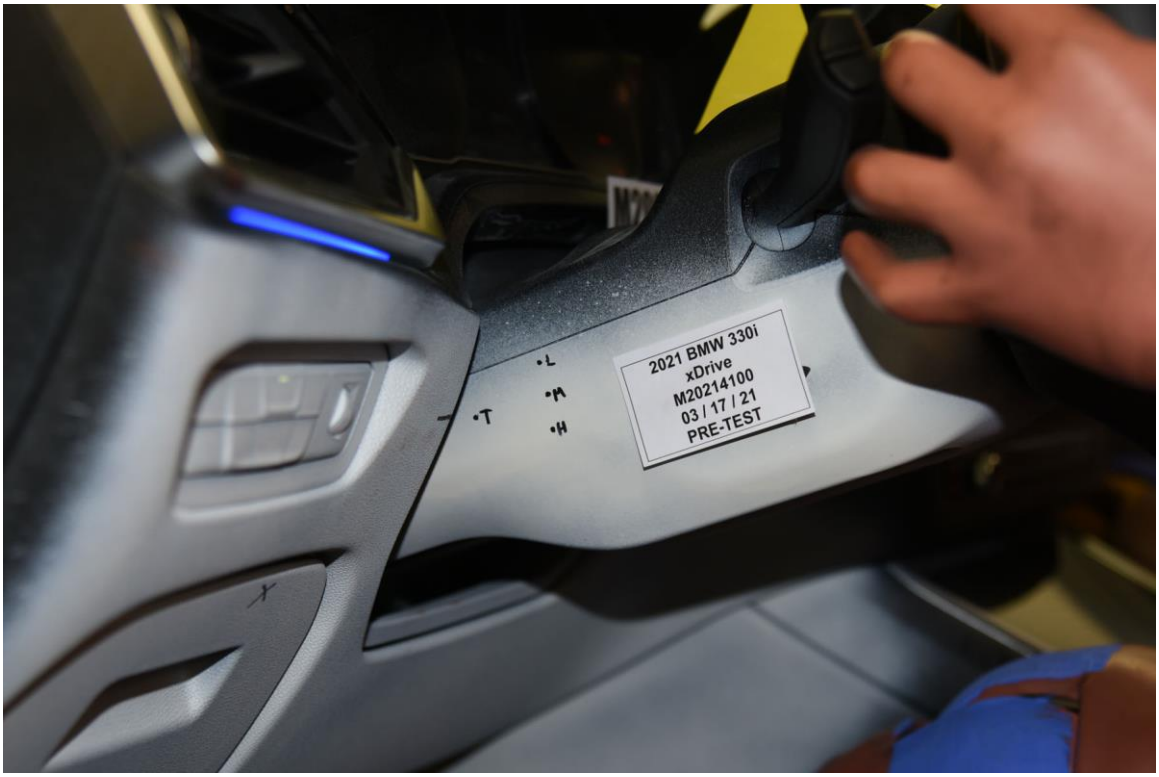


FIGURE 51. Pre-Test View of the Steering Wheel

FIGURE 52. Post-Test View of the Steering Wheel

FIGURE 53. Pre-Test Passenger Dummy Front View

FIGURE 54. Post-Test Passenger Dummy Front View

FIGURE 55. Pre-Test Passenger Dummy Window View

FIGURE 56. Post-Test Passenger Dummy Window View

FIGURE 57. Pre-Test Passenger Dummy and Vehicle Interior View

FIGURE 58. Post-Test Passenger Dummy and Vehicle Interior View

FIGURE 59. Pre-Test Passenger's Seat Fore-Aft Markings

FIGURE 60. Post-Test Passenger's Seat Fore-Aft Markings

FIGURE 61. Pre-Test View of Belt Anchorage for Passenger Dummy

FIGURE 62. Post-Test View of Belt Anchorage for Passenger Dummy

FIGURE 63. Pre-Test View of Belt Buckle and Latch Plate for Passenger Dummy

FIGURE 64. Post-Test View of Belt Buckle and Latch Plate for Passenger Dummy

FIGURE 65. Pre-Test Passenger Dummy Feet

FIGURE 66. Post-Test Passenger Dummy Feet

FIGURE 67. Pre-Test Passenger's Side Knee Bolster

FIGURE 68. Post-Test Passenger's Side Knee Bolster

FIGURE 69. Pre-Test Passenger's Side Floorpan

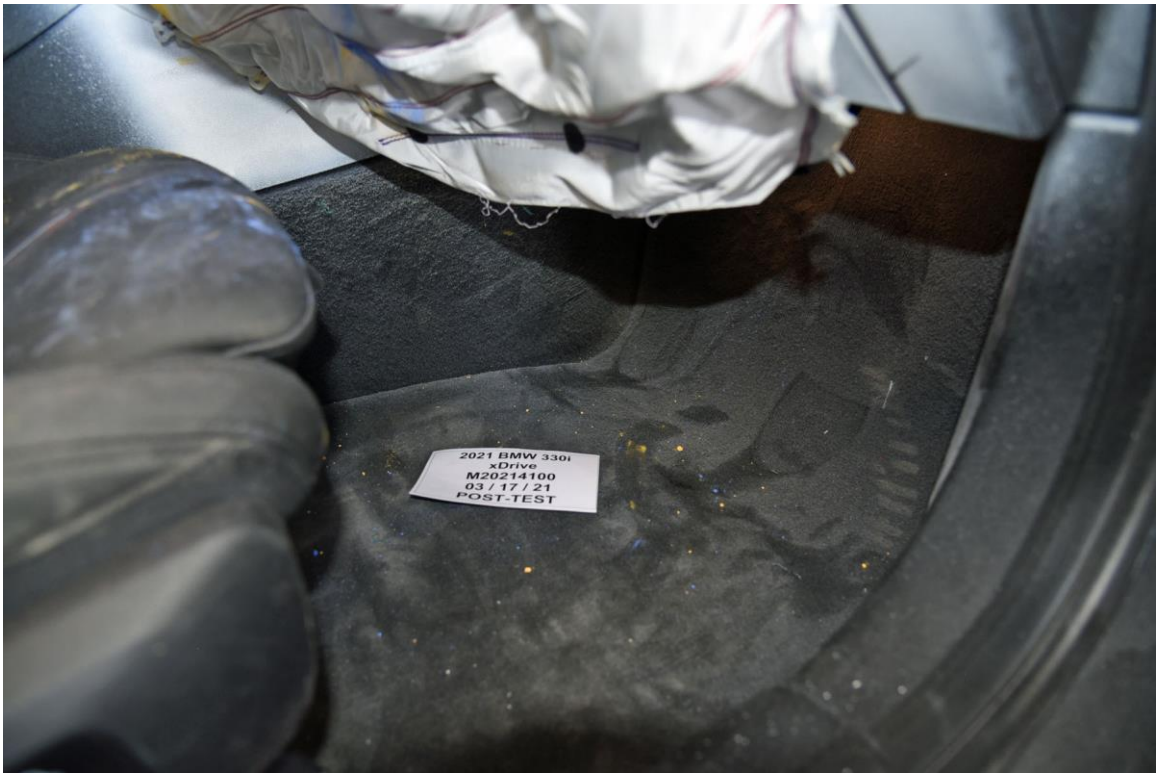


FIGURE 70. Post-Test Passenger's Side Floorpan

FIGURE 71. Post-Test Passenger Dummy Face

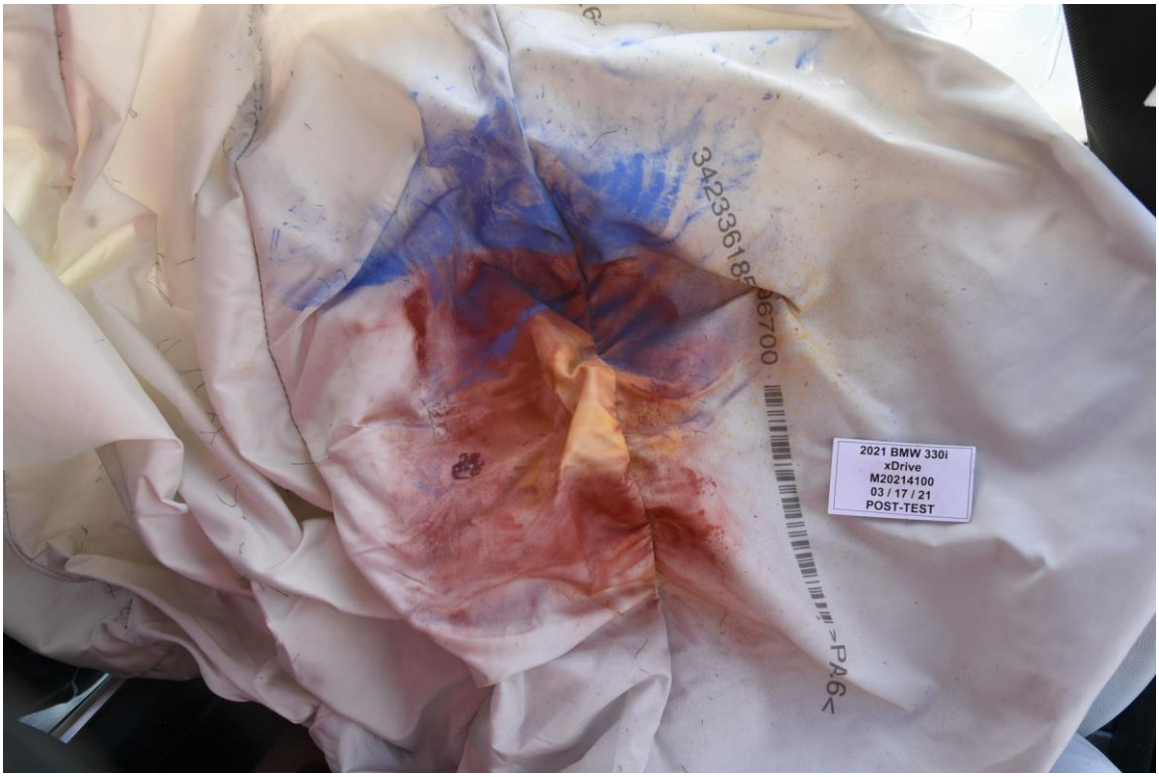


FIGURE 72. Post-Test Passenger Dummy Contact with Airbag

FIGURE 73. Post-Test Passenger Dummy Contact with Headrest

FIGURE 73a. Post-Test Passenger Dummy Contact with Knee Bolster

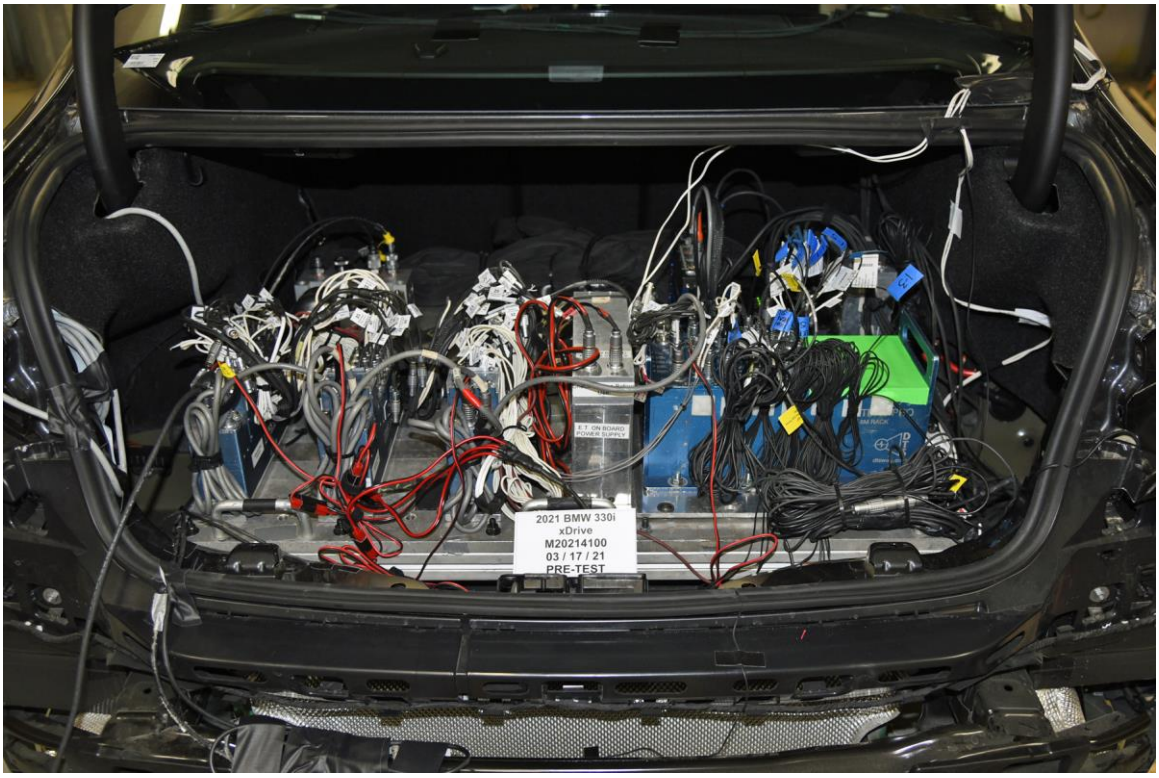


FIGURE 74. Photograph of Ballast Installed in Vehicle

Photograph Not Applicable

No Stoddard Solvent Spillage

FIGURE 75. Post-Test Stoddard Solvent Spillage Location View

FIGURE 76. Post-Test Speed Trap Read-Out

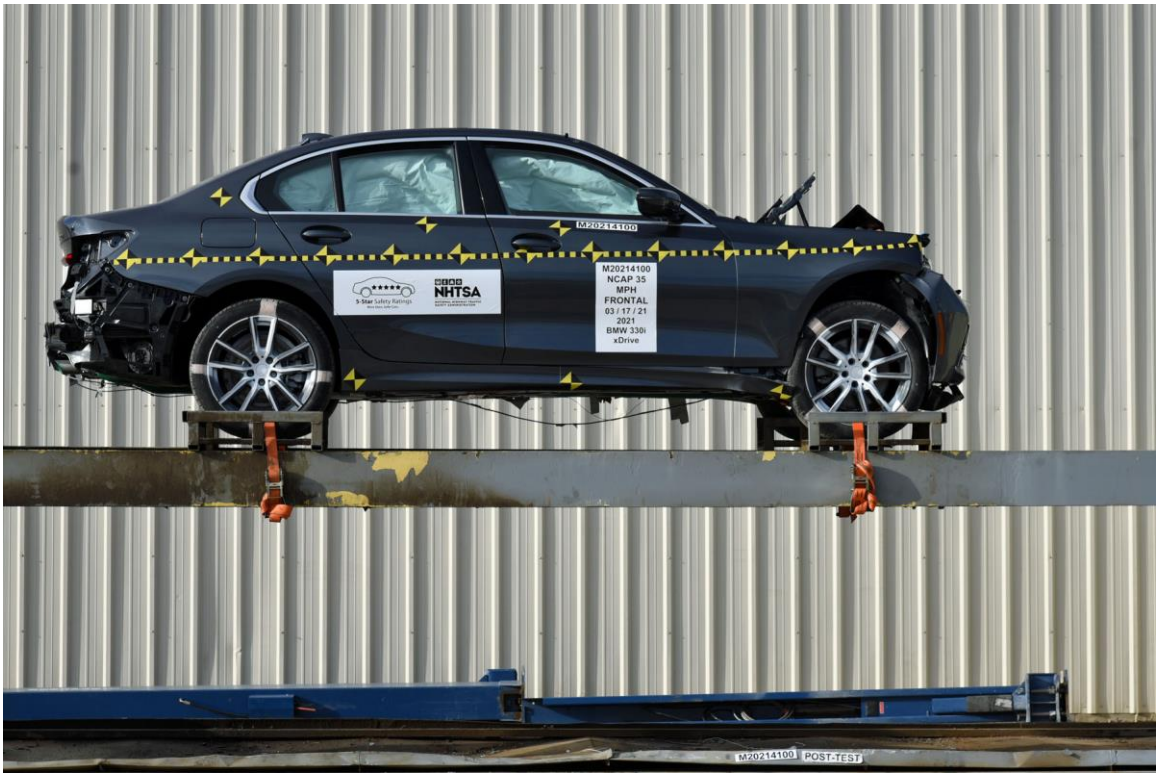


FIGURE 77. Vehicle at 0° on Static Rollover Device

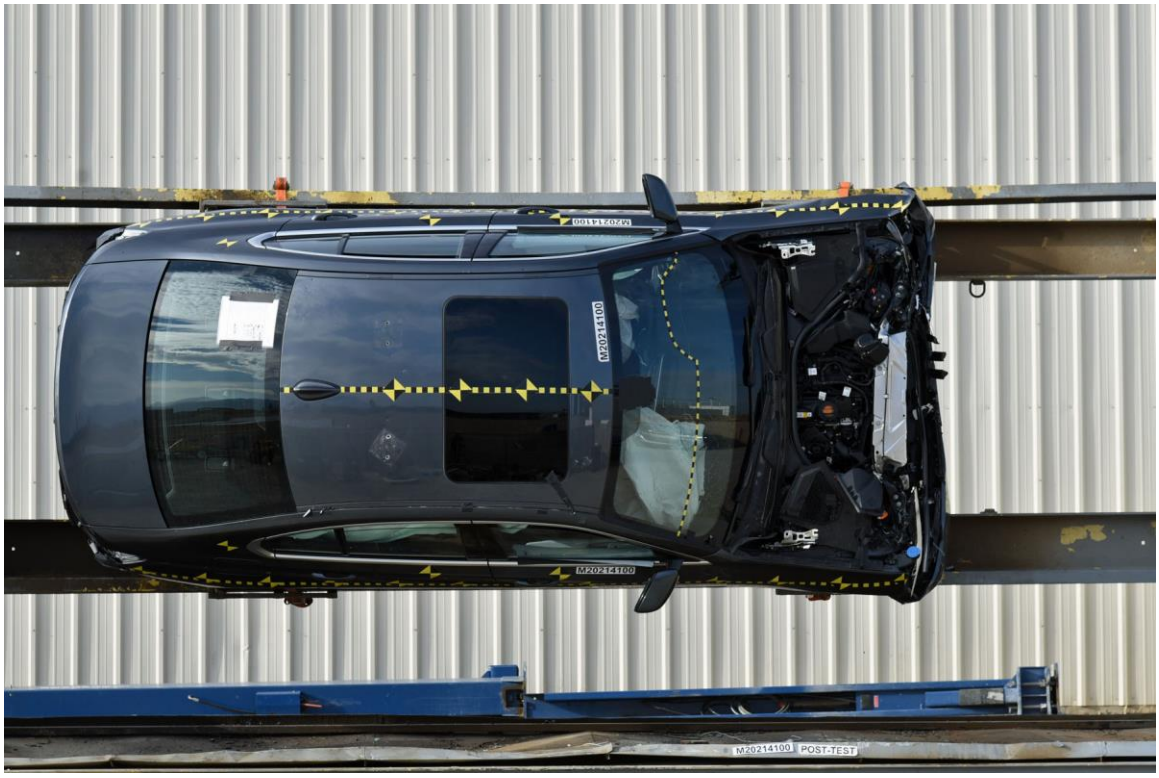


FIGURE 78. Vehicle at 90° on Static Rollover Device

FIGURE 79. Vehicle at 180° on Static Rollover Device

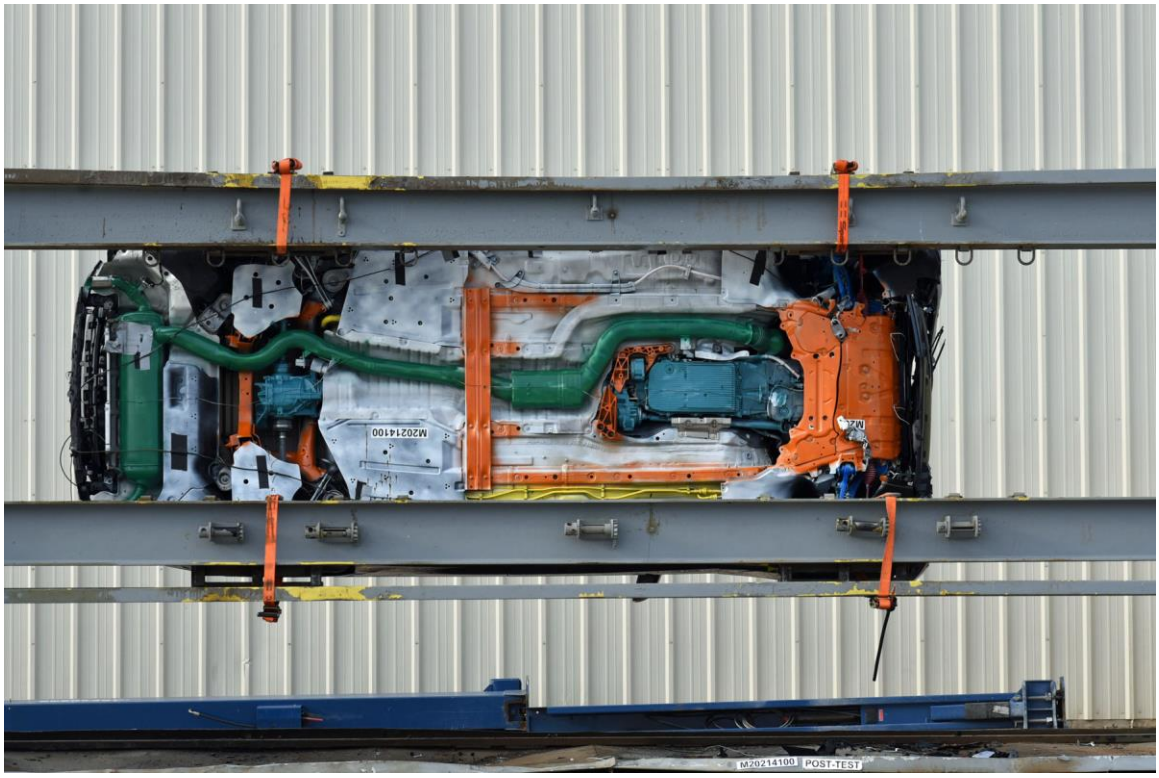


FIGURE 80. Vehicle at 270° on Static Rollover Device

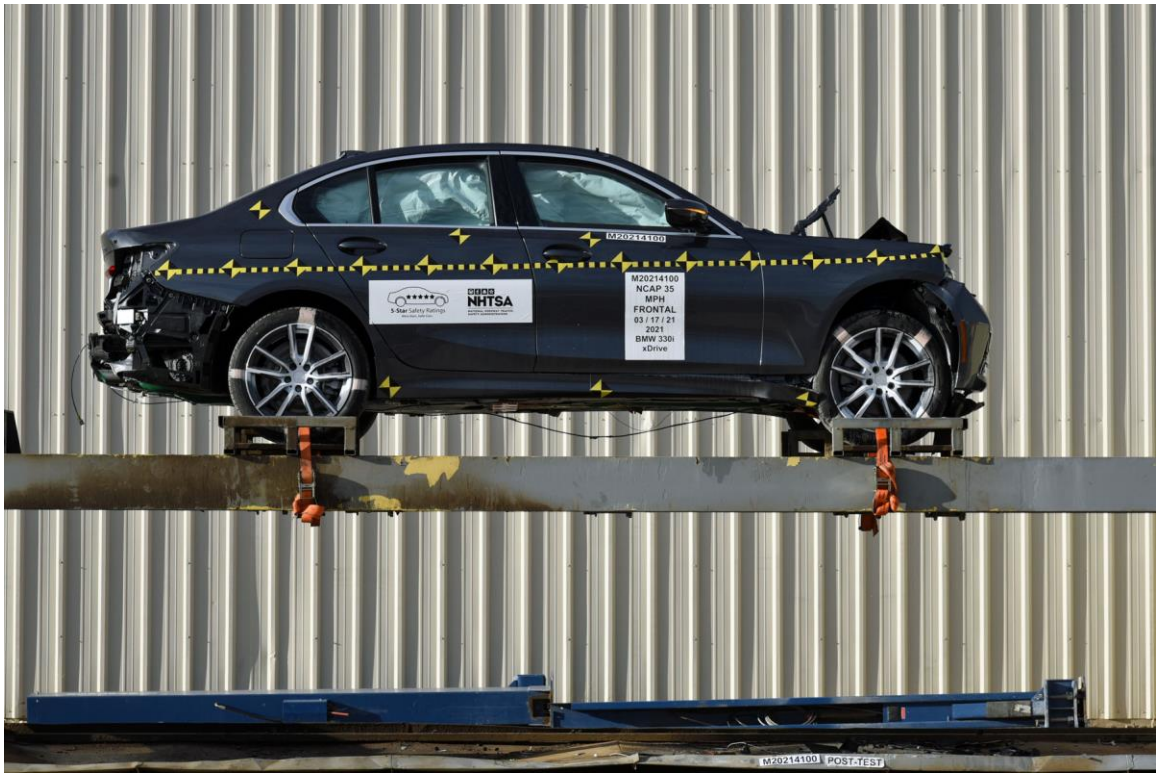


FIGURE 81. Vehicle at 360° on Static Rollover Device

FIGURE 82. 2021 BMW 330i xDrive Frontal Impact Event

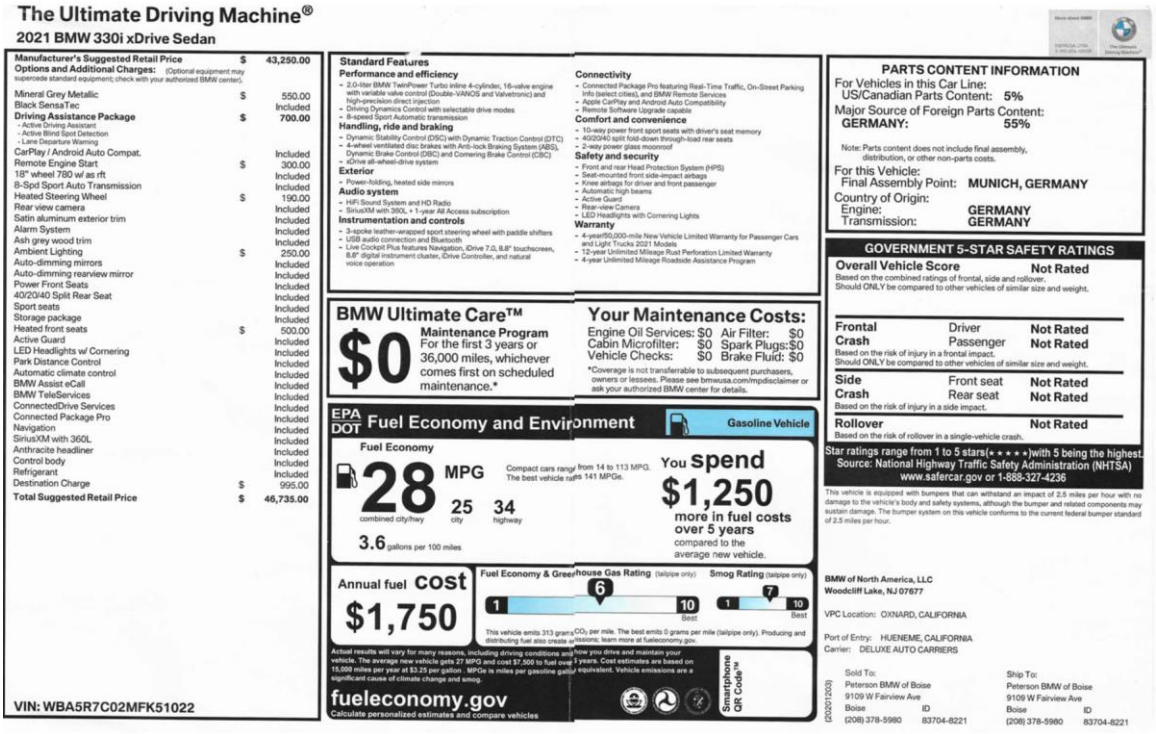


FIGURE 83. Monroney Label Photograph

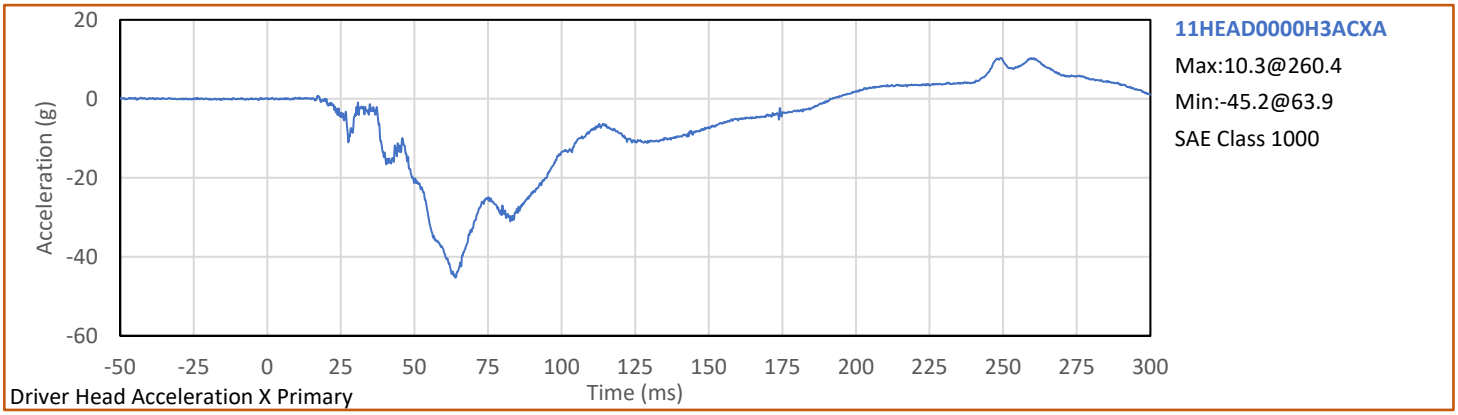
APPENDIX B
DUMMY RESPONSE DATA TRACES

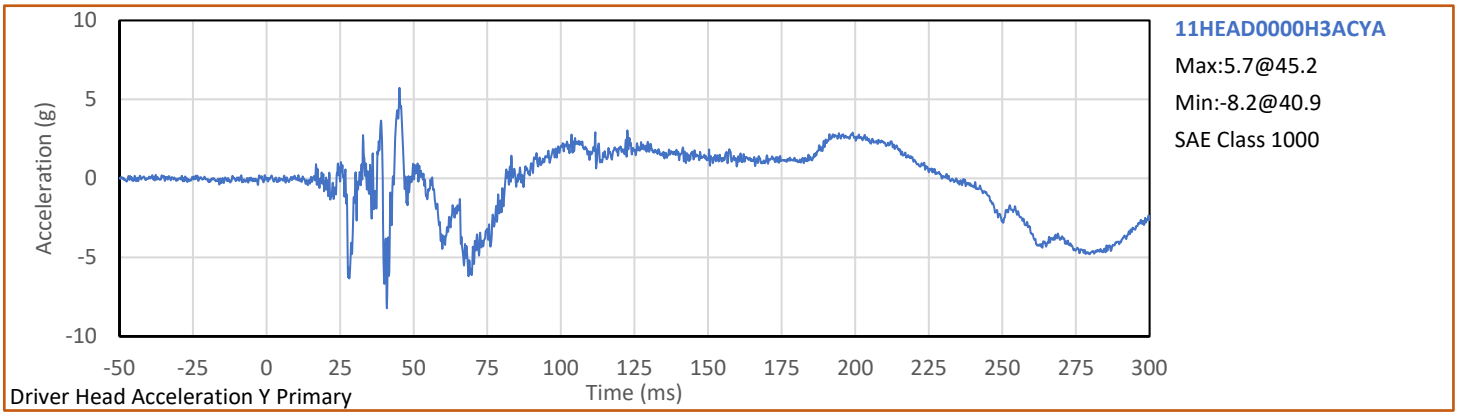
TABLE OF DATA PLOTS

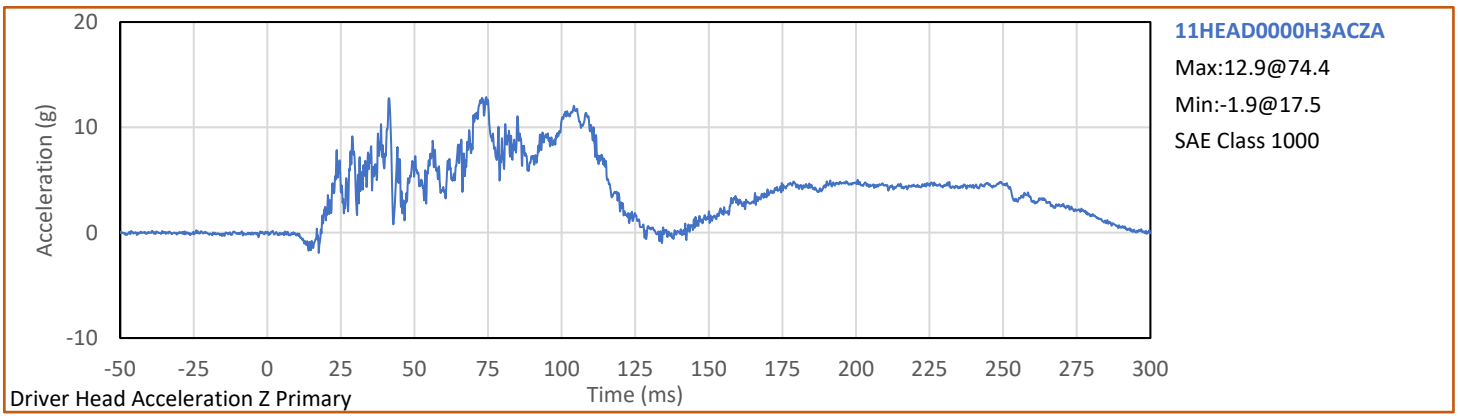
The following additional dummy and vehicle response data can be found in the R&D section of the NHTSA website at www.nhtsa.gov

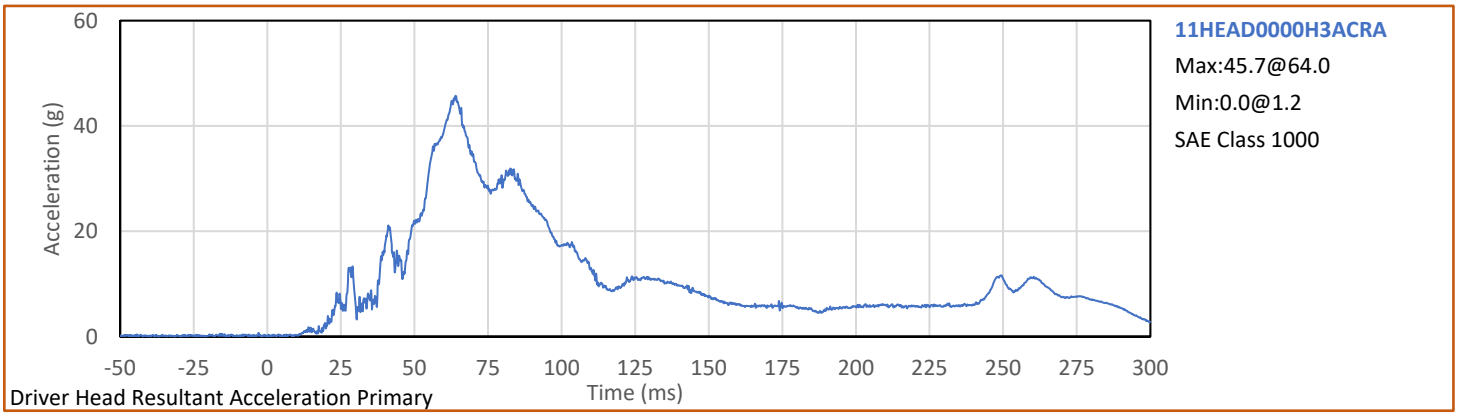
Driver Head X Acceleration Redundant
Driver Head Y Acceleration Redundant
Driver Head Z Acceleration Redundant
Driver Upper Neck Force Y
Driver Upper Neck Moment X
Driver Upper Neck Moment Z
Driver Chest X Acceleration Redundant
Driver Chest Y Acceleration Redundant
Driver Chest Z Acceleration Redundant
Driver Pelvis X
Driver Pelvis Y
Driver Pelvis Z
Driver Left Femur Force Z Redundant
Driver Right Femur Force Z Redundant
Driver Left Upper Tibia Moment X
Driver Left Upper Tibia Moment Y
Driver Left Upper Tibia Force Z
Driver Left Lower Tibia Moment X
Driver Left Lower Tibia Moment Y
Driver Left Lower Tibia Force Z
Driver Right Upper Tibia Moment X
Driver Right Upper Tibia Moment Y
Driver Right Upper Tibia Force Z
Driver Right Lower Tibia Moment X
Driver Right Lower Tibia Moment Y
Driver Right Lower Tibia Force Z
Driver Left Foot Fore Z
Driver Left Foot Aft X
Driver Left Foot Aft Z
Driver Right Foot Fore Z
Driver Right Foot Aft X
Driver Right Foot Aft Z
Driver Shoulder Belt Force
Driver Lap Belt Force
Driver Head Angular Velocity X
Driver Head Angular Velocity Y
Driver Head Angular Velocity Z
Passenger Head X Acceleration Redundant
Passenger Head Y Acceleration Redundant
Passenger Head Z Acceleration Redundant
Passenger Upper Neck Force X
Passenger Upper Neck Force Z
Passenger Upper Neck Moment Y

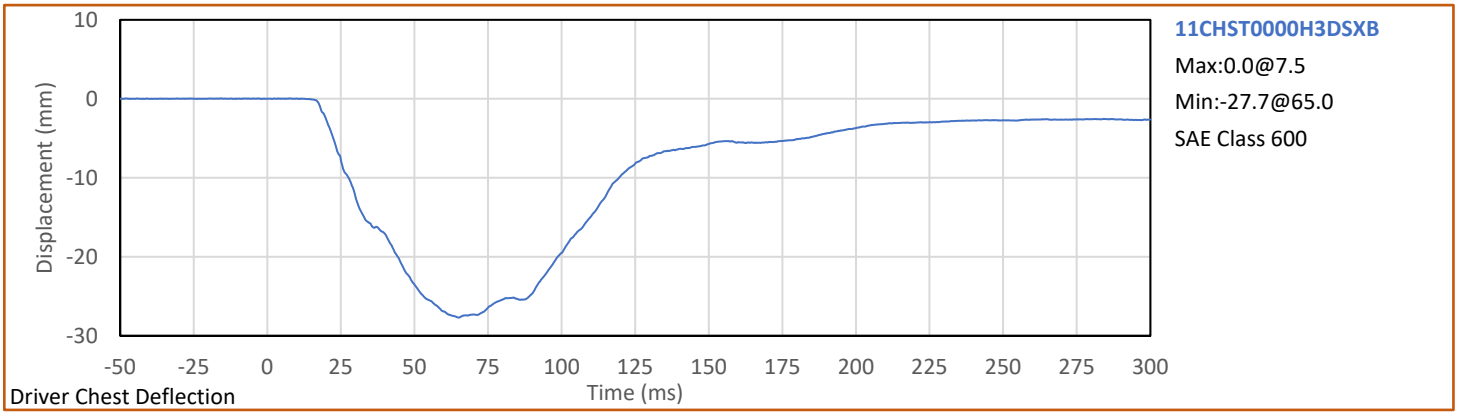
Passenger Chest X Acceleration Redundant
Passenger Chest Y Acceleration Redundant
Passenger Chest Z Acceleration Redundant
Passenger Pelvis X
Passenger Pelvis Y
Passenger Pelvis Z
Passenger Left Femur Force Redundant
Passenger Right Femur Force Redundant
Passenger Left Upper Tibia Moment X
Passenger Left Upper Tibia Moment Y
Passenger Left Upper Tibia Force Z
Passenger Left Lower Tibia Moment X
Passenger Left Lower Tibia Moment Y
Passenger Left Lower Tibia Force Z
Passenger Right Upper Tibia Moment X
Passenger Right Upper Tibia Moment Y
Passenger Right Upper Tibia Force Z
Passenger Right Lower Tibia Moment X
Passenger Right Lower Tibia Moment Y
Passenger Right Lower Tibia Force Z
Passenger Left Foot Fore Z
Passenger Left Foot Aft X
Passenger Left Foot Aft Z
Passenger Right Foot Fore Z
Passenger Right Foot Aft X
Passenger Right Foot Aft Z
Passenger Shoulder Belt Force
Passenger Lap Belt Force
Passenger Head Angular Velocity X
Passenger Head Angular Velocity Y
Passenger Head Angular Velocity Z
Left Rear Seat Crossmember X
Left Rear Seat Crossmember Z
Right Rear Seat Crossmember X
Right Rear Seat Crossmember Z
Left Rear Seat Crossmember X Redundant
Right Rear Seat Crossmember X Redundant
Vehicle Engine Top X
Vehicle Engine Bottom X
Load Cell Barrier Forces and Moments


11HEAD0000H3ACXA
Max:10.3@260.4
Min:-45.2@63.9
SAE Class 1000
Acceleration (g)
Time (ms)
Driver Head Acceleration X Primary

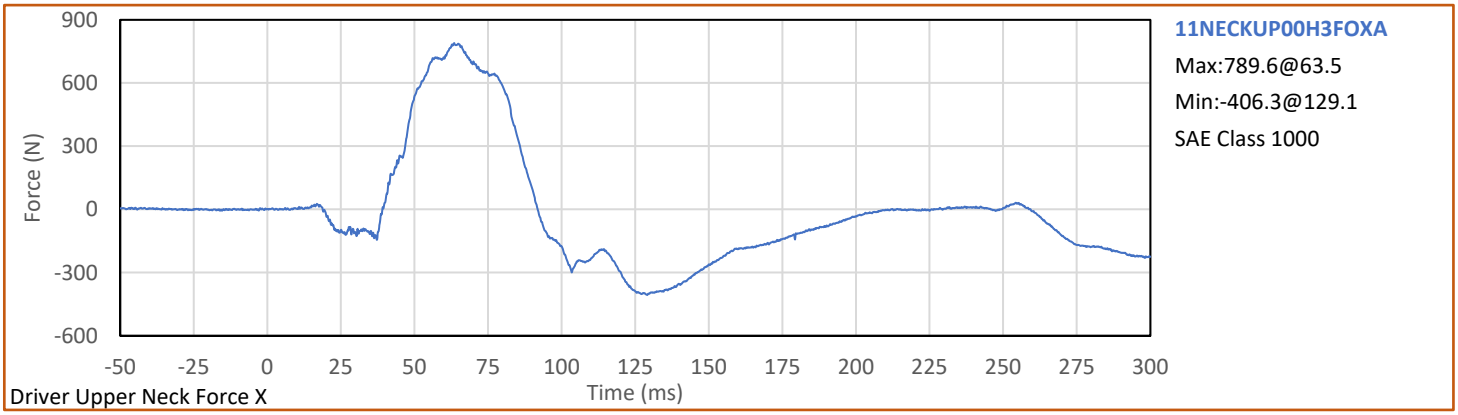

11HEAD0000H3ACYA
Max:5.7@45.2
Min:-8.2@40.9
SAE Class 1000
Acceleration (g)
Time (ms)
Driver Head Acceleration Y Primary

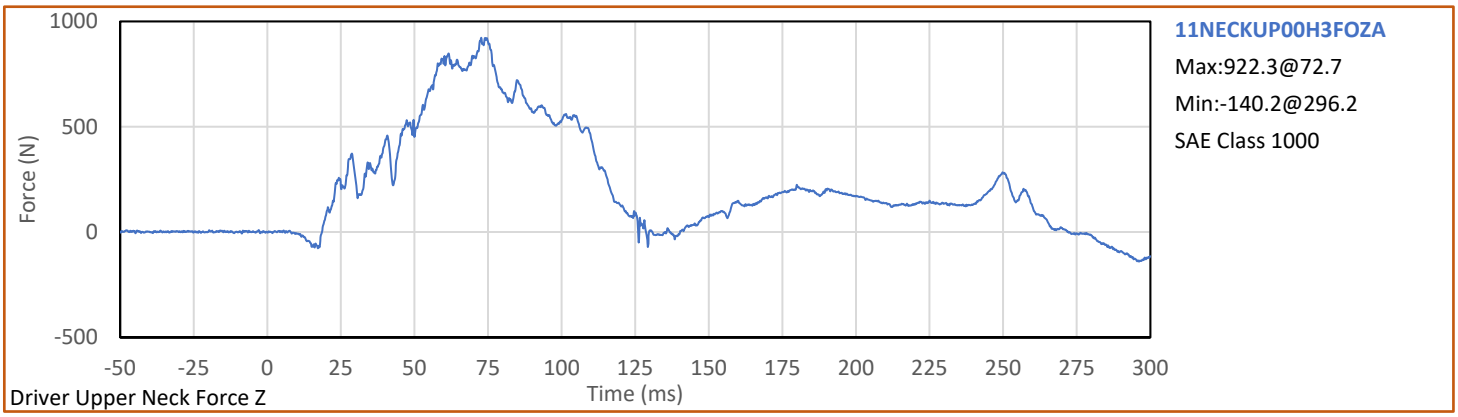

11HEAD0000H3ACZA
Max:12.9@74.4
Min:-1.9@17.5
SAE Class 1000
Acceleration (g)
Time (ms)
Driver Head Acceleration Z Primary

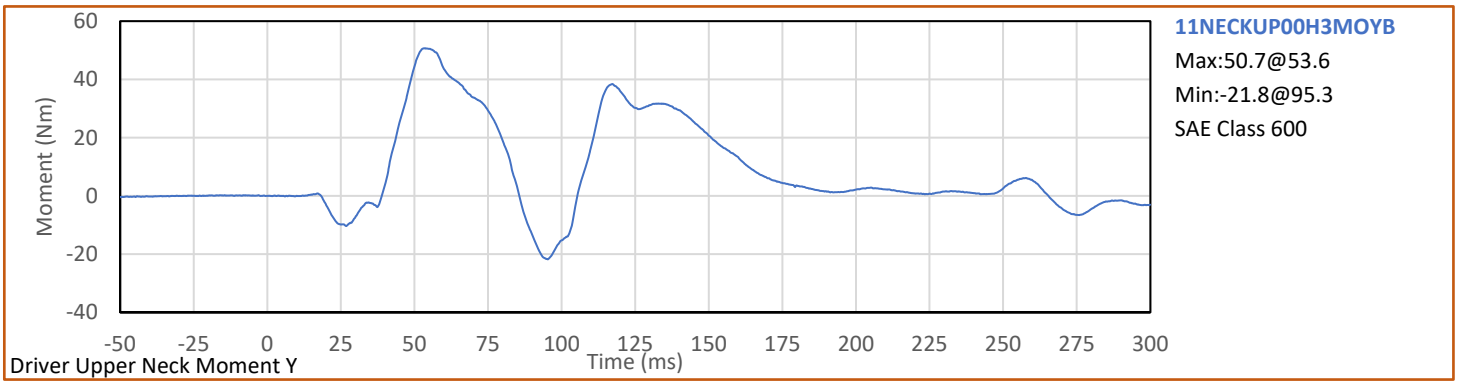

11HEAD0000H3ACRA
Max:45.7@64.0
Min:0.0@1.2
SAE Class 1000
Acceleration (g)
Time (ms)
Driver Head Resultant Acceleration Primary

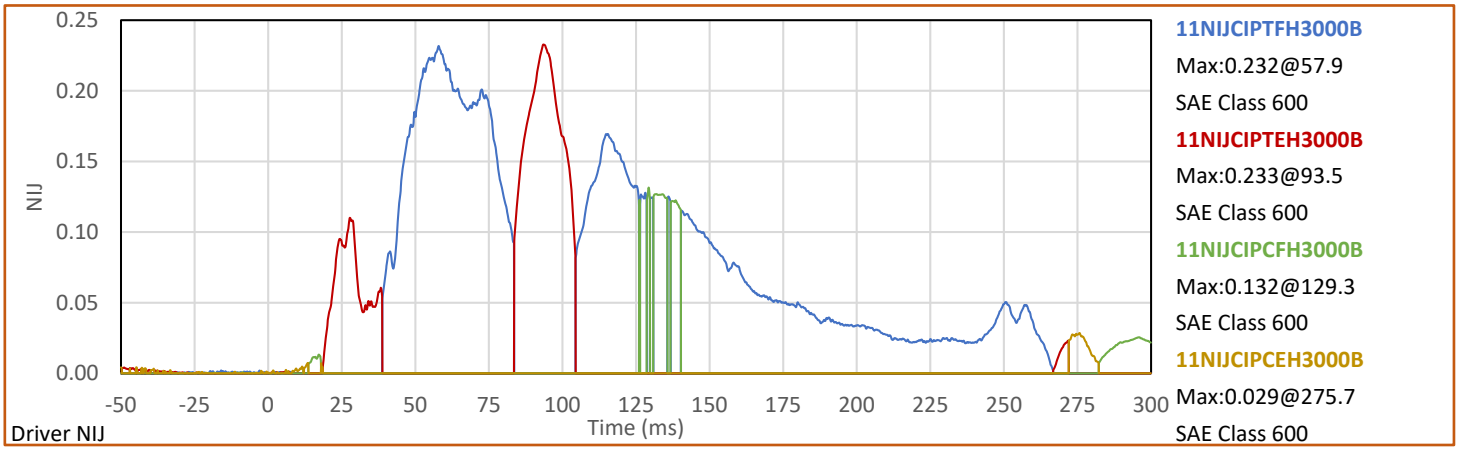


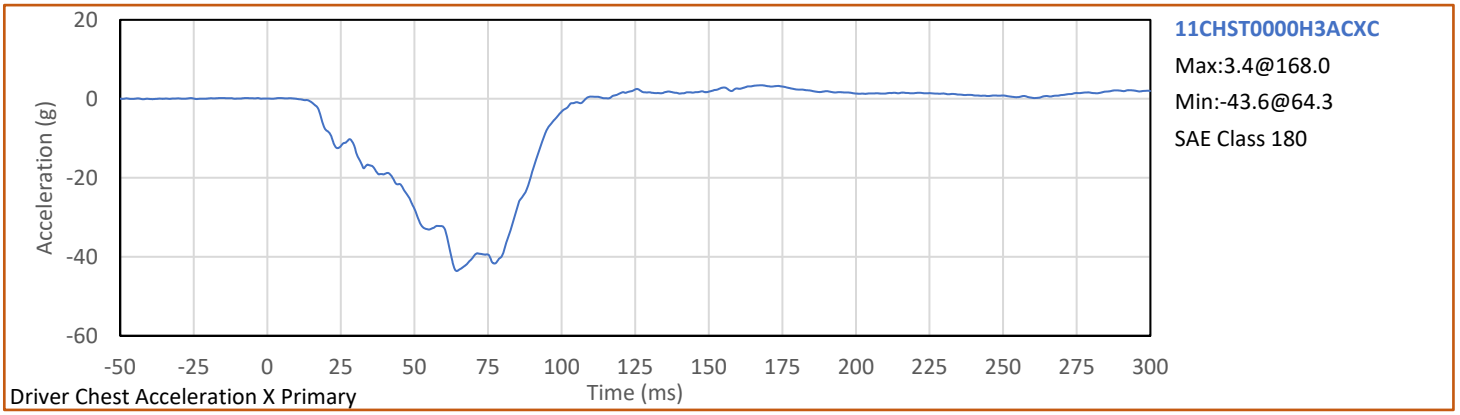
Driver Chest Deflection


900
600
300
0
-300
-600
Force (N)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
11NECKUP00H3FOXA
Max:789.6@63.5
Min:-406.3@129.1
SAE Class 1000
Driver Upper Neck Force X


1000
500
0
-500
Force (N)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
11NECKUP00H3FOZA
Max:922.3@72.7
Min:-140.2@296.2
SAE Class 1000
Driver Upper Neck Force Z

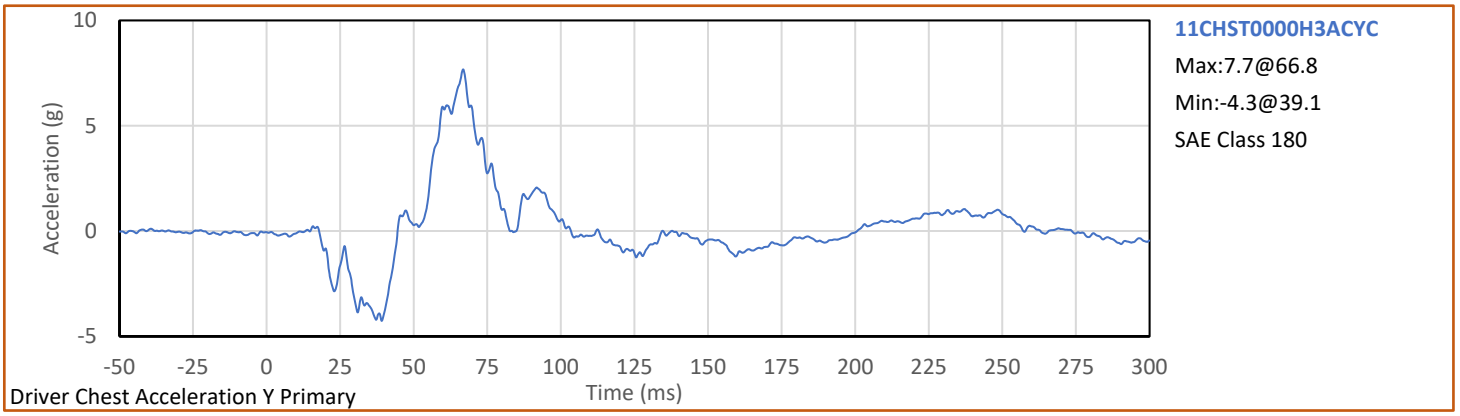

60
40
20
0
-20
-40
Moment (Nm)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
11NECKUP00H3MOYB
Max:50.7@53.6
Min:-21.8@95.3
SAE Class 600
Driver Upper Neck Moment Y


0.25
0.20
0.15
0.10
0.05
0.00
NIJ
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
11NIJCIPTFH3000B
Max:0.232@57.9
SAE Class 600
11NIJCIPTEH3000B
Max:0.233@93.5
SAE Class 600
11NIJCIPCFH3000B
Max:0.132@129.3
SAE Class 600
11NIJCIPCEH3000B
Max:0.029@275.7
SAE Class 600
Driver NIJ



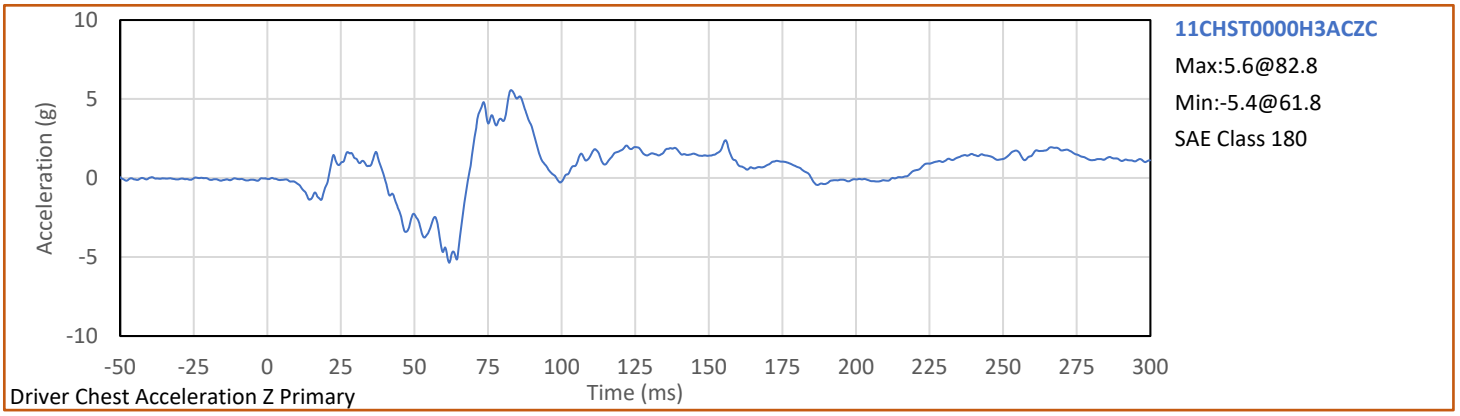
Driver Chest Acceleration X Primary

11CHST0000H3ACXC
Max:3.4@168.0
Min:-43.6@64.3
SAE Class 180



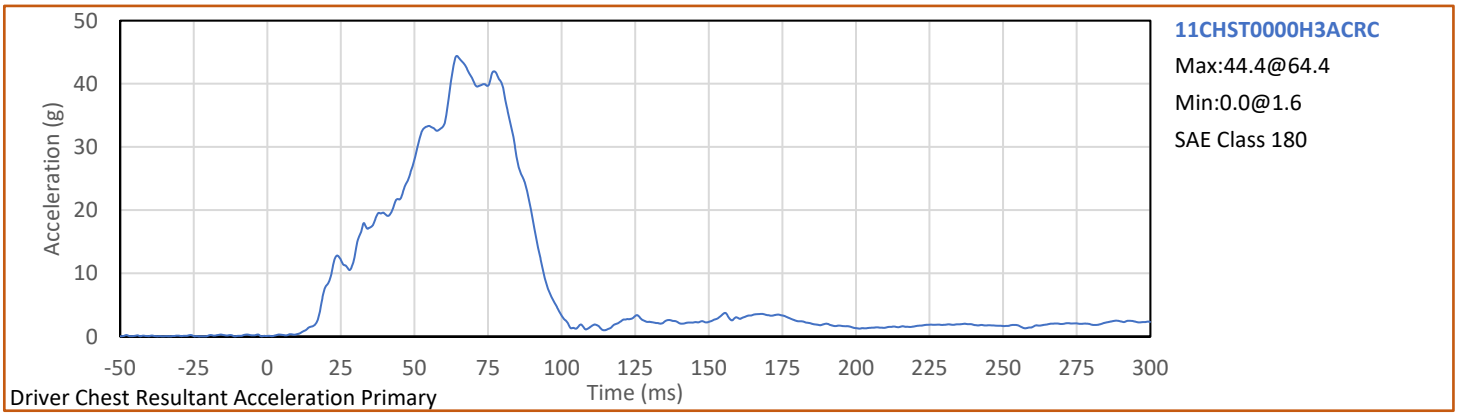
Driver Chest Acceleration Y Primary

11CHST0000H3ACYC
Max:7.7@66.8
Min:-4.3@39.1
SAE Class 180



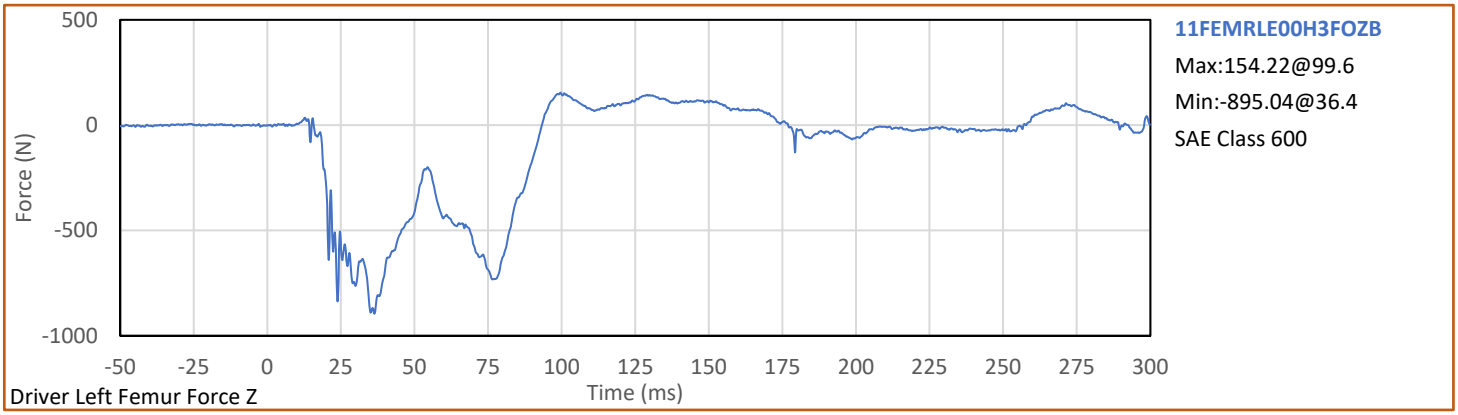
Driver Chest Acceleration Z Primary

11CHST0000H3ACZC
Max:5.6@82.8
Min:-5.4@61.8
SAE Class 180

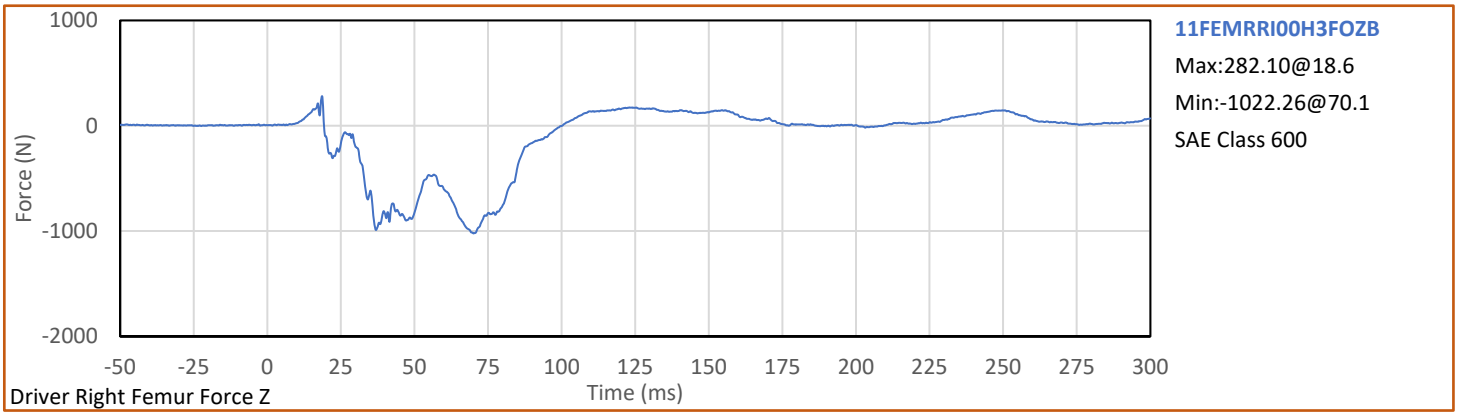


Driver Chest Resultant Acceleration Primary

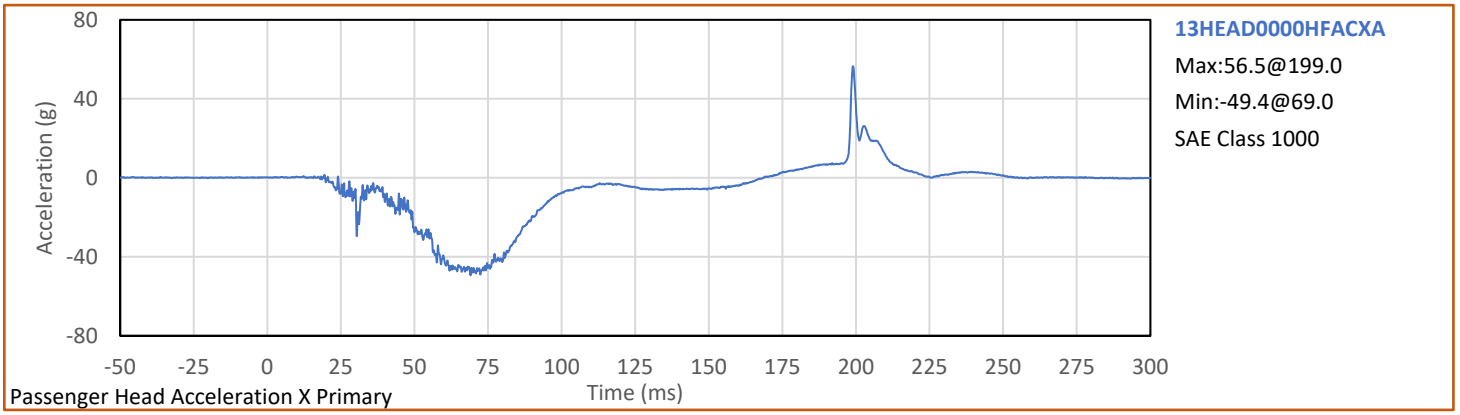
11CHST0000H3ACRC
Max:44.4@64.4
Min:0.0@1.6
SAE Class 180



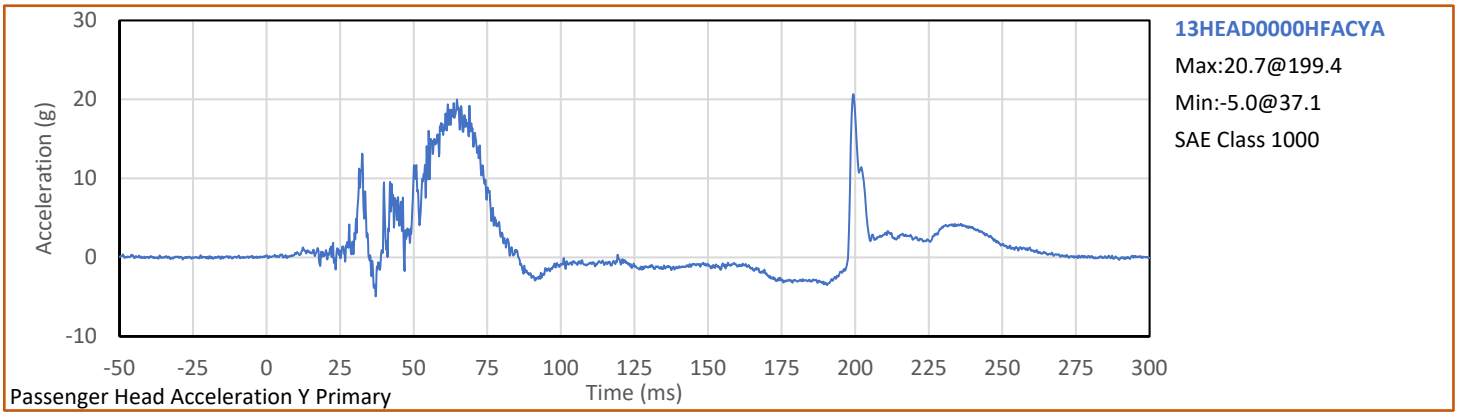
Driver Left Femur Force Z



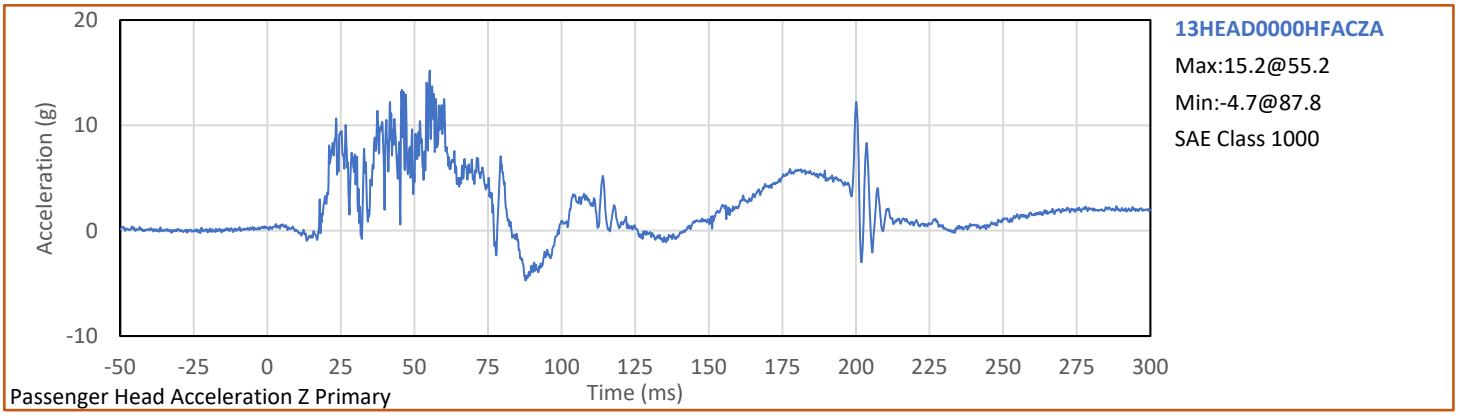
Driver Right Femur Force Z



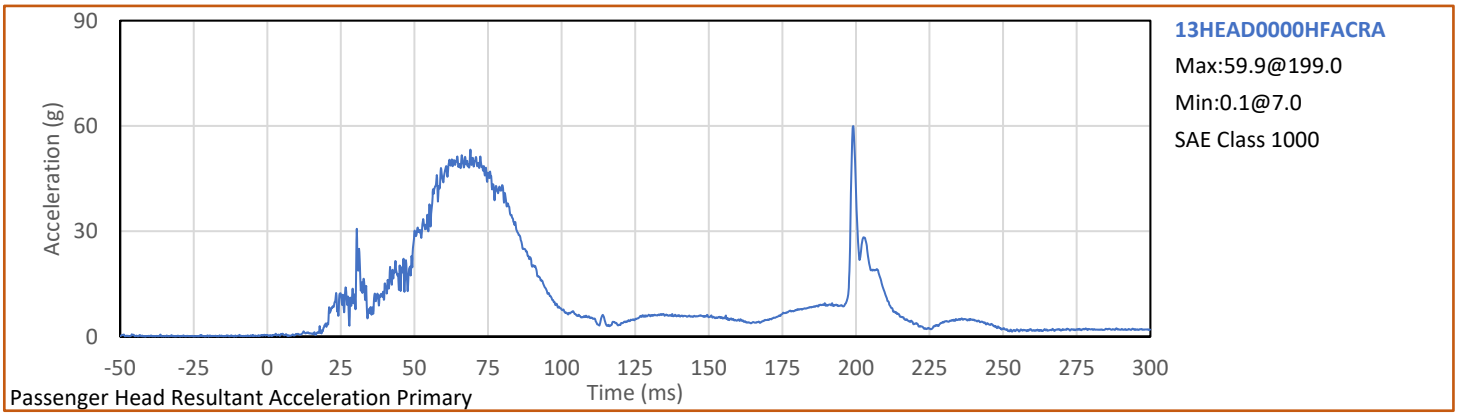
Passenger Head Acceleration X Primary



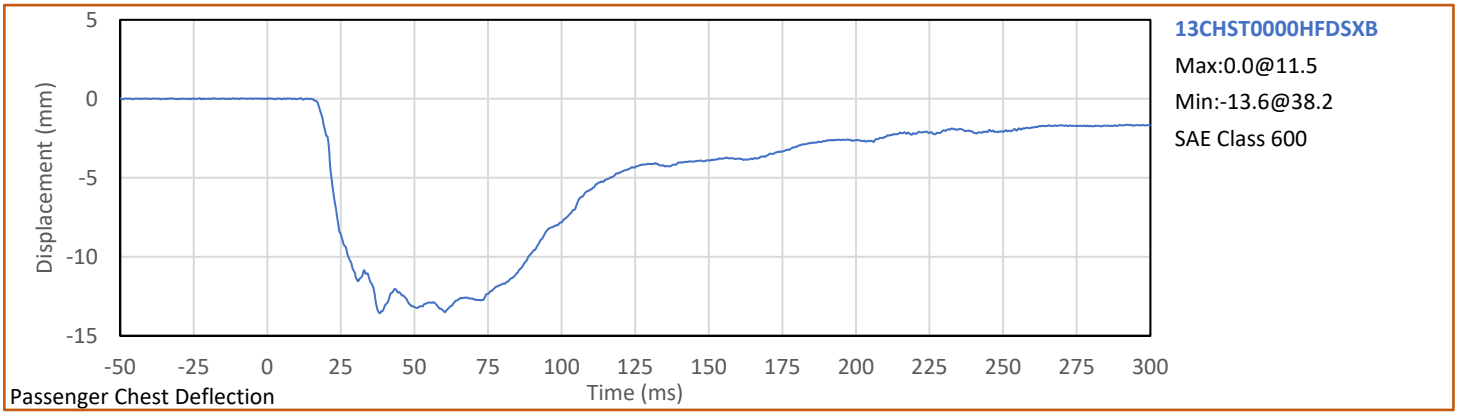
Passenger Head Acceleration Y Primary



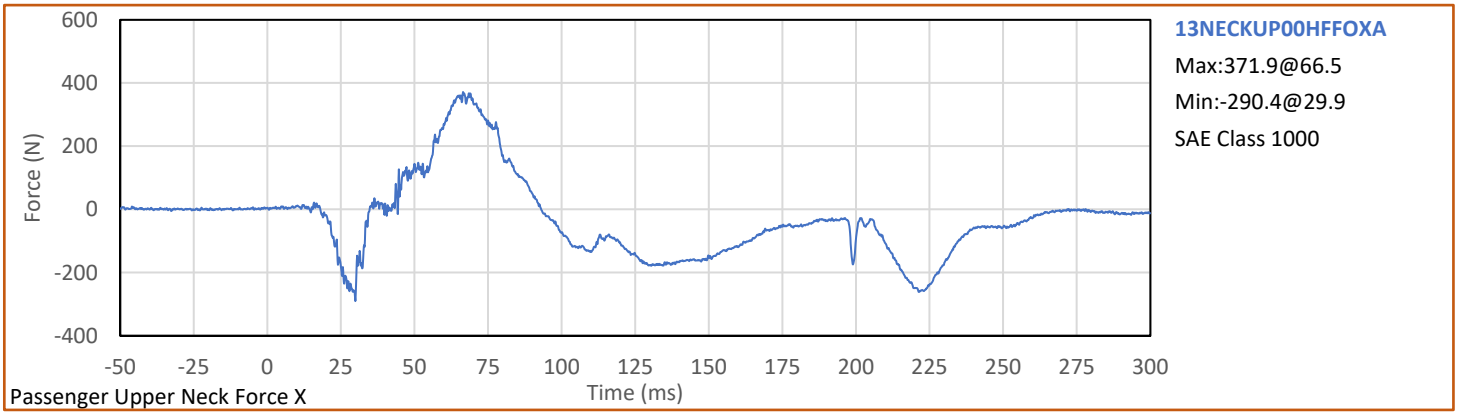
Passenger Head Acceleration Z Primary

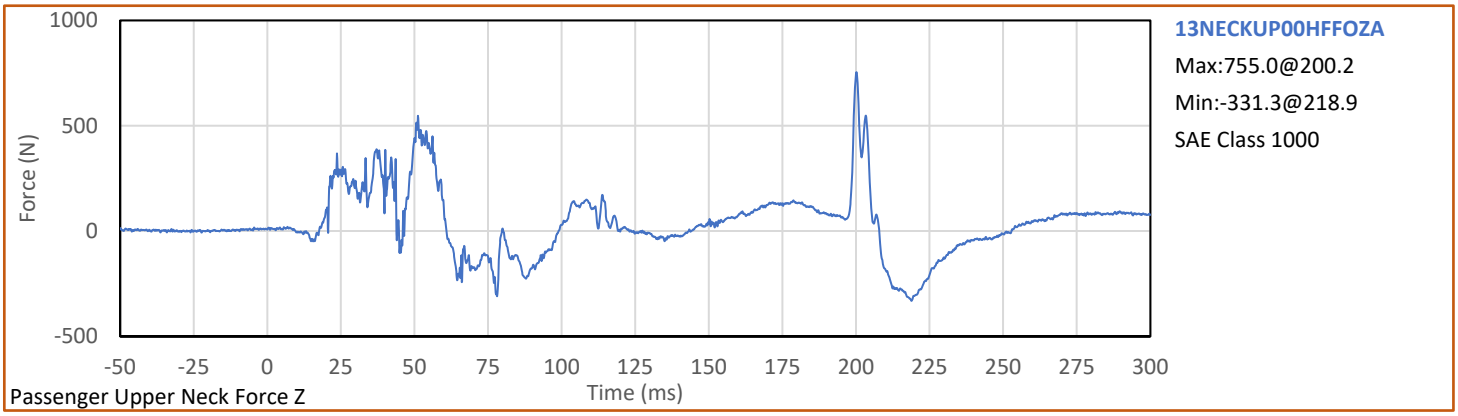


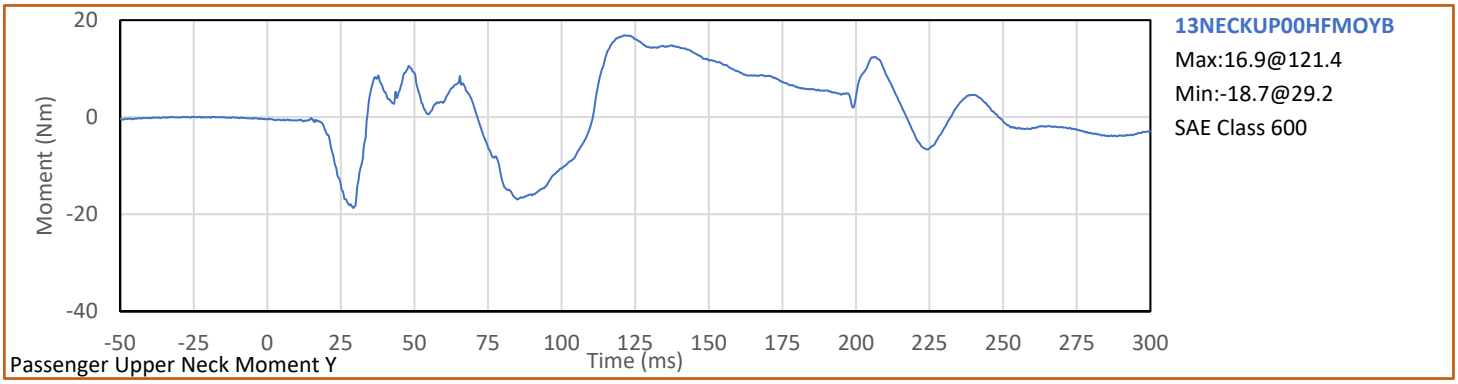
Passenger Head Resultant Acceleration Primary

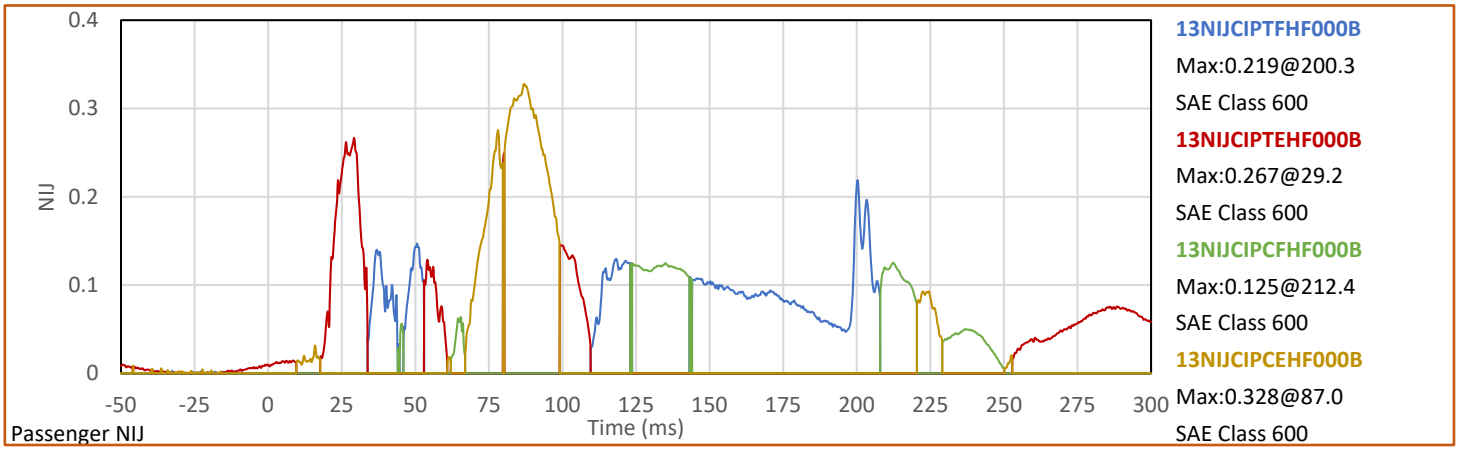


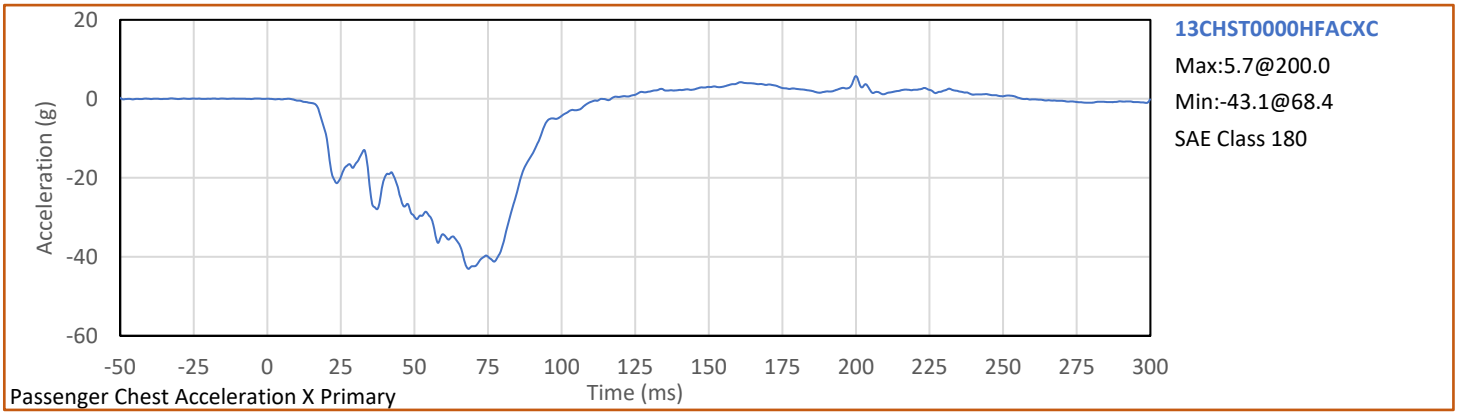
Passenger Chest Deflection


600
400
200
0
-200
-400
Force (N)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
Passenger Upper Neck Force X
13NECKUP00HFFOXA
Max:371.9@66.5
Min:-290.4@29.9
SAE Class 1000


1000
500
0
-500
Force (N)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
Passenger Upper Neck Force Z
13NECKUP00HFFOZA
Max:755.0@200.2
Min:-331.3@218.9
SAE Class 1000

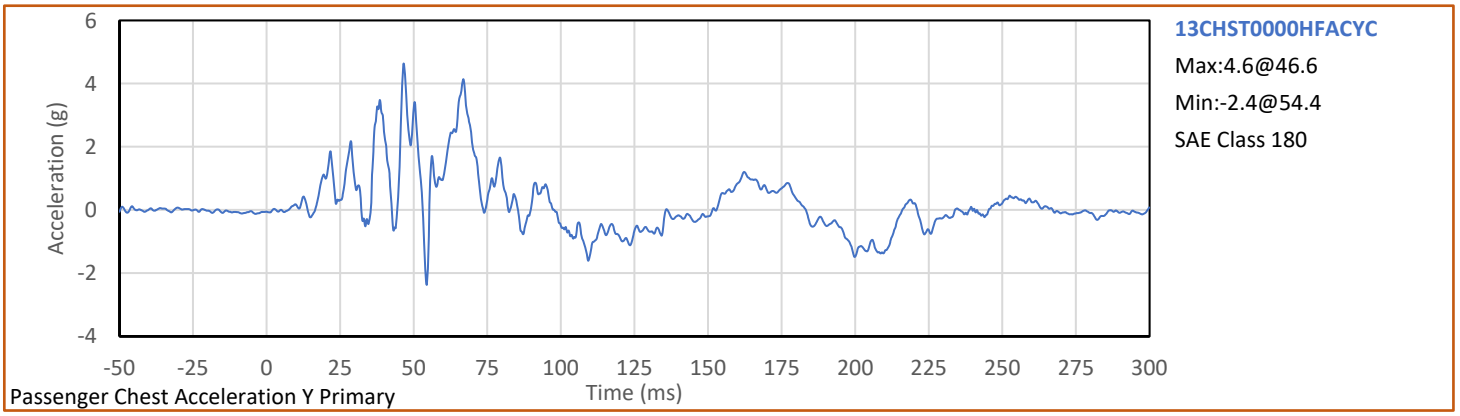

20
0
-20
-40
Moment (Nm)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
Passenger Upper Neck Moment Y
13NECKUP00HFMOYB
Max:16.9@121.4
Min:-18.7@29.2
SAE Class 600


0.4
0.3
0.2
0.1
0
NIJ
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
Passenger NIJ
13NIJCIPTFHF000B
Max:0.219@200.3
SAE Class 600
13NIJCIPTEHF000B
Max:0.267@29.2
SAE Class 600
13NIJCIPCFHF000B
Max:0.125@212.4
SAE Class 600
13NIJCIPCEHF000B
Max:0.328@87.0
SAE Class 600



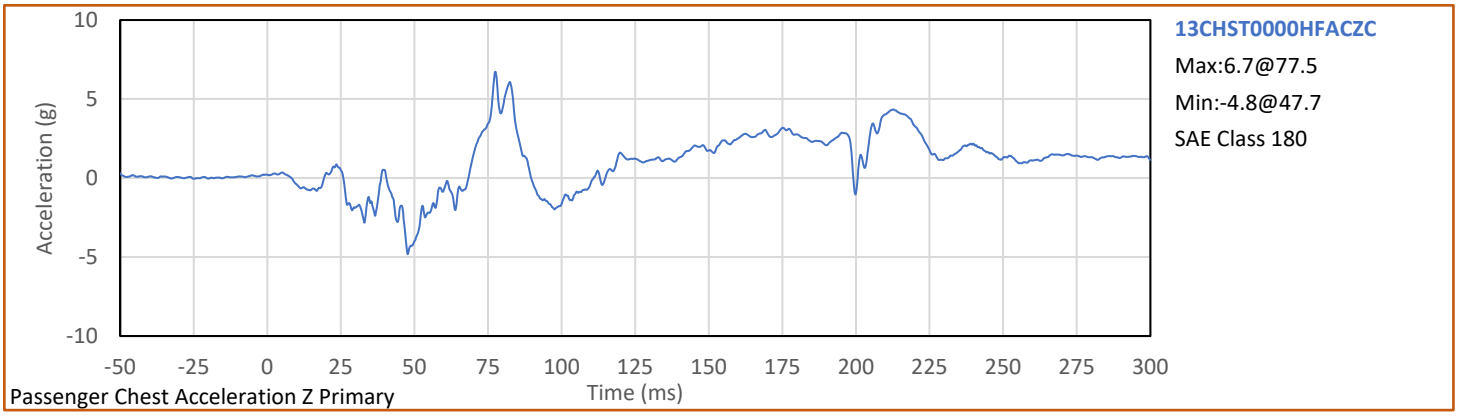
Passenger Chest Acceleration X Primary

13CHST0000HFACXC
Max:5.7@200.0
Min:-43.1@68.4
SAE Class 180



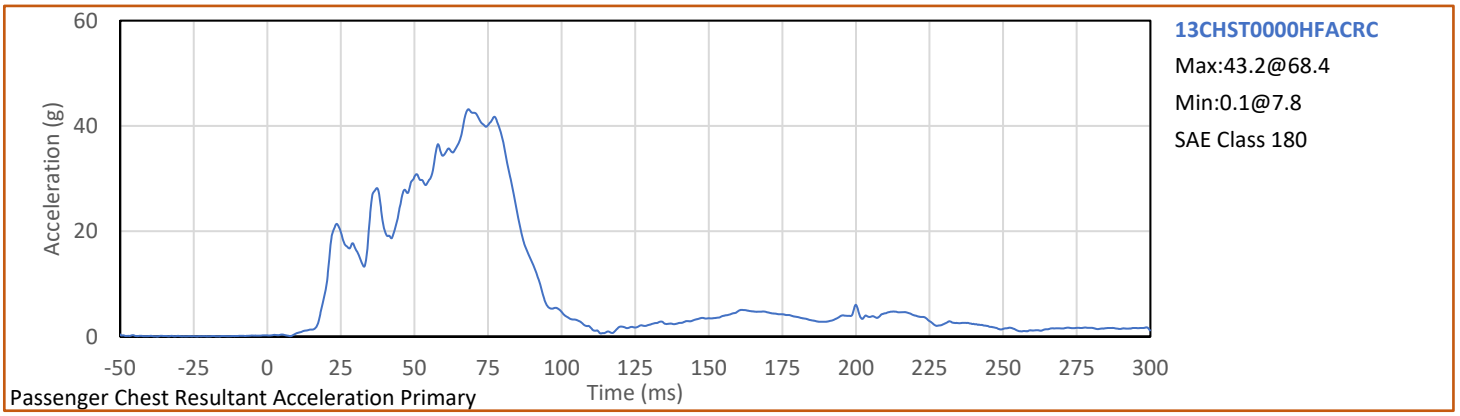
Passenger Chest Acceleration Y Primary

13CHST0000HFACYC
Max:4.6@46.6
Min:-2.4@54.4
SAE Class 180



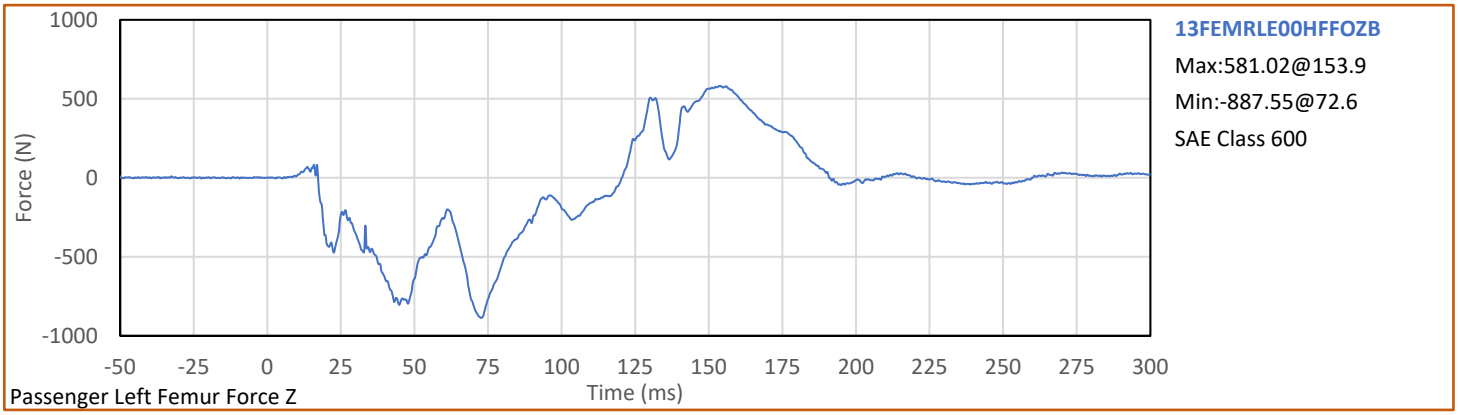
Passenger Chest Acceleration Z Primary

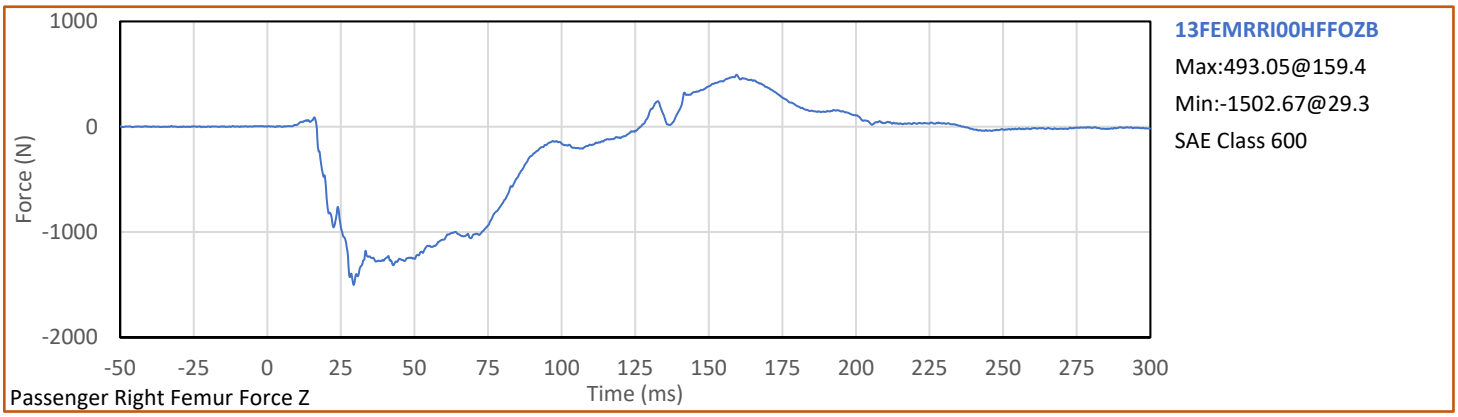
13CHST0000HFACZC
Max:6.7@77.5
Min:-4.8@47.7
SAE Class 180



Passenger Chest Resultant Acceleration Primary

13CHST0000HFACRC
Max:43.2@68.4
Min:0.1@7.8
SAE Class 180


1000
500
0
-500
-1000
Force (N)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
13FEMRLE00HFFOZB
Max:581.02@153.9
Min:-887.55@72.6
SAE Class 600
Passenger Left Femur Force Z


1000
0
-1000
-2000
Force (N)
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Time (ms)
13FEMRRI00HFFOZB
Max:493.05@159.4
Min:-1502.67@29.3
SAE Class 600
Passenger Right Femur Force Z

APPENDIX C

DUMMY QUALIFICATION AND PERFORMANCE VERIFICATION DATA

APPENDIX C
Pre-Test ATD Qualification and Performance Verification
Hybrid III 50th Percentile Male ATD
S/N: 360

Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
ATD Damage Checklist

ATD Serial No.: 360 Test Date: 2021-02-23

Dummy Item	Inspect for	Comments	Damage	OK
Entire ATD	Perform general cleaning			✓
Outer Skin	Gashes, rips, cracks			✓
Head	Ballast secure			✓
	General appearance			✓
Neck bracket	Upper neck firmly attached to lower bracket			✓
Neck	Broken or cracked rubber			✓
	Looseness at the condyle joint			✓
Nodding block	Cracked or out of position			✓
Lumbar Spine	Broken or cracked rubber			✓
Ribs	Broken or bent ribs			✓
	Broken or bent rib supports			✓
	Damping material separated or cracked			✓
	Rubber bumpers in place			✓
Chest Displ.	Bent shaft			✓
Assembly	Slider arm riding in track			✓
Sensors	Check cables for cuts, tears			✓
	Check for damaged insulation			✓
Accelerometer	Head mounting secure			✓
Mounting	Chest mounting secure			✓
Knees	Skin condition			✓
	Insert (do not remove)			✓
	Casting			✓
Limbs	Normal movement and adjustment			✓
Knee Sliders	Wires intact			✓
	Rubber returned to "resting" position			✓
Pelvis	Broken			✓
Other	Describe below as needed			✓

Describe any repairs or replacement of parts or other findings:

No Problems Found

Technician: J. Hernandez

Approved By: P. Puzzuto

Applus IDIADA
KARCO

Hybrid III 50th Percentile Male ATD
External Measurements

ATD Serial No.: 360 Test Date: 2021-02-23

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.4	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
A - Total sitting height	mm	879	889	885	Pass
B - Shoulder pivot height	mm	505	521	517	Pass
C - 'H' point height	mm	84	89	88	Pass
D - 'H' point location from backline	mm	135	140	138	Pass
E - Shoulder pivot from backline	mm	84	94	89	Pass
F - Thigh clearance	mm	140	155	147	Pass
G - Back of elbow to wrist pivot	mm	290	305	294	Pass
H - Head back to backline	mm	41	46	46	Pass
I - Shoulder to elbow length	mm	330	345	338	Pass
J - Elbow rest height	mm	190	211	204	Pass
K - Buttock to knee length	mm	579	604	596	Pass
L - Popliteal length	mm	429	455	446	Pass
M - Knee pivot height	mm	485	500	498	Pass
N - Buttock popliteal length	mm	452	477	464	Pass
O - Chest depth without jacket	mm	213	229	217	Pass
P - Foot length	mm	251	267	258	Pass
V - Shoulder breadth	mm	422	437	429	Pass
W - Foot breadth	mm	91	107	98	Pass
Y - Chest circum. (w/chest jacket)	mm	970	1001	988	Pass
Z - Waist circum.	mm	836	866	851	Pass
AA - Location for chest circum.	mm	429	434	431	Pass
BB - Location for waist circum.	mm	226	231	228	Pass
			Overall Test Results		Pass

Technician: J. Hernandez

Approved By: P. Puzzuto

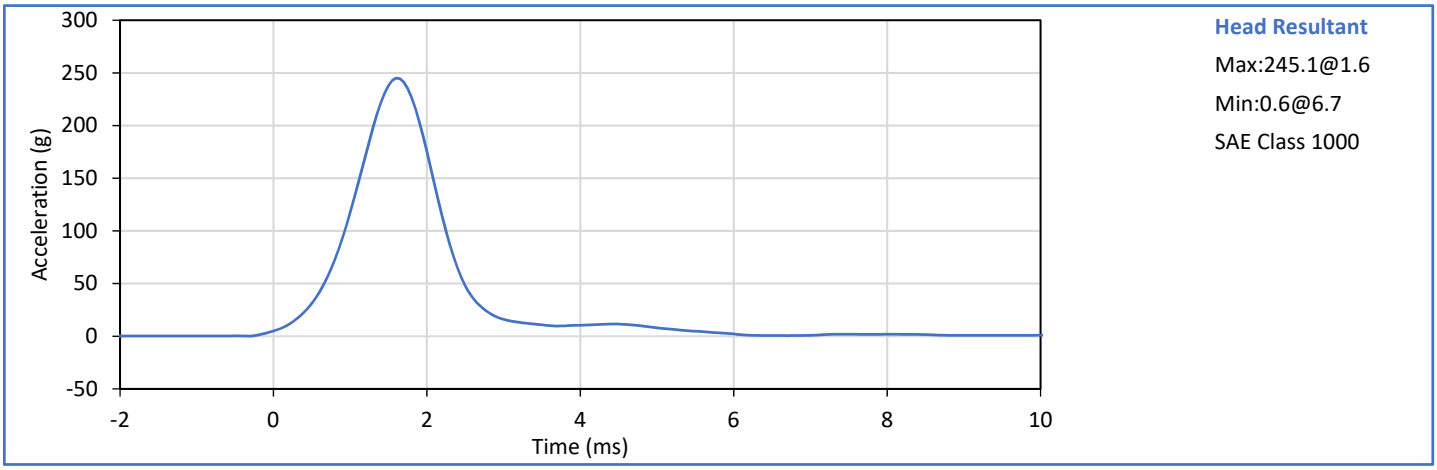
Applus IDIADA KARCO

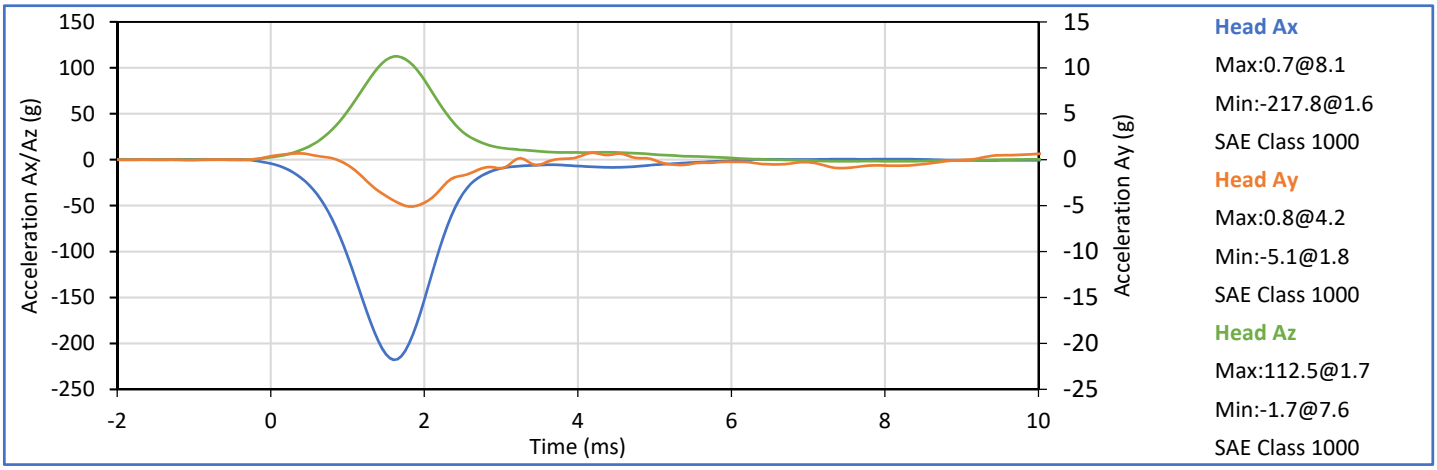
Hybrid III 50th Percentile Male ATD
Head Drop

ATD Serial No.: 360

Test Date: 2021-02-26

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	18.9	25.6	21.7	Pass
Laboratory Relative Humidity	%	10	70	12	Pass
Peak Resultant Acceleration	g	225.0	275.0	245.1	Pass
Peak Lateral Acceleration	g	-15.0	15.0	-5.1	Pass
Oscillations After Main Pulse	%	0.0	10.0	1.8	Pass
Is Acceleration Unimodal?	Yes/No	Yes		Yes	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

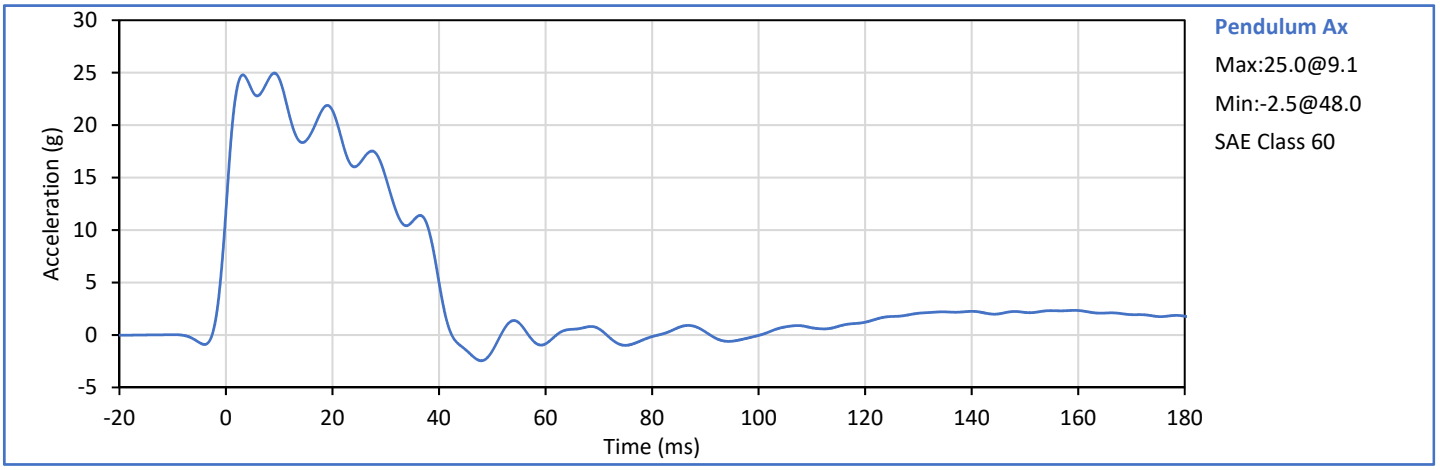
Approved By: P. Puzzuto

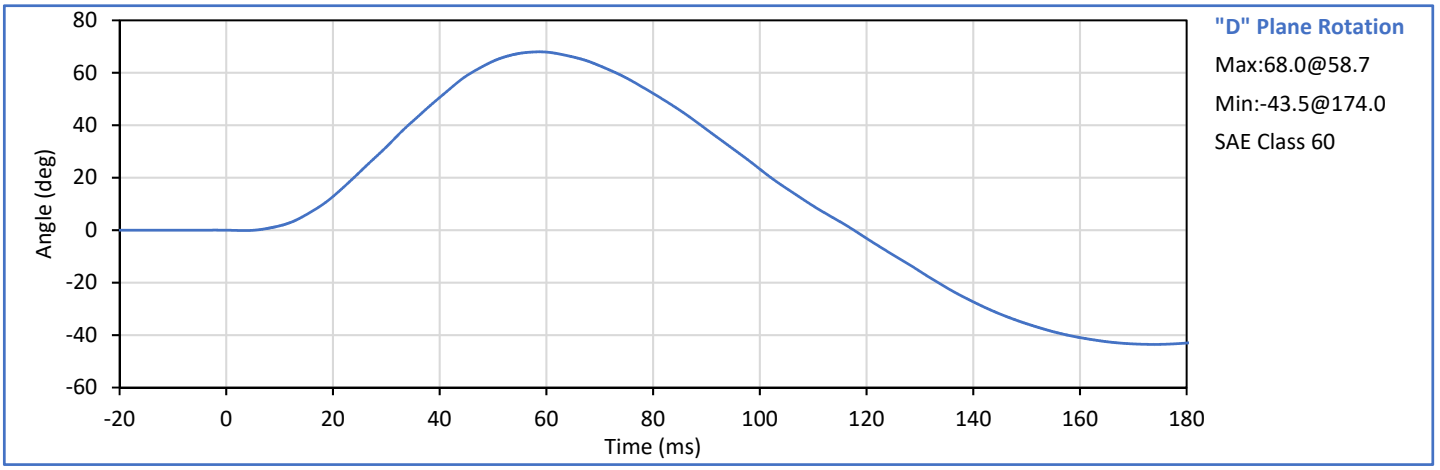
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Neck Flexion Test

ATD Serial No.: 360 Test Date: 2021-02-25

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
Pendulum Velocity	m/s	6.89	7.13	7.04	Pass
Pendulum Deceleration at 10 ms	g	22.5	27.5	24.4	Pass
Pendulum Deceleration at 20 ms	g	17.6	22.6	21.4	Pass
Pendulum Deceleration at 30 ms	g	12.5	18.5	15.0	Pass
Peak Pendulum Decel. after 30 ms	g	0.0	29.0	15.0	Pass
Deceleration Decay to Cross 5 g	ms	34.0	42.0	40.0	Pass
"D" Plane Rotation peak	deg	64.0	78.0	68.0	Pass
	ms	57.0	64.0	58.7	Pass
"D" Plane Rotation Decay To Zero	ms	113.0	128.0	117.7	Pass
Moment About Occipital Condyle	Nm	88.1	108.5	99.3	Pass
	ms	47.0	58.0	52.9	Pass
Moment Decay, Peak to Zero	ms	97.0	107.0	99.5	Pass
			Overall Test Results		Pass



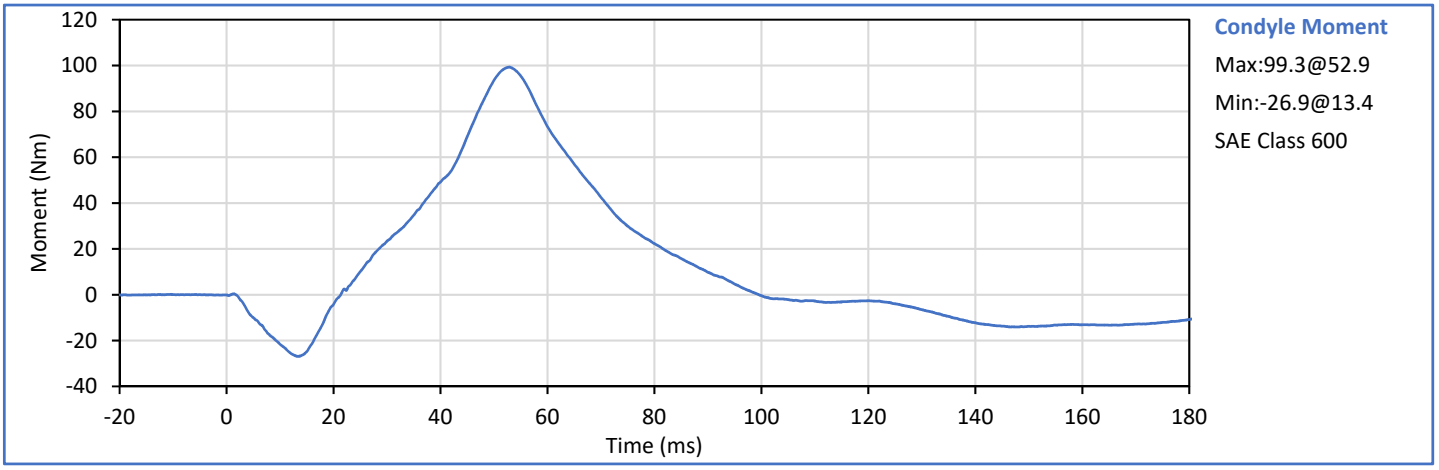


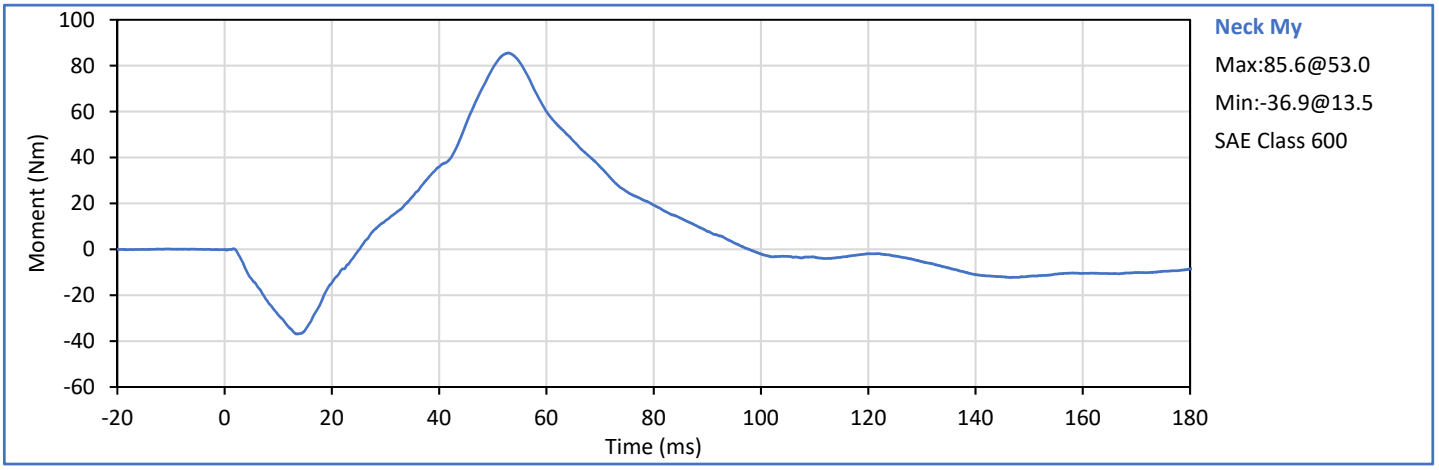
Technician: J. Hernandez

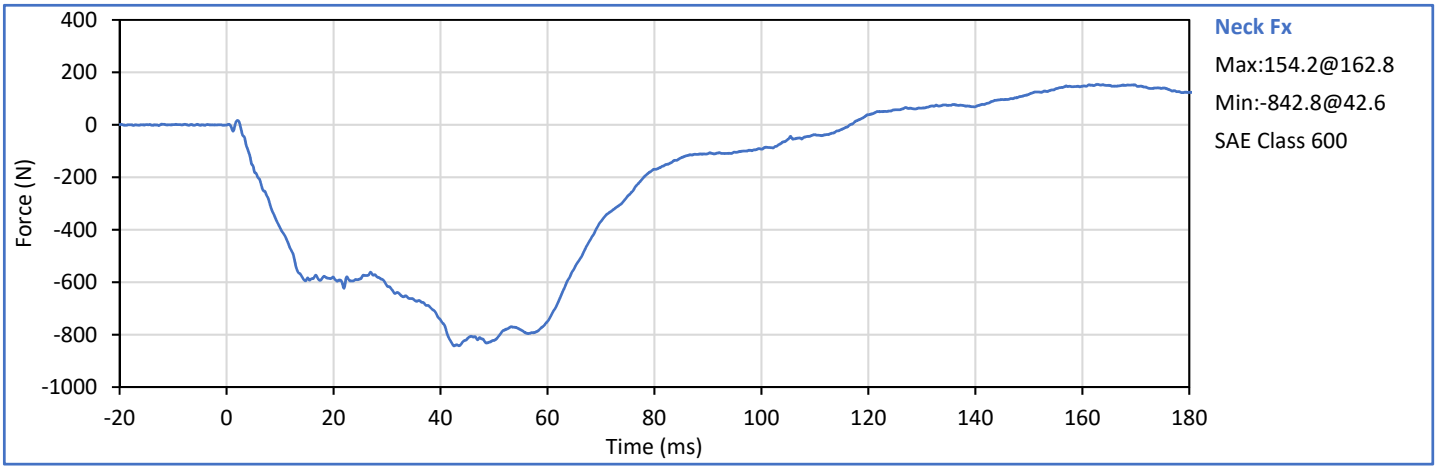
Approved By: P. Puzzuto

Hybrid III 50th Percentile Male ATD
Neck Flexion Test

ATD Serial No.: 360 Test Date: 2021-02-25





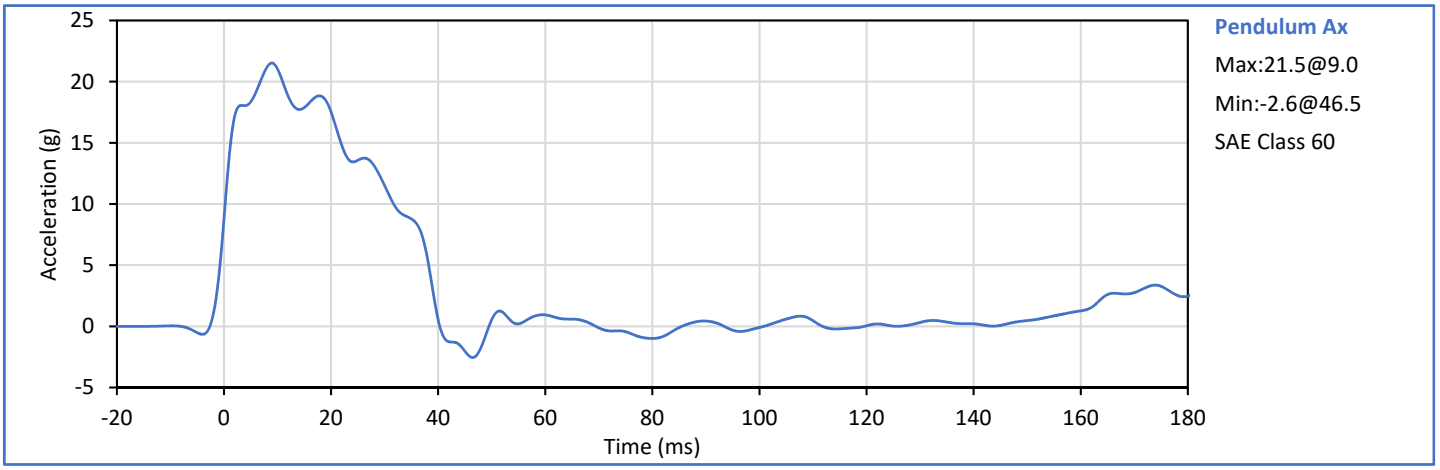


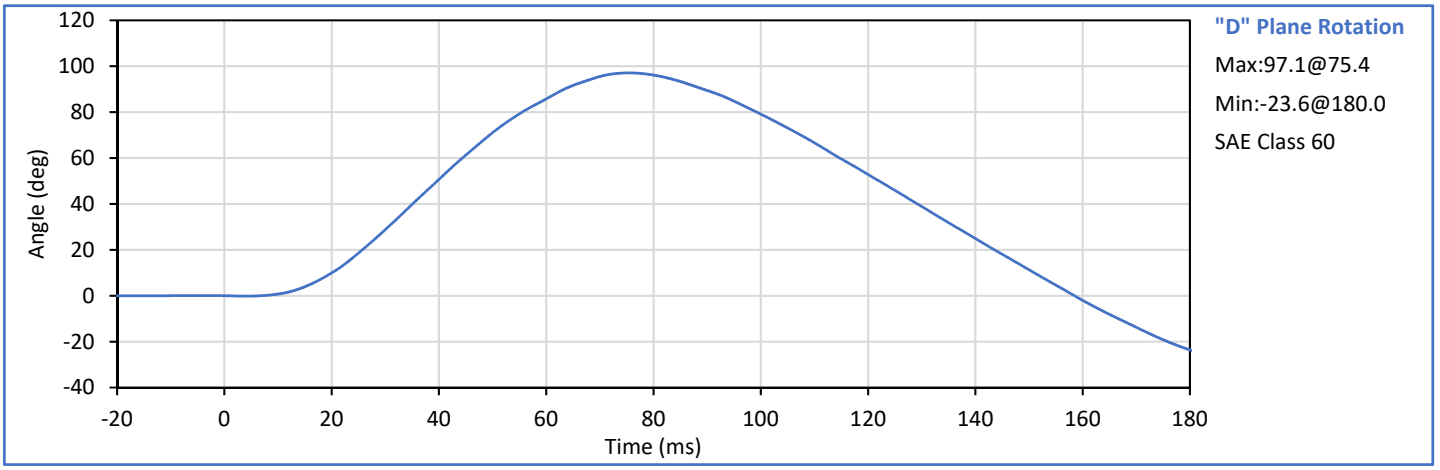
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Neck Extension Test

ATD Serial No.: 360 Test Date: 2021-02-25

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
Pendulum Velocity	m/s	5.94	6.19	6.10	Pass
Pendulum Deceleration at 10 ms	g	17.2	21.2	21.0	Pass
Pendulum Deceleration at 20 ms	g	14.0	19.0	17.5	Pass
Pendulum Deceleration at 30 ms	g	11.0	16.0	11.5	Pass
Peak Pendulum Decel. after 30 ms	g	0.0	22.0	11.5	Pass
Deceleration Decay to Cross 5 g	ms	38.0	46.0	38.2	Pass
"D" Plane Rotation peak	deg	81.0	106.0	97.1	Pass
	ms	72.0	82.0	75.4	Pass
"D" Plane Rotation Decay To Zero	ms	147.0	174.0	158.5	Pass
Moment About Occipital Condyle	Nm	-79.9	-52.9	-72.5	Pass
	ms	65.0	79.0	69.9	Pass
Moment Decay, Peak to Zero	ms	120.0	148.0	137.3	Pass
			Overall Test Results		Pass





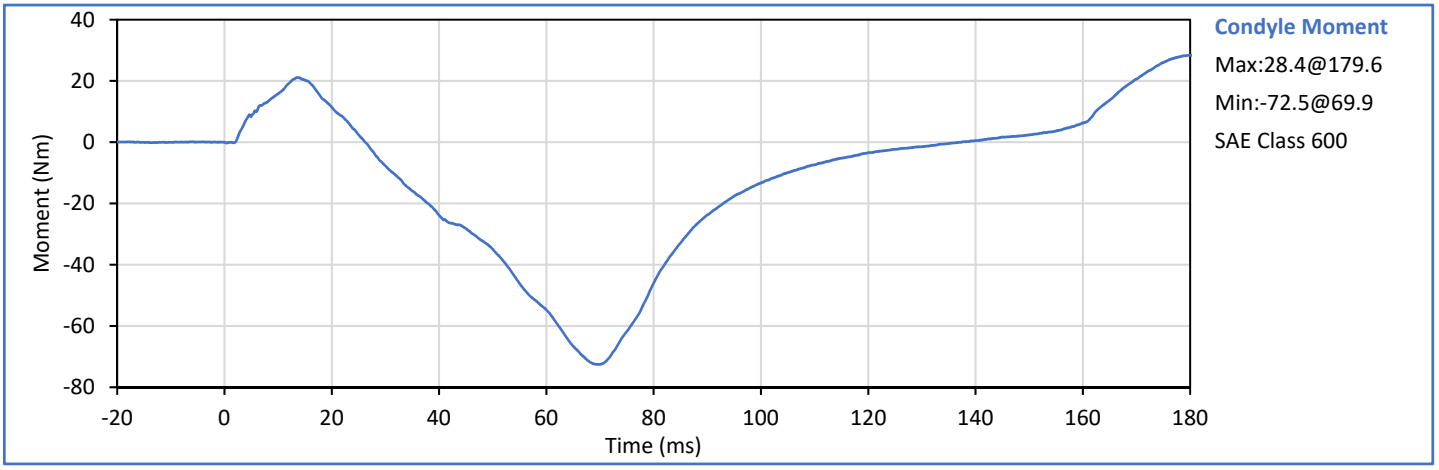
Technician: J. Hernandez

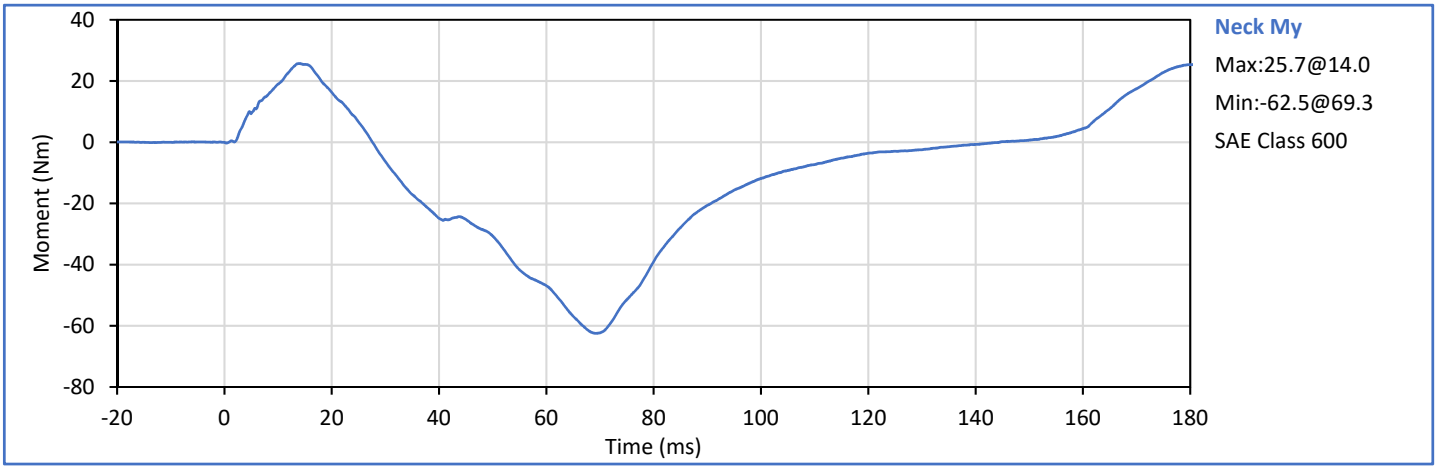
Approved By: P. Puzzuto

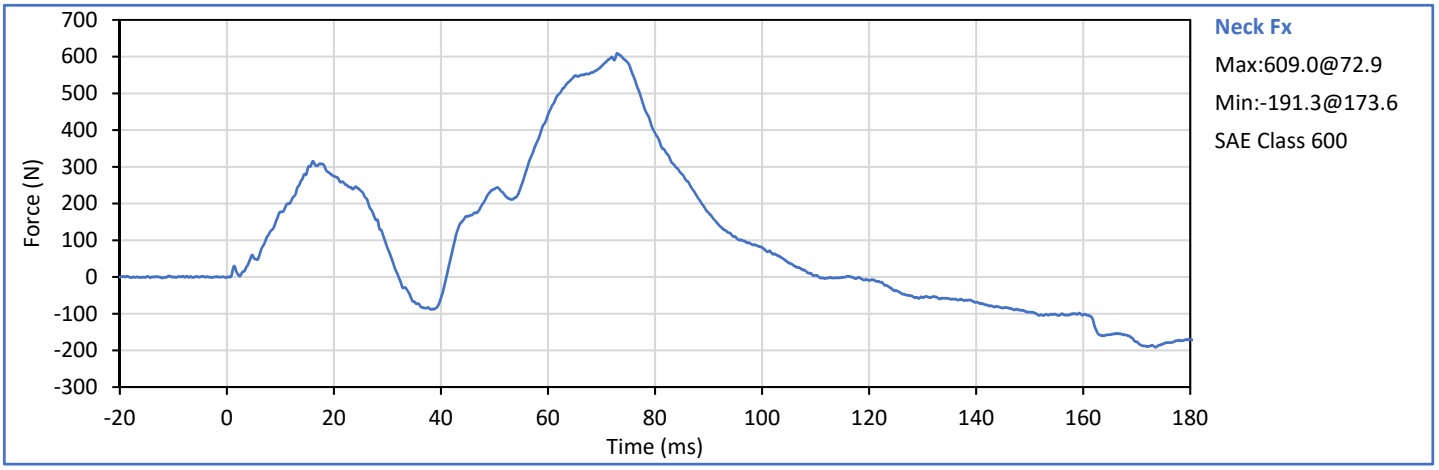
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Neck Extension Test

ATD Serial No.: 360 Test Date: 2021-02-25







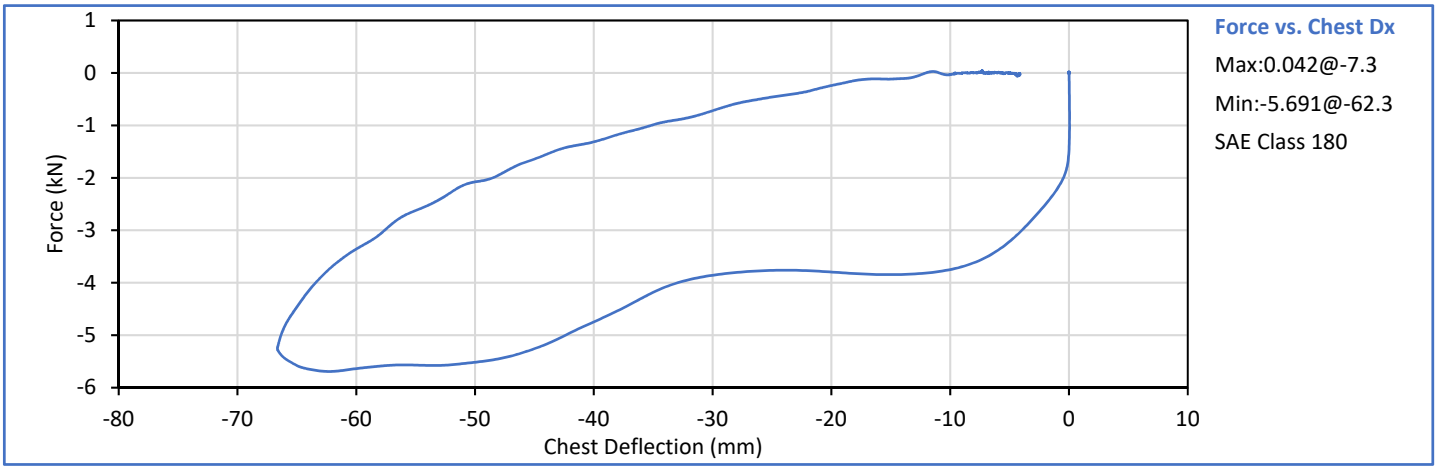
Applus IDIADA
KARCO

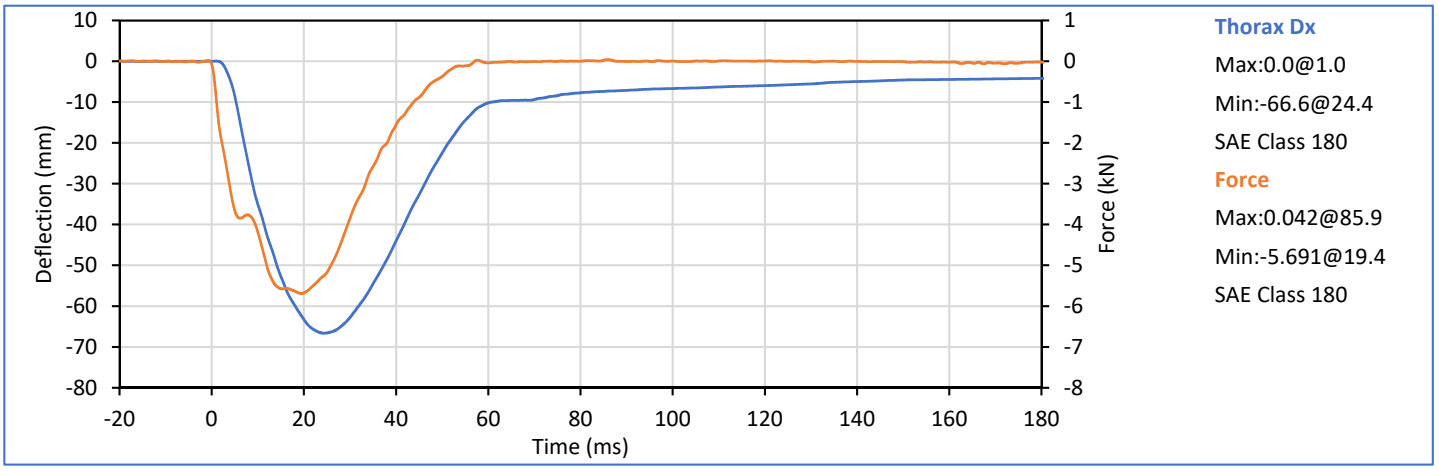
Hybrid III 50th Percentile Male ATD
Thorax Impact

ATD Serial No.: 360

Test Date: 2021-02-23

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	19	Pass
Probe Velocity	m/s	6.58	6.82	6.72	Pass
Peak Chest Deflection	mm	-72.6	-63.5	-66.6	Pass
Peak Probe Force	kN	-5.893	-5.159	-5.691	Pass
Internal Hysterisis	%	69.0	85.0	70.8	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

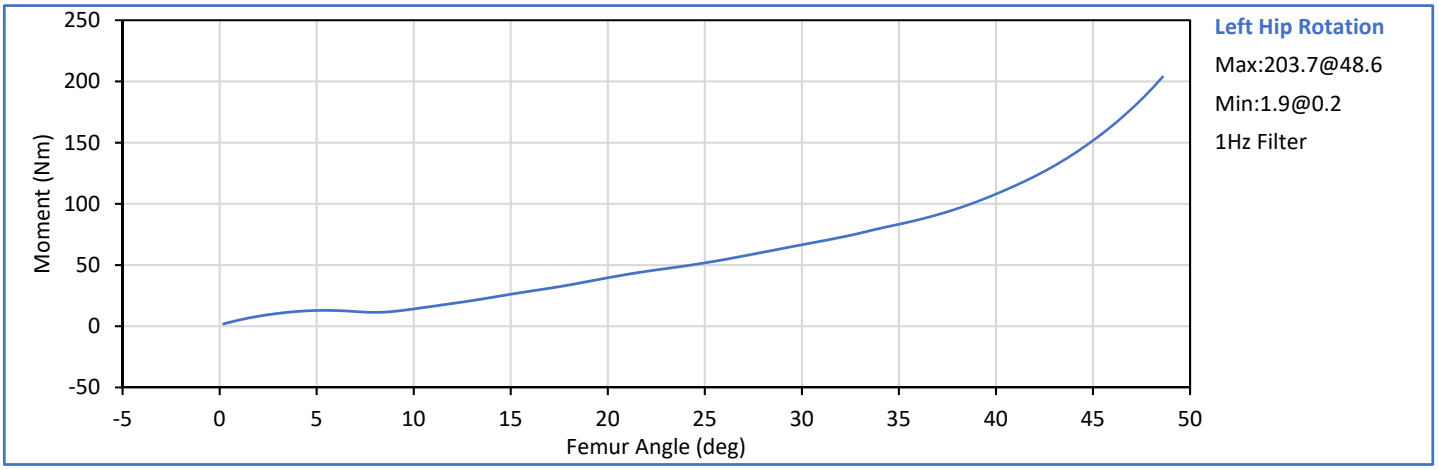
Approved By: P. Puzzuto

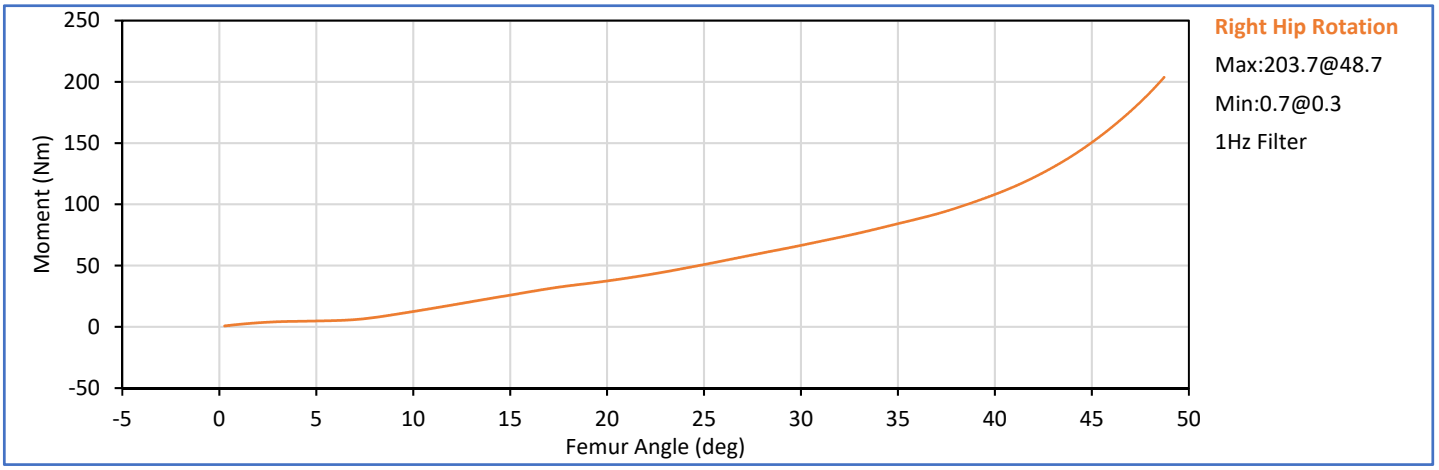
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Hip Flexion (Left/Right)

ATD Serial No.: 360 Test Date: 2021-02-26

	Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
	Laboratory Temperature	°C	18.9	25.6	21.7	Pass
	Laboratory Relative Humidity	%	10	70	17	Pass
Left Hip	Left Hip Rotation Rate	deg/s	5.0	10.0	5.7	Pass
	Left Femur Torque at 30°	Nm	0.0	95.0	66.6	Pass
	Left Hip Rotation at 203 Nm	deg	40.0	50.0	48.5	Pass
Right Hip	Right Hip Rotation Rate	deg/s	5.0	10.0	5.7	Pass
	Right Femur Torque at 30°	Nm	0.0	95.0	66.5	Pass
	Right Hip Rotation at 203 Nm	deg	40.0	50.0	48.7	Pass
				Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

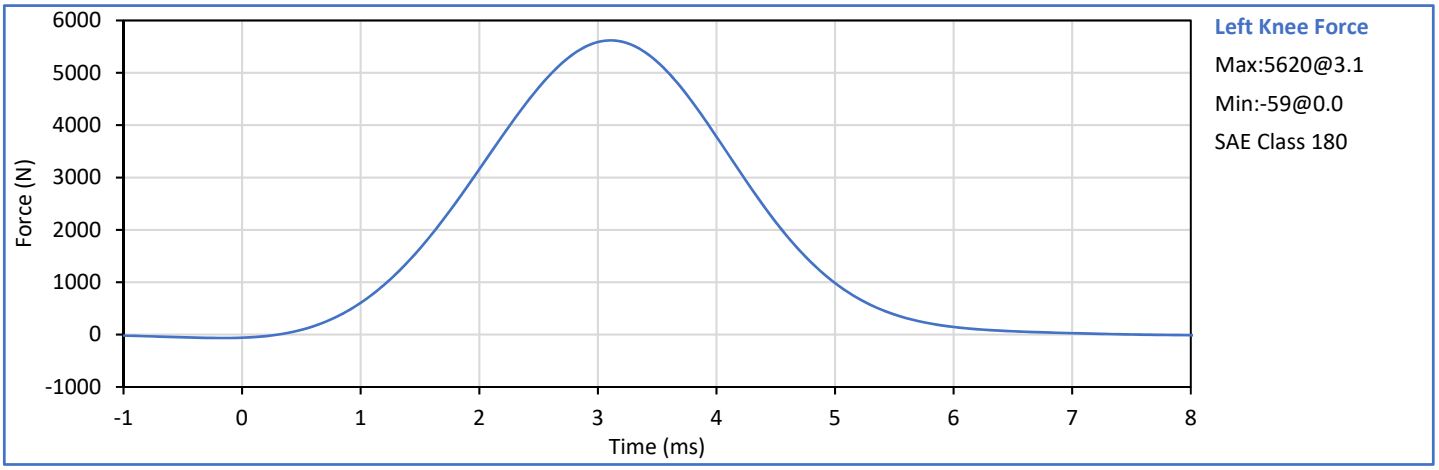
Applus IDIADA KARCO

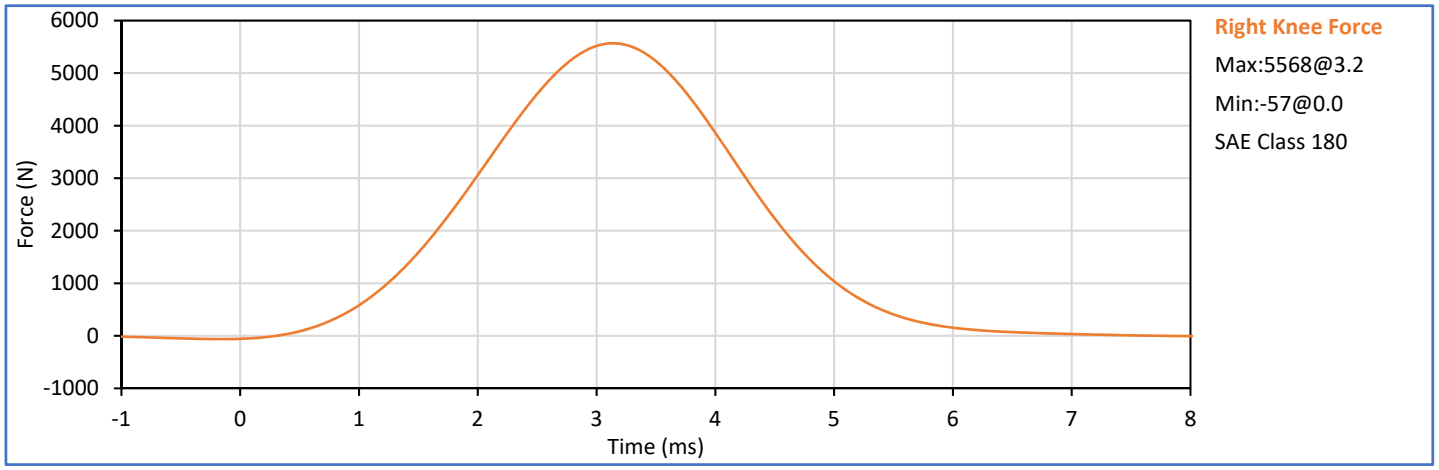
Hybrid III 50th Percentile Male ATD
Knee Impact (Left/Right)

ATD Serial No.: 360

Test Date: 2021-02-24

	Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
	Laboratory Temperature	°C	18.9	25.6	21.2	Pass
	Laboratory Relative Humidity	%	10	70	21	Pass
Left Knee	Probe Velocity	m/s	2.070	2.130	2.098	Pass
	Peak Resistive Force	N	4715	5782	5620	Pass
Right Knee	Probe Velocity	m/s	2.070	2.130	2.122	Pass
	Peak Resistive Force	N	4715	5782	5568	Pass
				Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

APPENDIX C
Pre-Test ATD Qualification and Performance Verification
Hybrid III 5th Percentile Female ATD
S/N: DH1644

Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Damage Checklist

ATD Serial No.: DH1644 Test Date: 2021-02-23

Dummy Item	Inspect for	Comments	Damage	Okay
Entire ATD	Perform general cleaning			✓
Outer Skin	Gashes, rips, cracks			✓
Head	Ballast secure			✓
	General appearance			✓
Neck bracket	Upper neck firmly attached to lower bracket			✓
Neck	Broken or cracked rubber			✓
	Looseness at the condyle joint			✓
Nodding block	Cracked or out of position			✓
Lumbar Spine	Broken or cracked rubber			✓
Ribs	Broken or bent ribs			✓
	Broken or bent rib supports			✓
	Damping material separated or cracked			✓
	Rubber bumpers in place			✓
Chest Displ.	Bent shaft			✓
Assembly	Slider arm riding in track			✓
Sensors	Check cables for cuts, tears			✓
	Check for damaged insulation			✓
Accelerometer	Head mounting secure			✓
Mounting	Chest mounting secure			✓
Knees	Skin condition			✓
	Insert (do not remove)			✓
	Casting			✓
Limbs	Normal movement and adjustment			✓
Knee Sliders	Wires intact			✓
	Rubber returned to "resting" position			✓
Pelvis	Broken			✓
Other	Describe below as needed			✓

Describe any repairs or replacement of parts or other findings:

No Problems Found

Technician: J. Hernandez

Approved By: P. Puzzuto

Applus IDIADA
KARCO

Hybrid III 5th Percentile Female ATD
External Measurements

ATD Serial No.: DH1644 Test Date: 2021-02-23

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	15	Pass
A - Total sitting height	mm	775	800	787	Pass
B - Shoulder pivot height	mm	432	457	443	Pass
C - 'H' point height	mm	81	86	86	Pass
D - 'H' point location from backline	mm	145	150	149	Pass
E - Shoulder pivot from backline	mm	69	84	81	Pass
F - Thigh clearance	mm	119	135	127	Pass
G - Back of elbow to wrist pivot	mm	244	259	254	Pass
H - Head back to backline	mm	41	46	43	Pass
I - Shoulder to elbow length	mm	277	297	293	Pass
J - Elbow rest height	mm	183	203	193	Pass
K - Buttock to knee length	mm	521	546	531	Pass
L - Popliteal length	mm	356	376	365	Pass
M - Knee pivot height	mm	394	419	408	Pass
N - Buttock popliteal length	mm	414	439	424	Pass
O - Chest depth without jacket	mm	175	191	185	Pass
P - Foot length	mm	219	234	226	Pass
R - Buttock to Knee Pivot Length	mm	457	483	472	Pass
S - Head Breadth	mm	137	147	141	Pass
T - Head Depth	mm	178	188	185	Pass
U - Hip Breadth	mm	300	315	311	Pass
V - Shoulder breadth	mm	351	366	360	Pass
W - Foot breadth	mm	79	94	81	Pass
X - Head circum.	mm	528	549	536	Pass
Y - Chest circum. (w/chest jacket)	mm	851	881	857	Pass
Z - Waist circum.	mm	760	790	774	Pass
AA - Location for chest circum.	mm	333	358	341	Pass
BB - Location for waist circum.	mm	160	170	166	Pass
			Overall Test Results		Pass

Technician: J. Hernandez

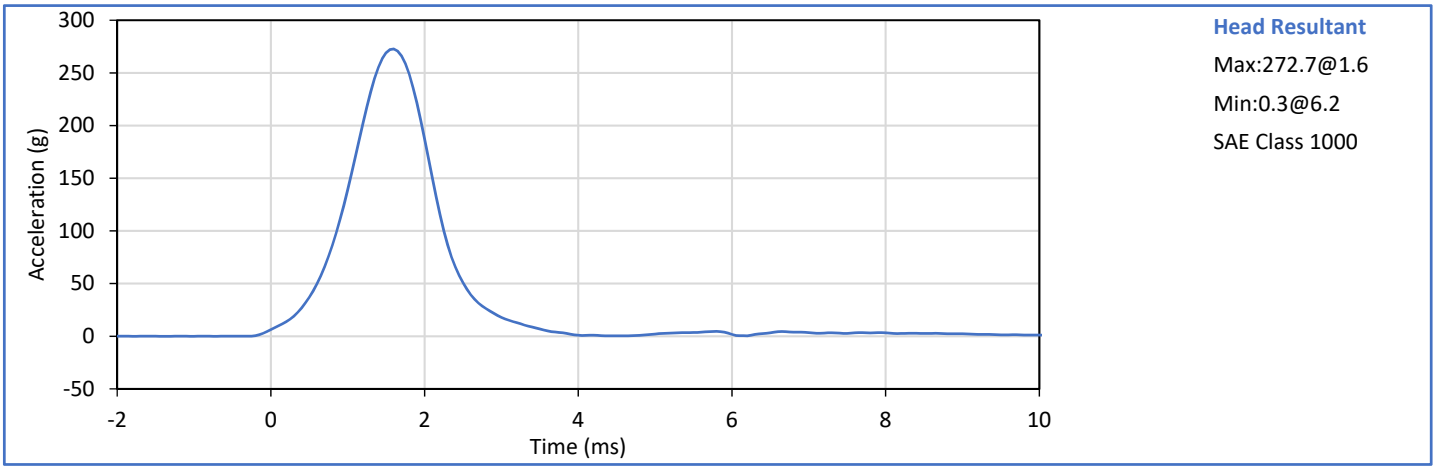
Approved By: P. Puzzuto

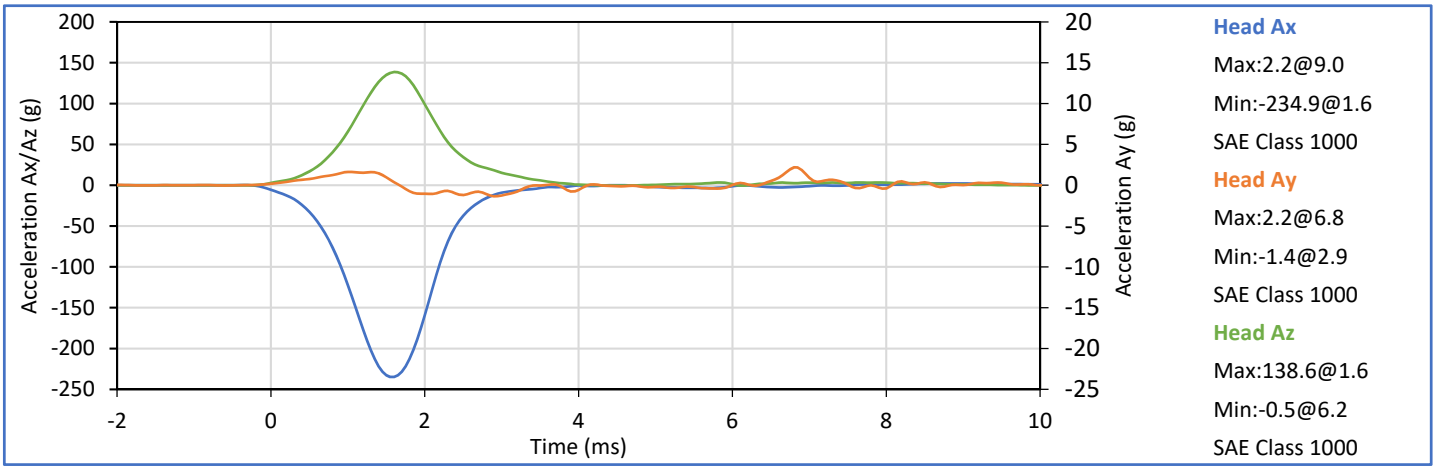
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Head Drop Test

ATD Serial No.: DH1644 Test Date: 2021-02-26

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	18.9	25.6	21.7	Pass
Laboratory Humidity	%	10	70	12	Pass
Peak Resultant Acceleration	g	250.0	300.0	272.7	Pass
Peak Lateral Acceleration	g	-15.0	15.0	2.2	Pass
Oscillations After Main Pulse	%	0.0	10.0	1.7	Pass
Is Acceleration Unimodal?	Yes/No	Yes		Yes	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

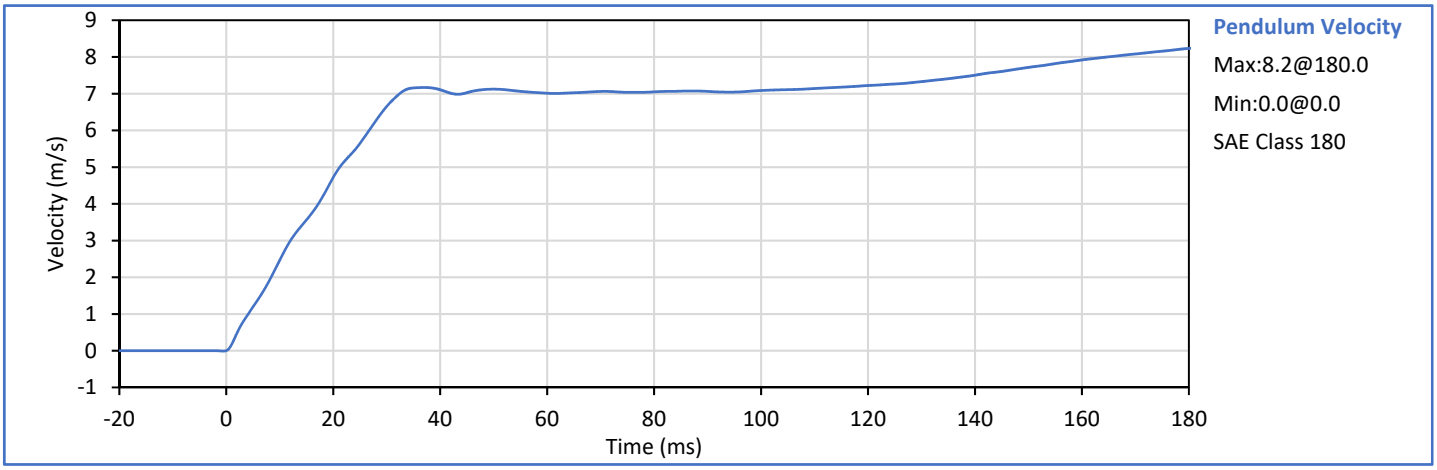
Approved By: P. Puzzuto

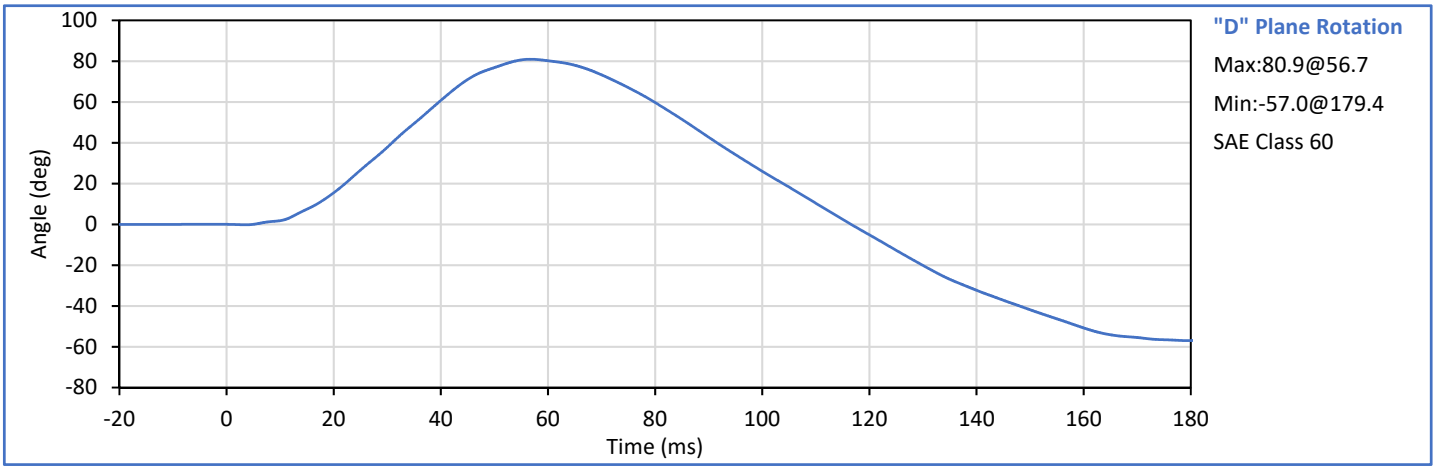
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Neck Flexion Test

ATD Serial No.: DH1644 Test Date: 2021-02-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.1	Pass
Laboratory Humidity	%	10	70	21	Pass
Pendulum Velocity	m/s	6.89	7.13	7.00	Pass
Pendulum Velocity at 10 ms	m/s	2.10	2.50	2.47	Pass
Pendulum Velocity at 20 ms	m/s	4.00	5.00	4.72	Pass
Pendulum Velocity at 30 ms	m/s	5.80	7.00	6.65	Pass
Peak "D" Plane Rotation	deg	77.0	91.0	80.9	Pass
Peak Moment in Rotation	Nm	69.0	83.0	76.6	Pass
Positive Moment Decay to 10 Nm	ms	80.0	100.0	84.4	Pass
			Overall Test Results		Pass



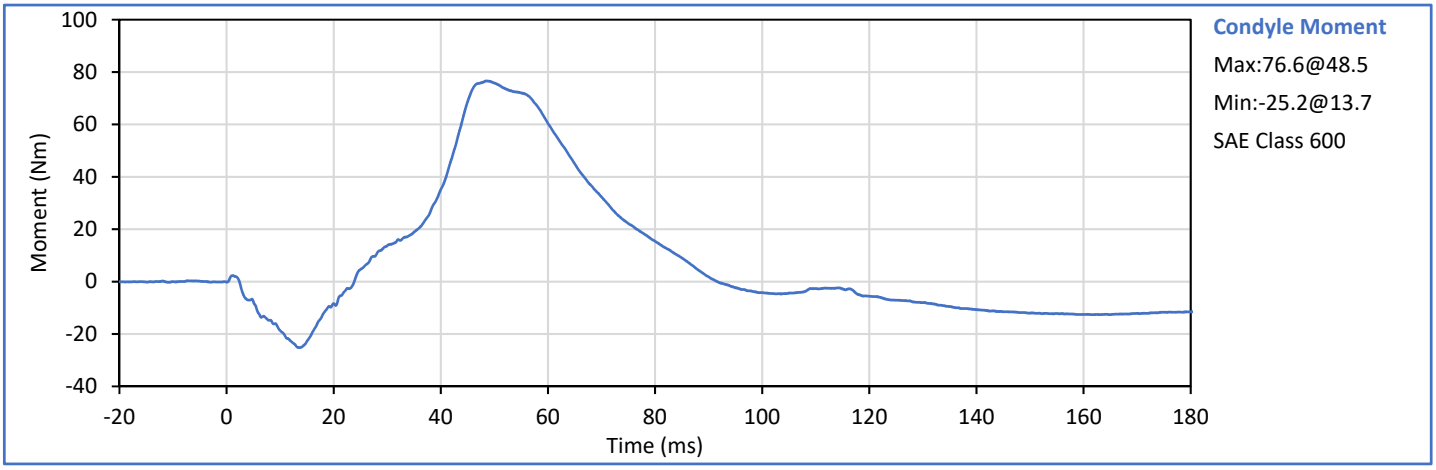


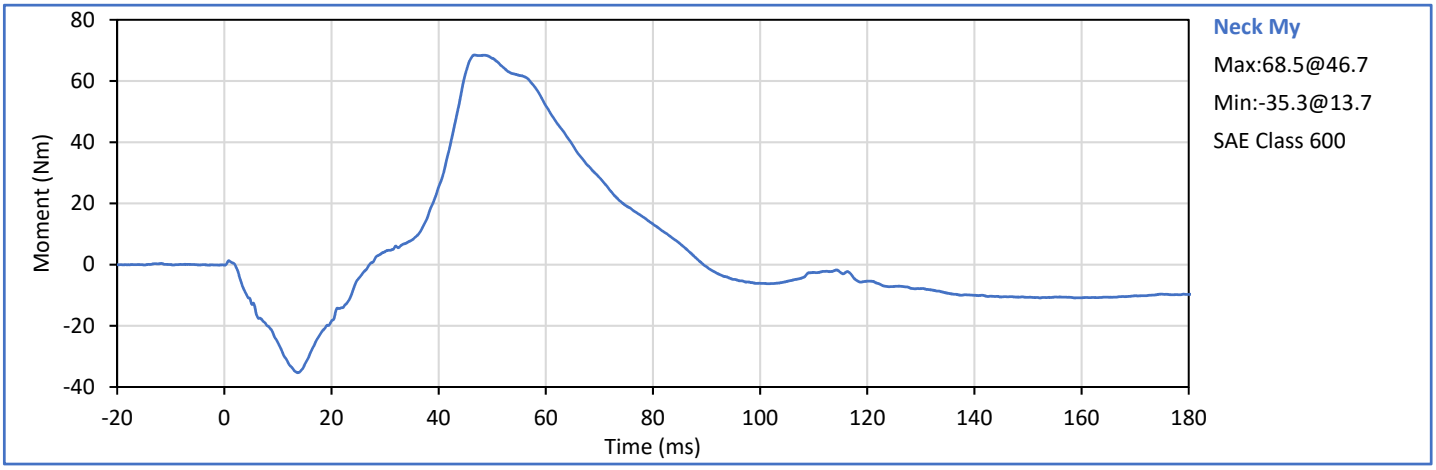
Technician: J. Hernandez

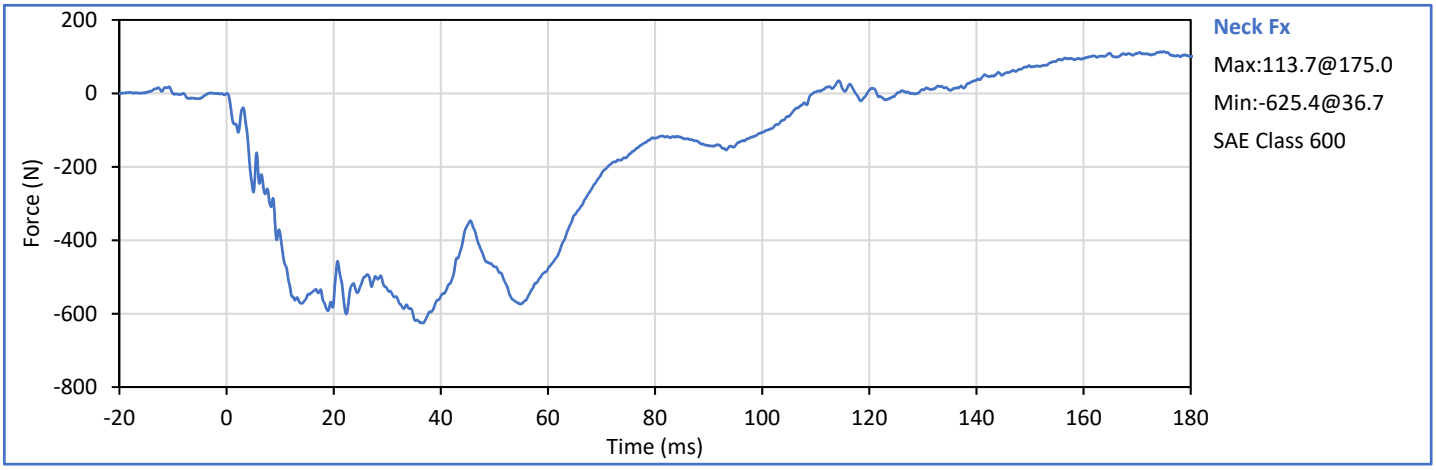
Approved By: P. Puzzuto

Hybrid III 5th Percentile Female ATD
Neck Flexion Test

ATD Serial No.: DH1644 Test Date: 2021-02-24





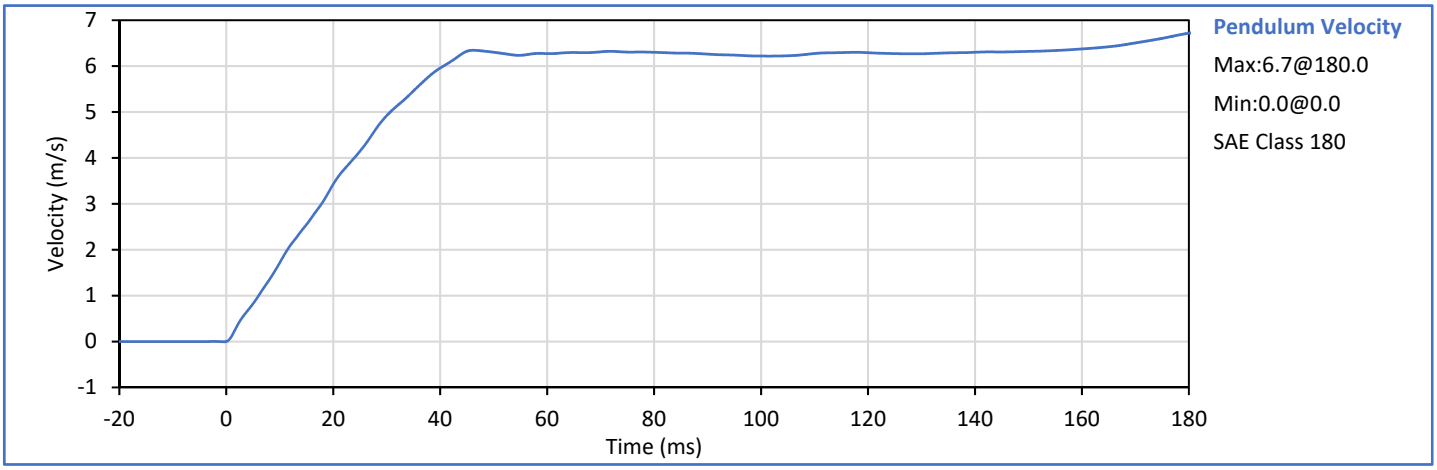


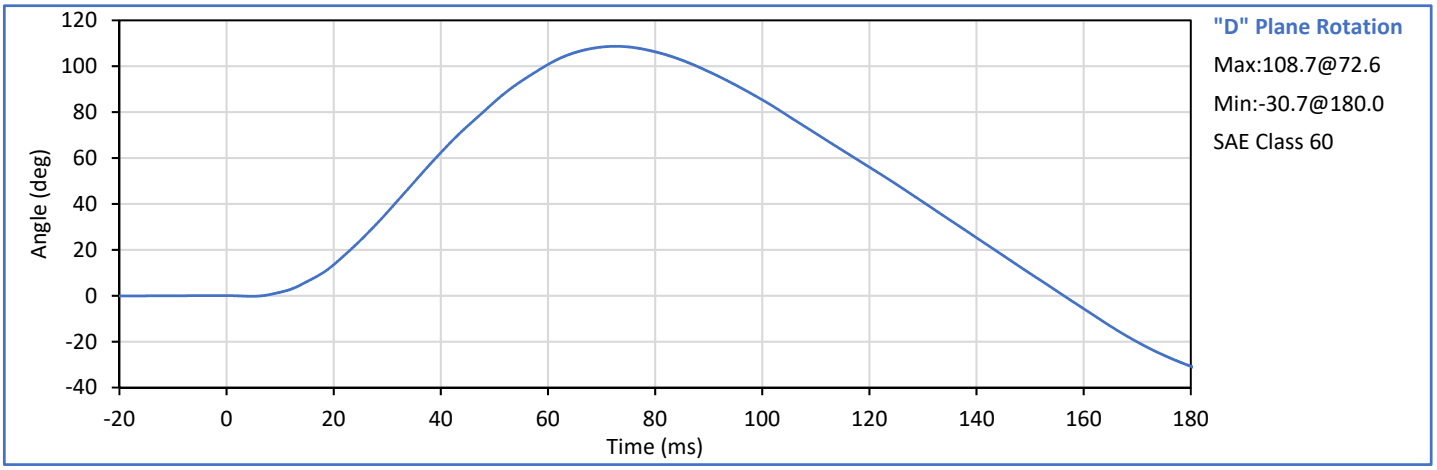
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Neck Extension Test

ATD Serial No.: DH1644 Test Date: 2021-02-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.1	Pass
Laboratory Humidity	%	10	70	21	Pass
Pendulum Velocity	m/s	5.95	6.19	6.11	Pass
Pendulum Velocity at 10 ms	m/s	1.50	1.90	1.72	Pass
Pendulum Velocity at 20 ms	m/s	3.10	3.90	3.43	Pass
Pendulum Velocity at 30 ms	m/s	4.60	5.60	4.92	Pass
Peak "D" Plane Rotation	deg	99.0	114.0	108.7	Pass
Peak Moment in Rotation	Nm	-65.0	-53.0	-59.5	Pass
Negative Moment Decay to -10 Nm	ms	94.0	114.0	98.7	Pass
			Overall Test Results		Pass



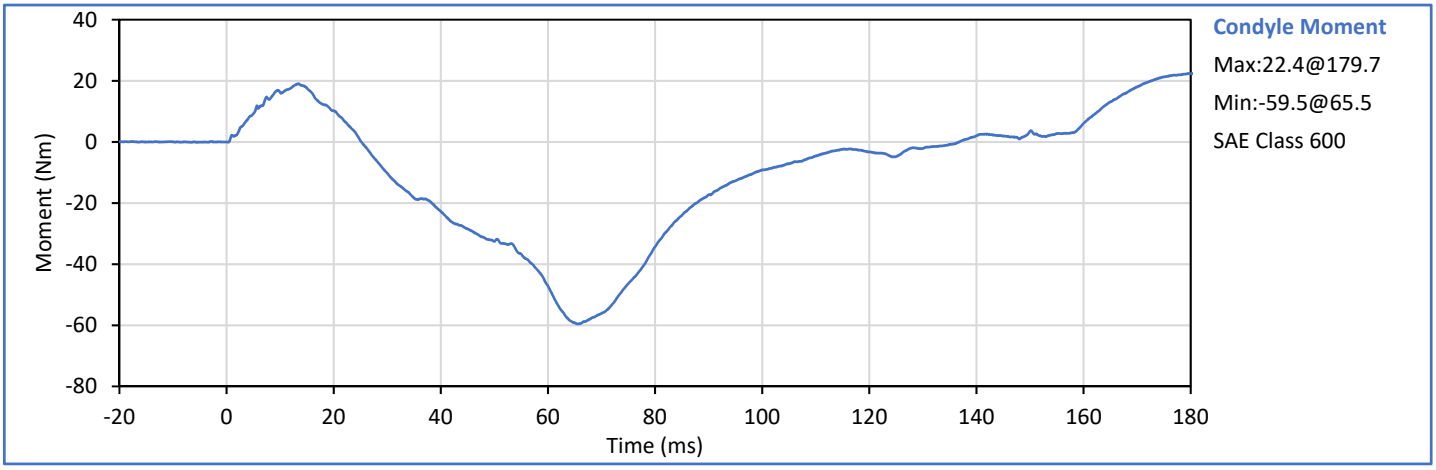


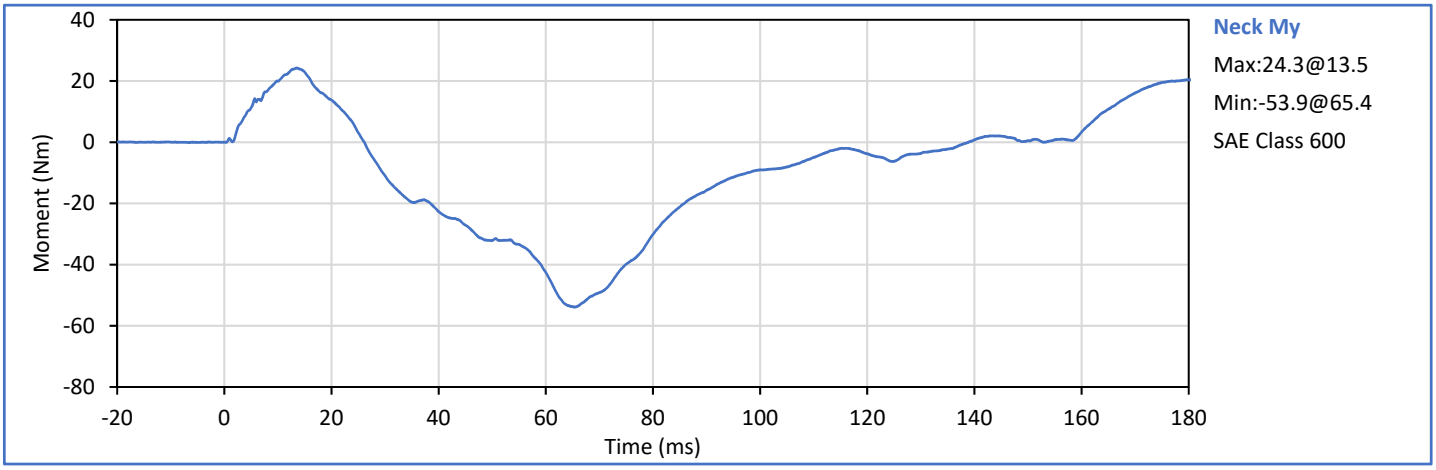
Technician: J. Hernandez

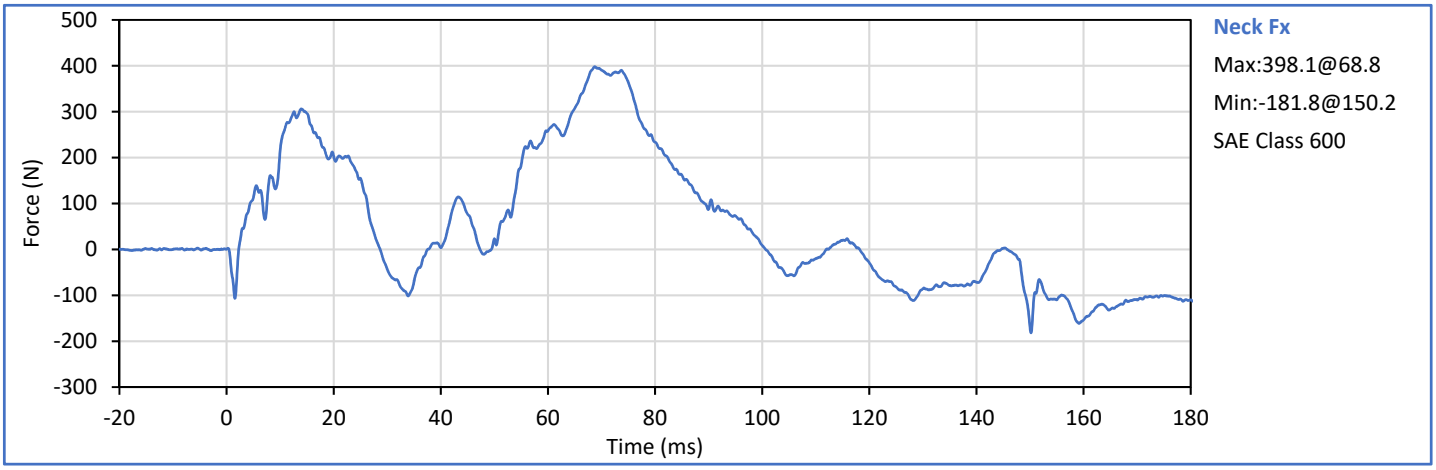
Approved By: P. Puzzuto

Hybrid III 5th Percentile Female ATD
Neck Extension Test

ATD Serial No.: DH1644 Test Date: 2021-02-24







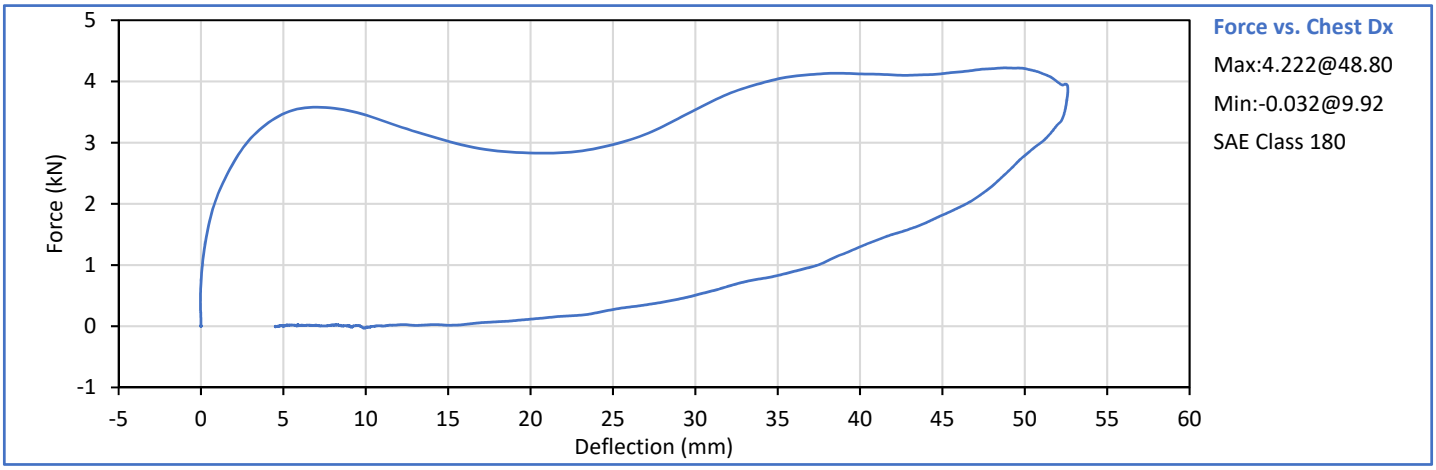
Applus IDIADA KARCO

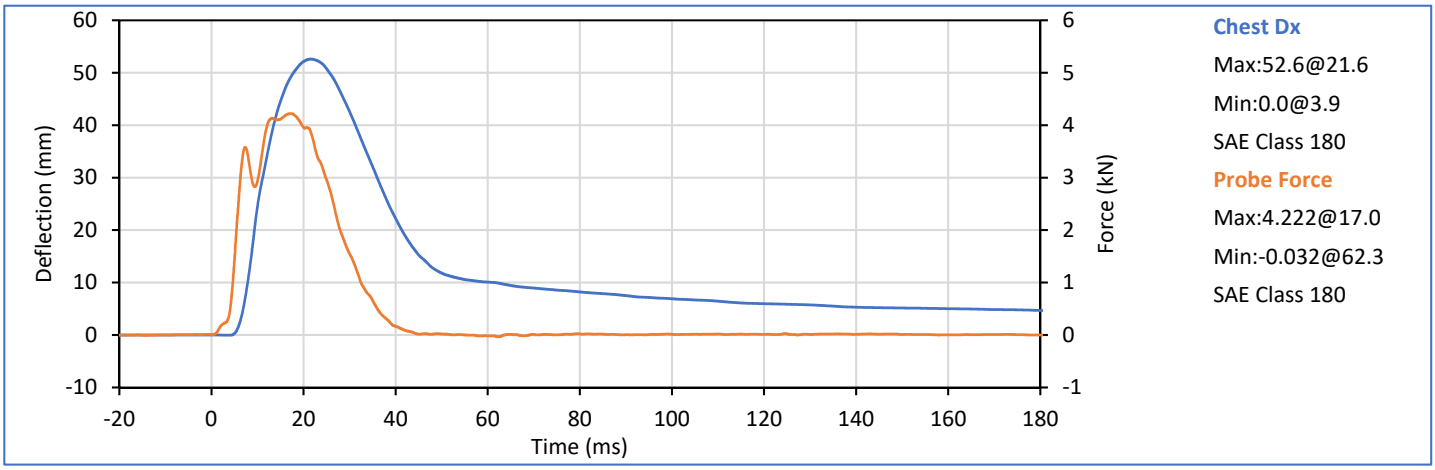
Hybrid III 5th Percentile Female ATD
Thorax Impact

ATD Serial No.: DH1644

Test Date: 2021-02-23

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Humidity	%	10	70	19	Pass
Probe Velocity	m/s	6.59	6.83	6.67	Pass
Peak Chest Deflection	mm	50.0	58.0	52.6	Pass
Peak Probe Force, 50 and 58 mm	kN	3.900	4.400	4.208	Pass
Peak Probe Force, 18 and 50 mm	kN	0.000	4.600	4.222	Pass
Internal Hysterisis	%	69.0	85.0	78.9	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

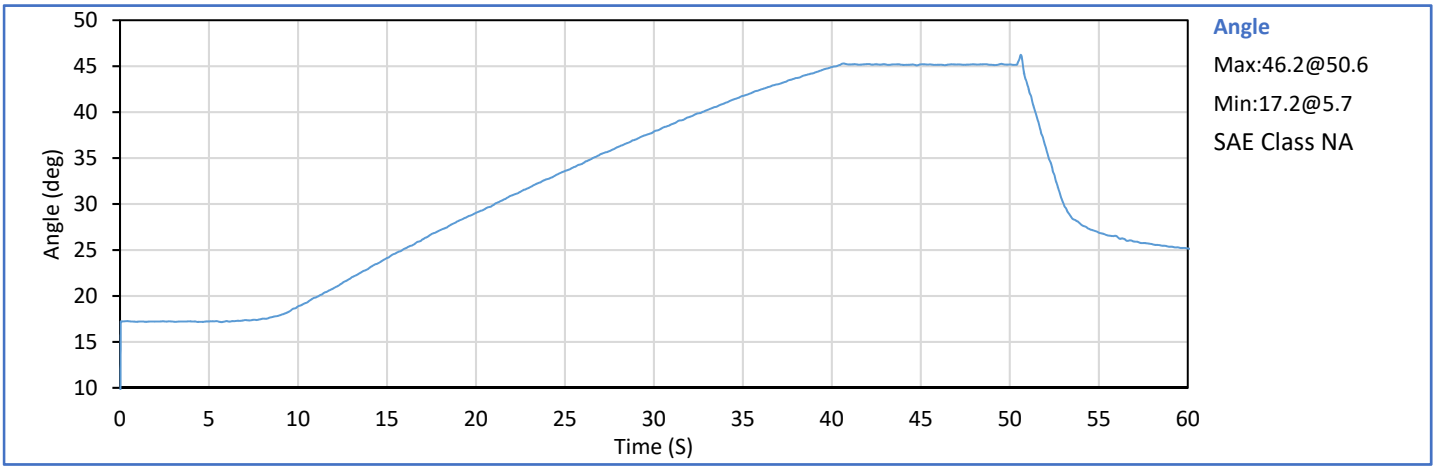
Approved By: P. Puzzuto

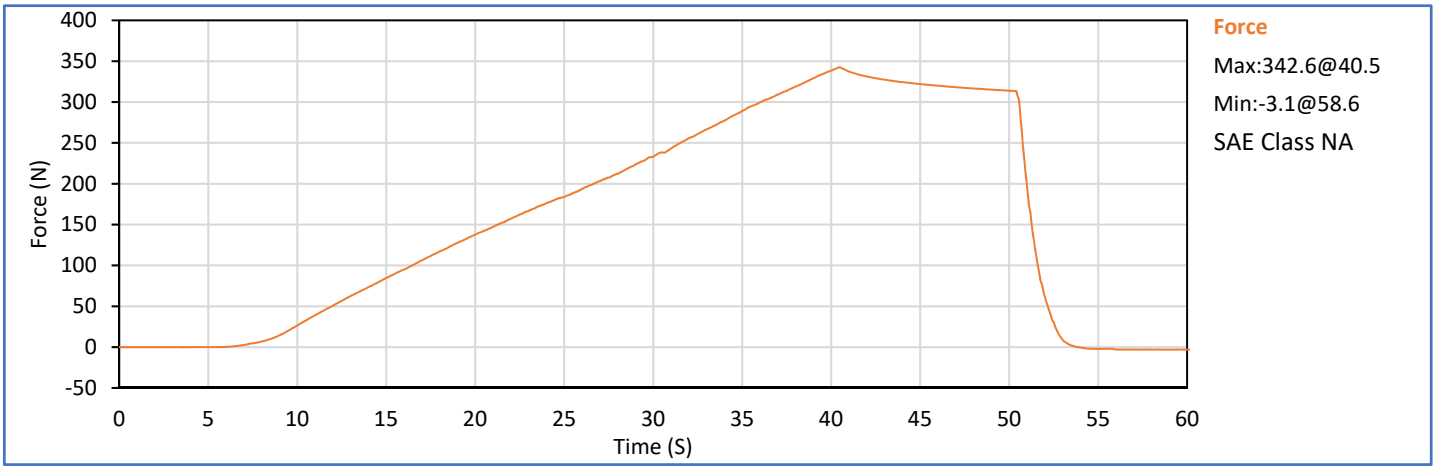
Applus IDIADA
KARCO

Hybrid III 5th Percentile Female ATD
Torso Flexion Test

ATD Serial No.: DH1644 Test Date: 2021-02-23

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	18.9	25.6	21.7	Pass
Laboratory Humidity	%	10	70	23	Pass
Orientation Angle	deg	0.0	20.0	15.1	Pass
Test Initial Angle	deg	11.0	19.0	17.2	Pass
Peak Force at 45° (+/-0.5°)	N	320.0	390.0	341.9	Pass
Torso Flexion Rate	deg/s	0.50	1.50	0.87	Pass
Final Reference Plane Angle	deg	-8.0	8.0	2.7	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

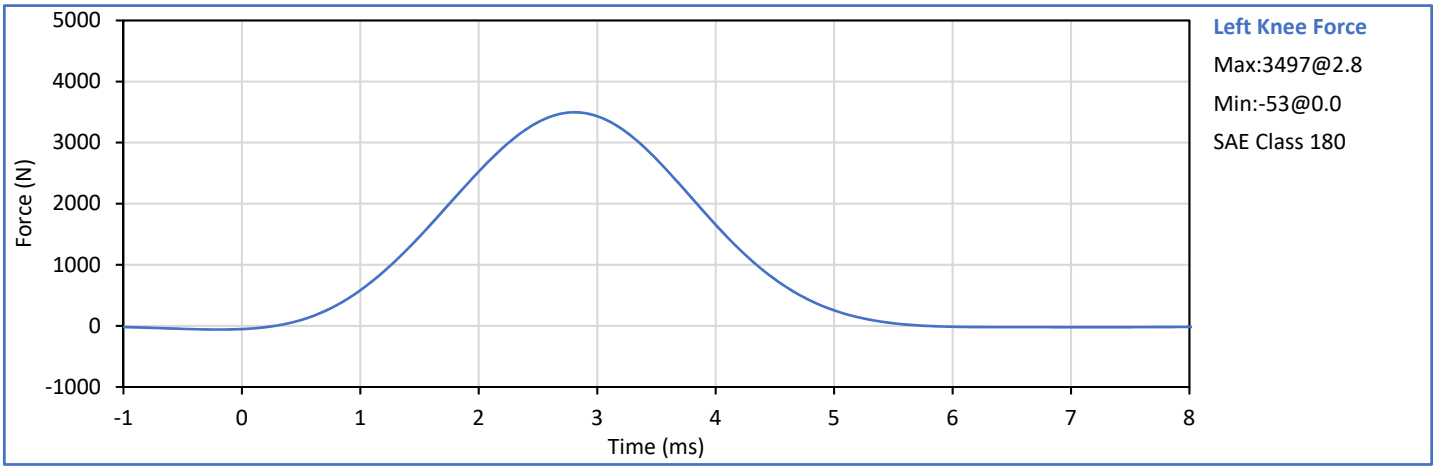
Approved By: P. Puzzuto

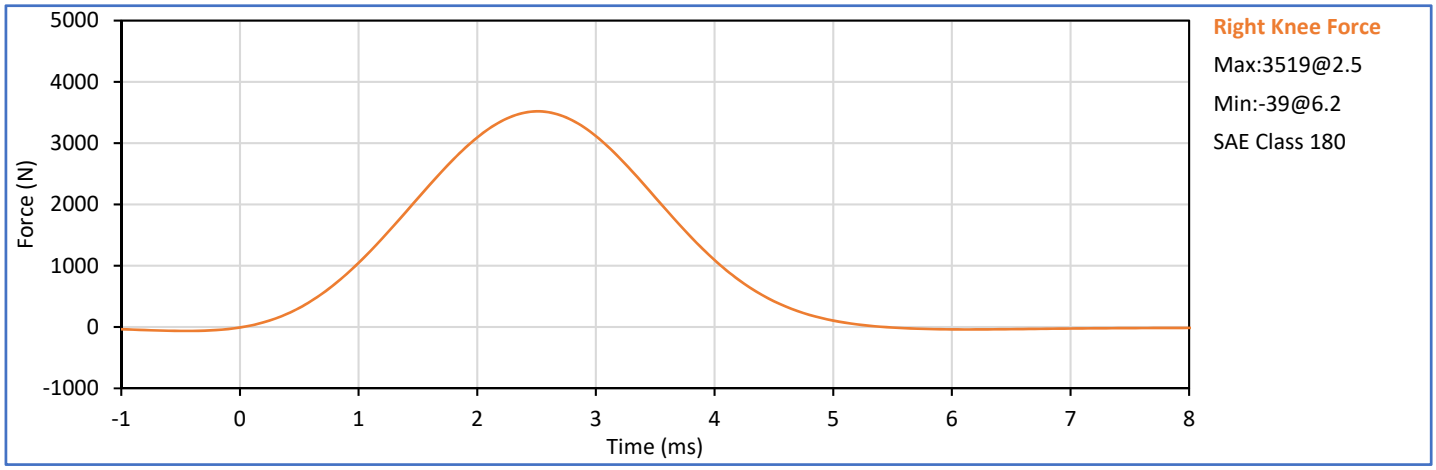
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Knee Impact (Left/Right)

ATD Serial No.: DH1644 Test Date: 2021-02-24

	Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
	Laboratory Temperature	°C	18.9	25.6	21.1	Pass
	Laboratory Humidity	%	10	70	23	Pass
Left Knee	Probe Velocity	m/s	2.070	2.130	2.110	Pass
	Peak Resistive Force	N	3450	4060	3497	Pass
Right Knee	Probe Velocity	m/s	2.070	2.130	2.114	Pass
	Peak Resistive Force	N	3450	4060	3519	Pass
				Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

APPENDIX C
Post-Test ATD Qualification and Performance Verification
Hybrid III 50th Percentile Male ATD
S/N: 360

Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
ATD Damage Checklist

ATD Serial No.: 360 Test Date: 2021-03-24

Dummy Item	Inspect for	Comments	Damage	OK
Entire ATD	Perform general cleaning			✓
Outer Skin	Gashes, rips, cracks			✓
Head	Ballast secure			✓
	General appearance			✓
Neck bracket	Upper neck firmly attached to lower bracket			✓
Neck	Broken or cracked rubber			✓
	Looseness at the condyle joint			✓
Nodding block	Cracked or out of position			✓
Lumbar Spine	Broken or cracked rubber			✓
Ribs	Broken or bent ribs			✓
	Broken or bent rib supports			✓
	Damping material separated or cracked			✓
	Rubber bumpers in place			✓
Chest Displ.	Bent shaft			✓
Assembly	Slider arm riding in track			✓
Sensors	Check cables for cuts, tears			✓
	Check for damaged insulation			✓
Accelerometer	Head mounting secure			✓
Mounting	Chest mounting secure			✓
Knees	Skin condition			✓
	Insert (do not remove)			✓
	Casting			✓
Limbs	Normal movement and adjustment			✓
Knee Sliders	Wires intact			✓
	Rubber returned to "resting" position			✓
Pelvis	Broken			✓
Other	Describe below as needed			✓

Describe any repairs or replacement of parts or other findings:

No Problems Found

Technician: J. Hernandez

Approved By: P. Puzzuto

Applus IDIADA
KARCO

Hybrid III 50th Percentile Male ATD
External Measurements

ATD Serial No.: 360 Test Date: 2021-03-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.4	Pass
Laboratory Relative Humidity	%	10	70	26	Pass
A - Total sitting height	mm	879	889	888	Pass
B - Shoulder pivot height	mm	505	521	512	Pass
C - 'H' point height	mm	84	89	88	Pass
D - 'H' point location from backline	mm	135	140	139	Pass
E - Shoulder pivot from backline	mm	84	94	89	Pass
F - Thigh clearance	mm	140	155	153	Pass
G - Back of elbow to wrist pivot	mm	290	305	296	Pass
H - Head back to backline	mm	41	46	45	Pass
I - Shoulder to elbow length	mm	330	345	338	Pass
J - Elbow rest height	mm	190	211	202	Pass
K - Buttock to knee length	mm	579	604	585	Pass
L - Popliteal length	mm	429	455	447	Pass
M - Knee pivot height	mm	485	500	491	Pass
N - Buttock popliteal length	mm	452	477	464	Pass
O - Chest depth without jacket	mm	213	229	221	Pass
P - Foot length	mm	251	267	261	Pass
V - Shoulder breadth	mm	422	437	429	Pass
W - Foot breadth	mm	91	107	104	Pass
Y - Chest circum. (w/chest jacket)	mm	970	1001	981	Pass
Z - Waist circum.	mm	836	866	855	Pass
AA - Location for chest circum.	mm	429	434	431	Pass
BB - Location for waist circum.	mm	226	231	229	Pass
			Overall Test Results		Pass

Technician: J. Hernandez

Approved By: P. Puzzuto

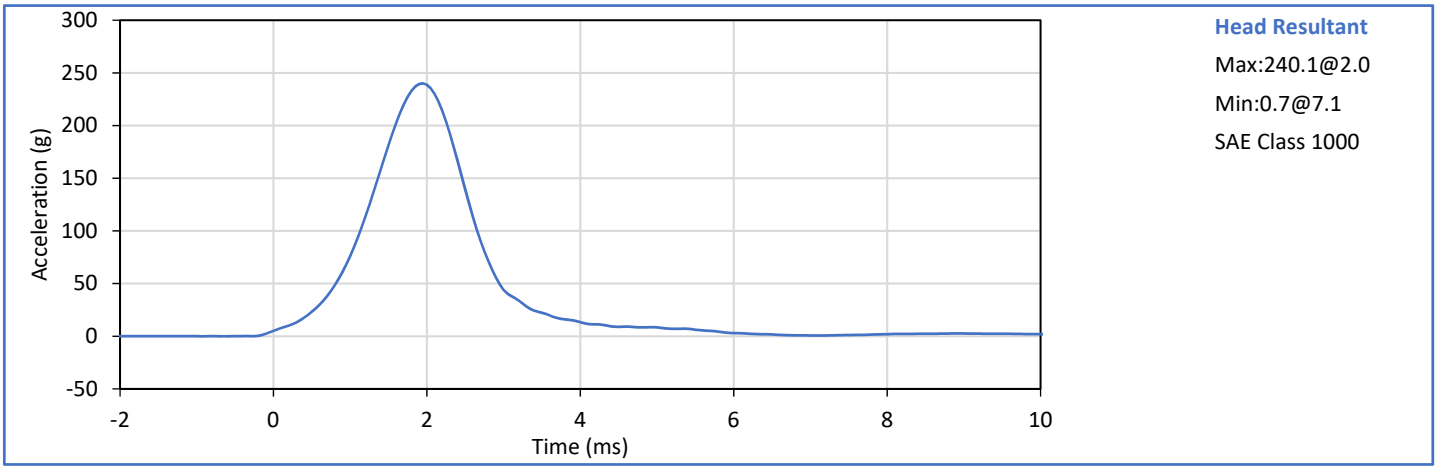
Applus IDIADA
KARCO

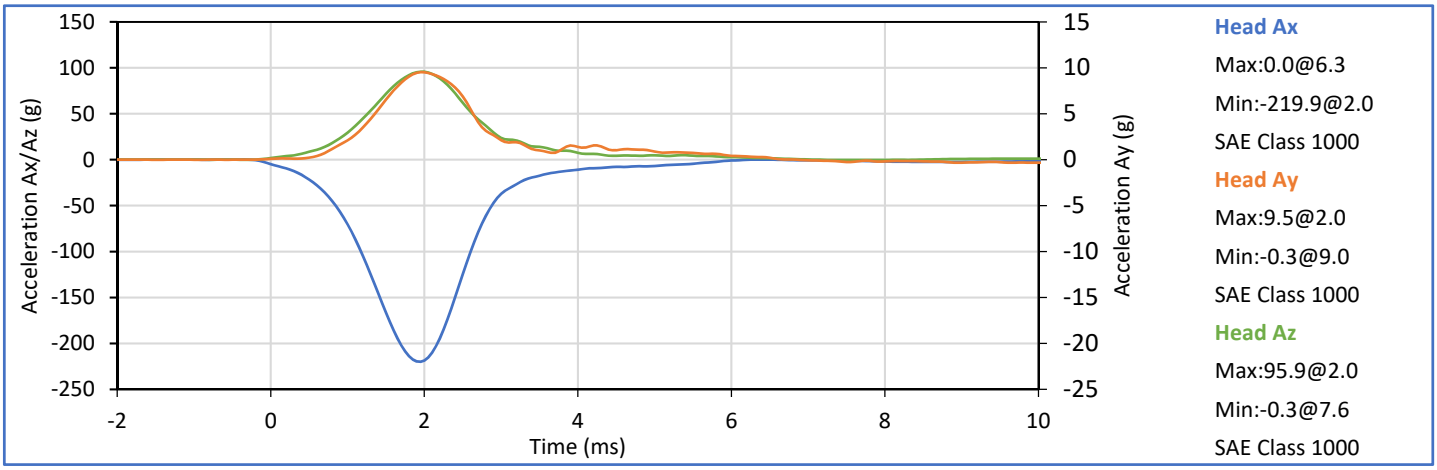
Hybrid III 50th Percentile Male ATD
Head Drop

ATD Serial No.: 360

Test Date: 2021-03-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	18.9	25.6	21.7	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
Peak Resultant Acceleration	g	225.0	275.0	240.1	Pass
Peak Lateral Acceleration	g	-15.0	15.0	9.5	Pass
Oscillations After Main Pulse	%	0.0	10.0	1.3	Pass
Is Acceleration Unimodal?	Yes/No	Yes		Yes	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

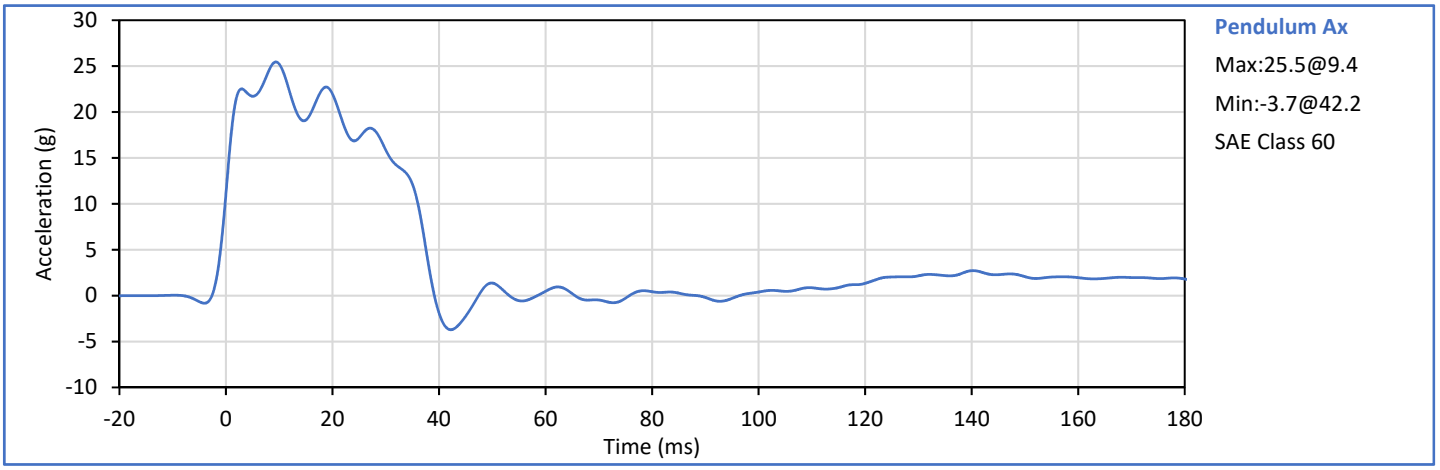
Applus IDIADA KARCO

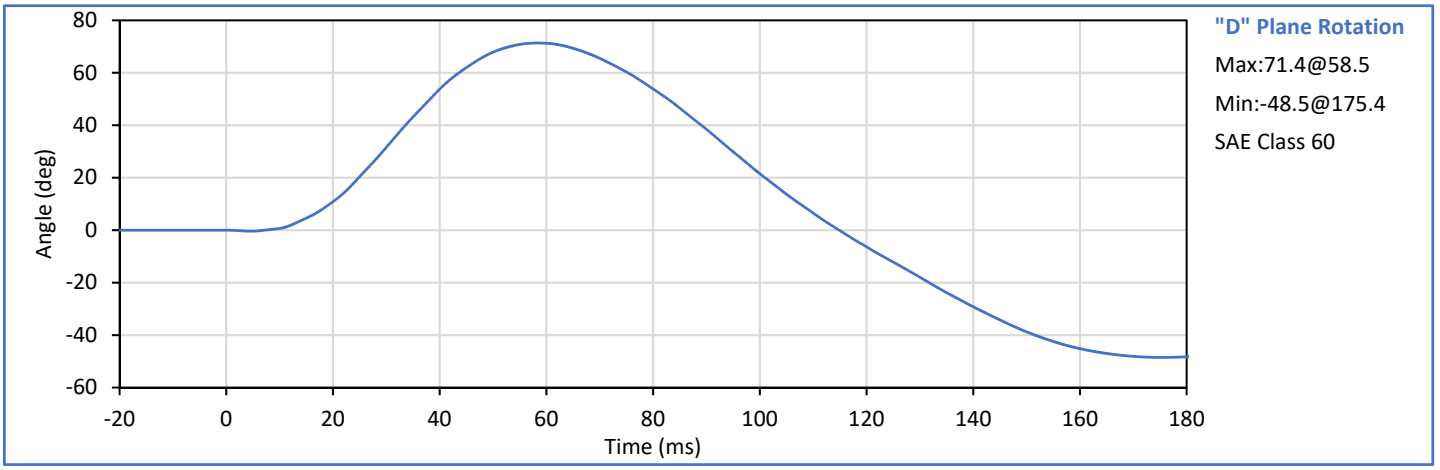
Hybrid III 50th Percentile Male ATD
Neck Flexion Test

ATD Serial No.: 360

Test Date: 2021-03-25

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
Pendulum Velocity	m/s	6.89	7.13	6.92	Pass
Pendulum Deceleration at 10 ms	g	22.5	27.5	25.2	Pass
Pendulum Deceleration at 20 ms	g	17.6	22.6	22.0	Pass
Pendulum Deceleration at 30 ms	g	12.5	18.5	15.9	Pass
Peak Pendulum Decel. after 30 ms	g	0.0	29.0	15.9	Pass
Deceleration Decay to Cross 5 g	ms	34.0	42.0	37.6	Pass
"D" Plane Rotation peak	deg	64.0	78.0	71.4	Pass
	ms	57.0	64.0	58.5	Pass
"D" Plane Rotation Decay To Zero	ms	113.0	128.0	114.9	Pass
Moment About Occipital Condyle	Nm	88.1	108.5	99.2	Pass
	ms	47.0	58.0	50.5	Pass
Moment Decay, Peak to Zero	ms	97.0	107.0	98.7	Pass
			Overall Test Results		Pass



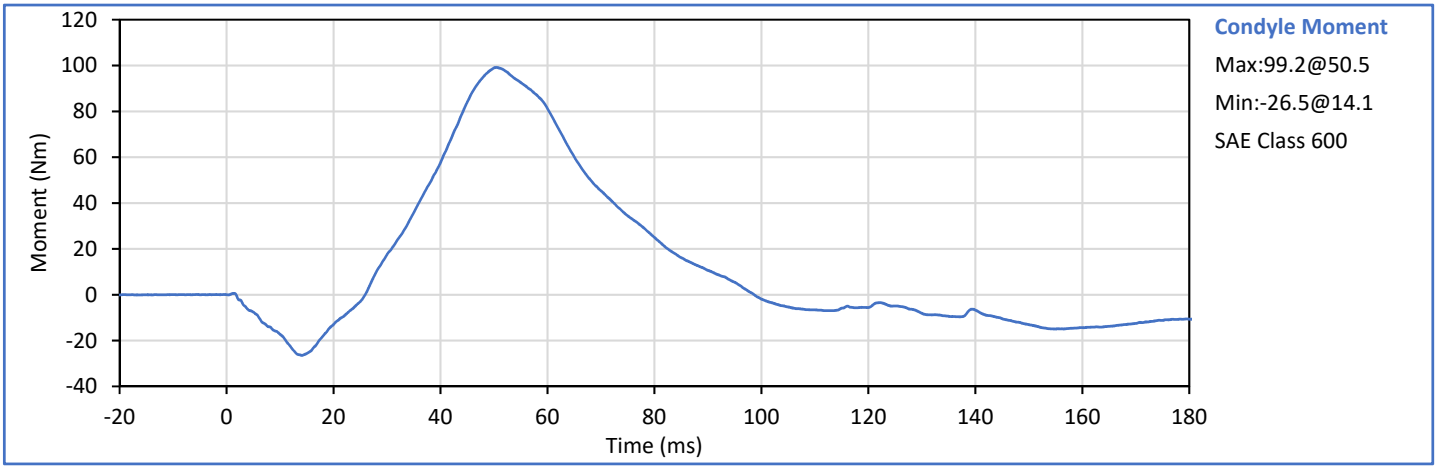


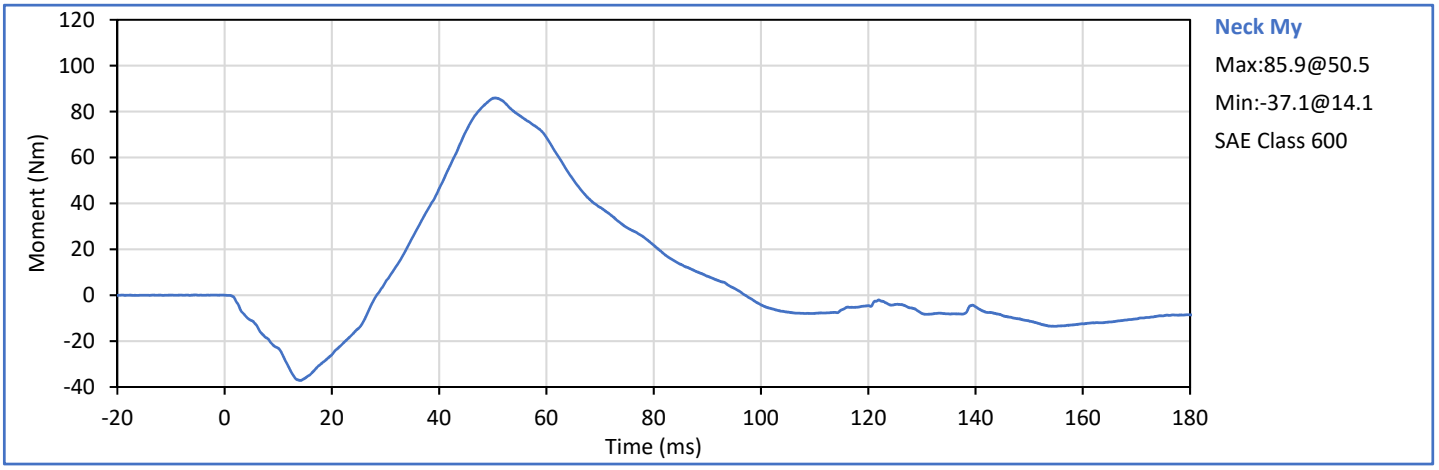
Technician: J. Hernandez

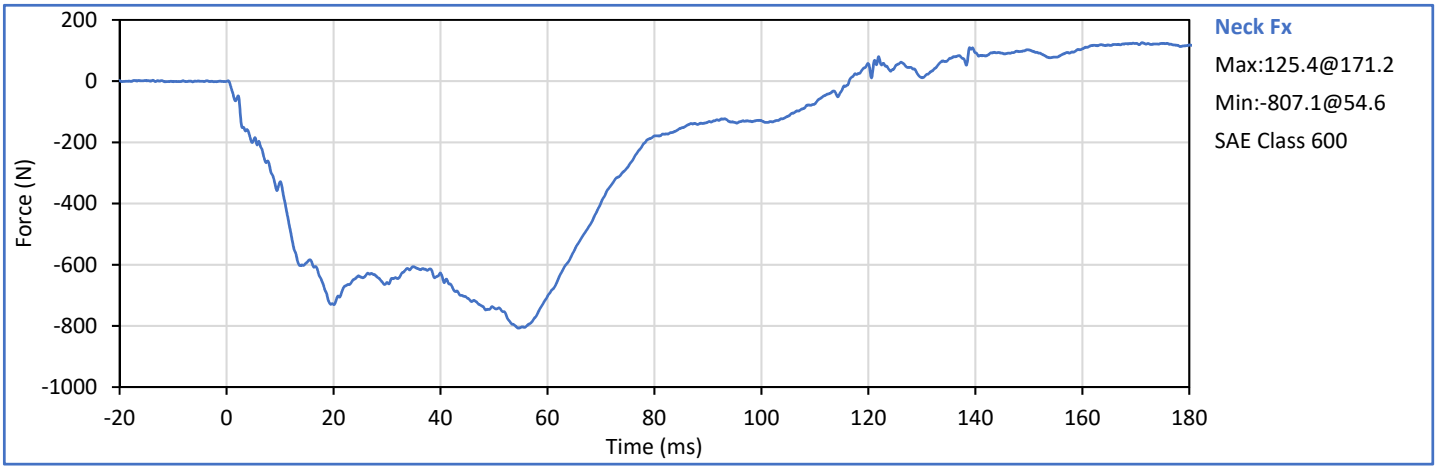
Approved By: P. Puzzuto

Hybrid III 50th Percentile Male ATD
Neck Flexion Test

ATD Serial No.: 360 Test Date: 2021-03-25





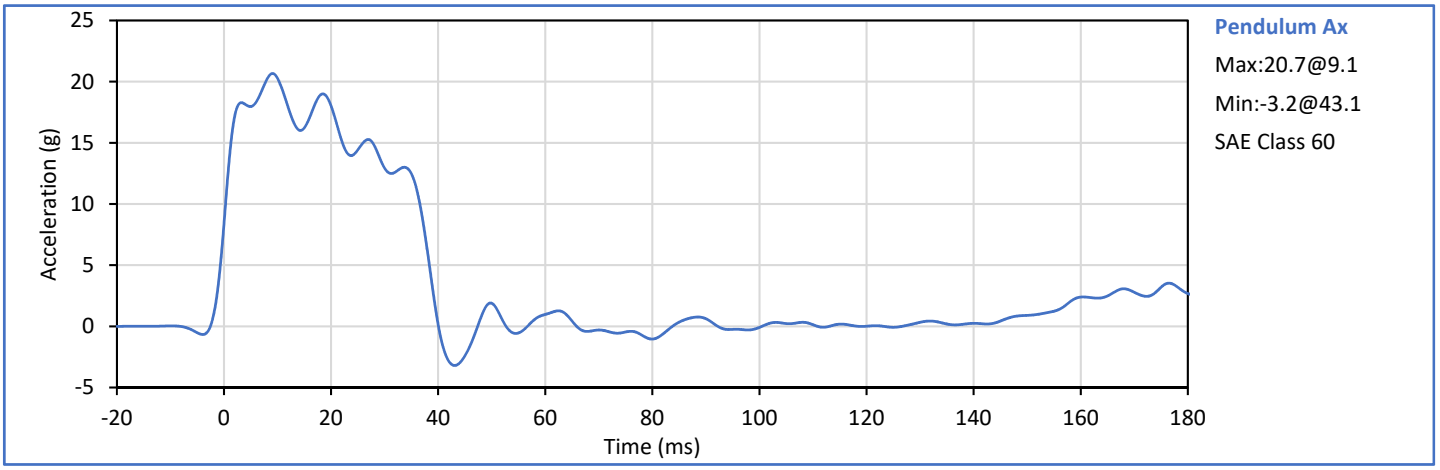


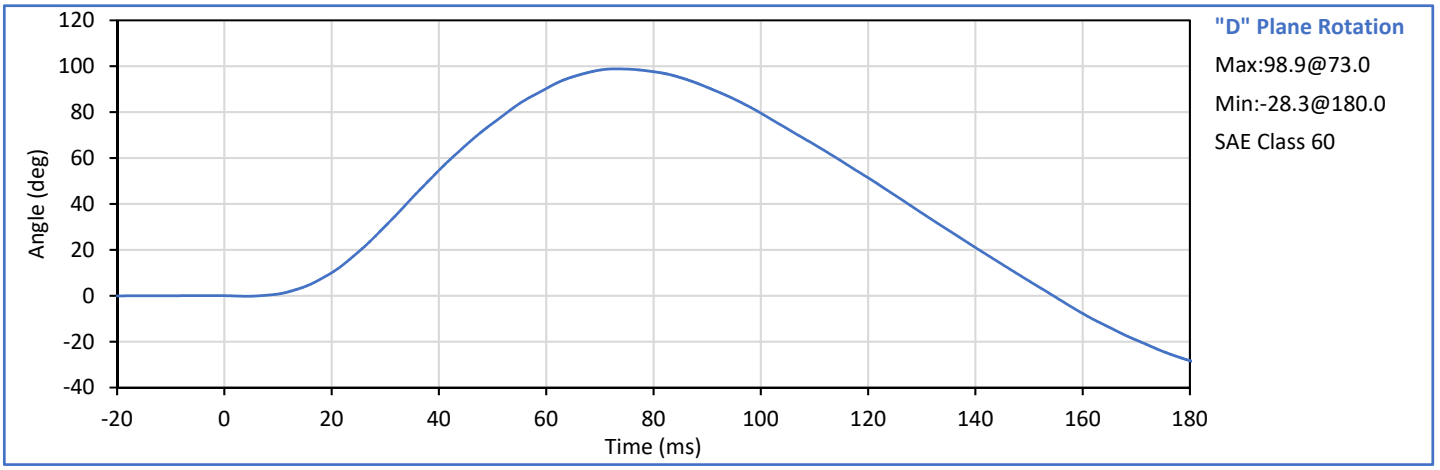
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Neck Extension Test

ATD Serial No.: 360 Test Date: 2021-03-25

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
Pendulum Velocity	m/s	5.94	6.19	6.09	Pass
Pendulum Deceleration at 10 ms	g	17.2	21.2	20.3	Pass
Pendulum Deceleration at 20 ms	g	14.0	19.0	18.0	Pass
Pendulum Deceleration at 30 ms	g	11.0	16.0	12.9	Pass
Peak Pendulum Decel. after 30 ms	g	0.0	22.0	13.0	Pass
Deceleration Decay to Cross 5 g	ms	38.0	46.0	38.4	Pass
"D" Plane Rotation peak	deg	81.0	106.0	98.9	Pass
	ms	72.0	82.0	73.0	Pass
"D" Plane Rotation Decay To Zero	ms	147.0	174.0	154.6	Pass
Moment About Occipital Condyle	Nm	-79.9	-52.9	-72.4	Pass
	ms	65.0	79.0	70.9	Pass
Moment Decay, Peak to Zero	ms	120.0	148.0	140.2	Pass
			Overall Test Results		Pass





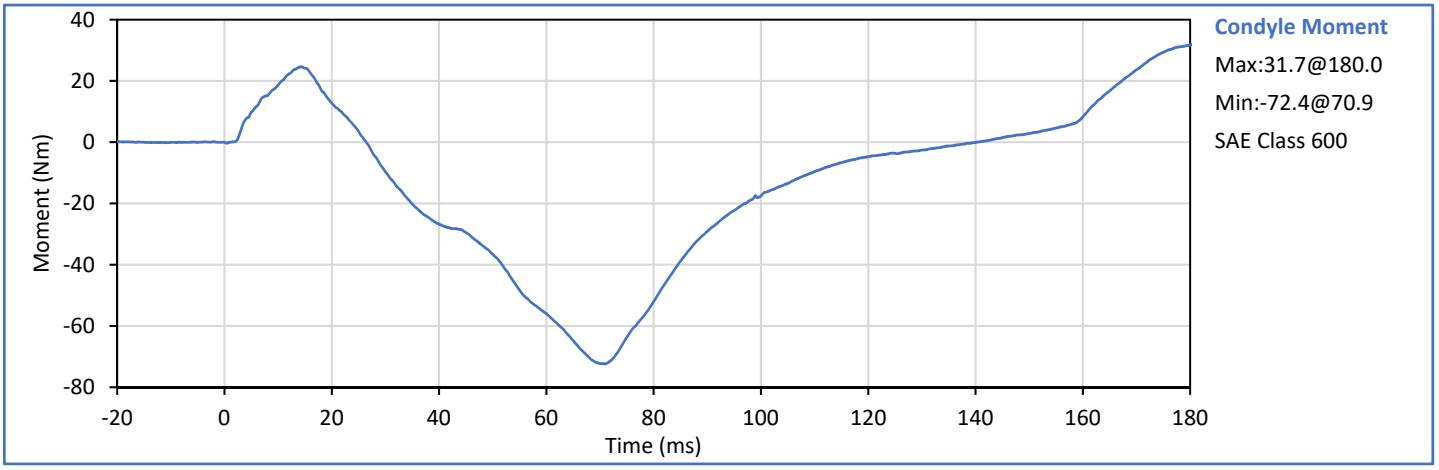
Technician: J. Hernandez

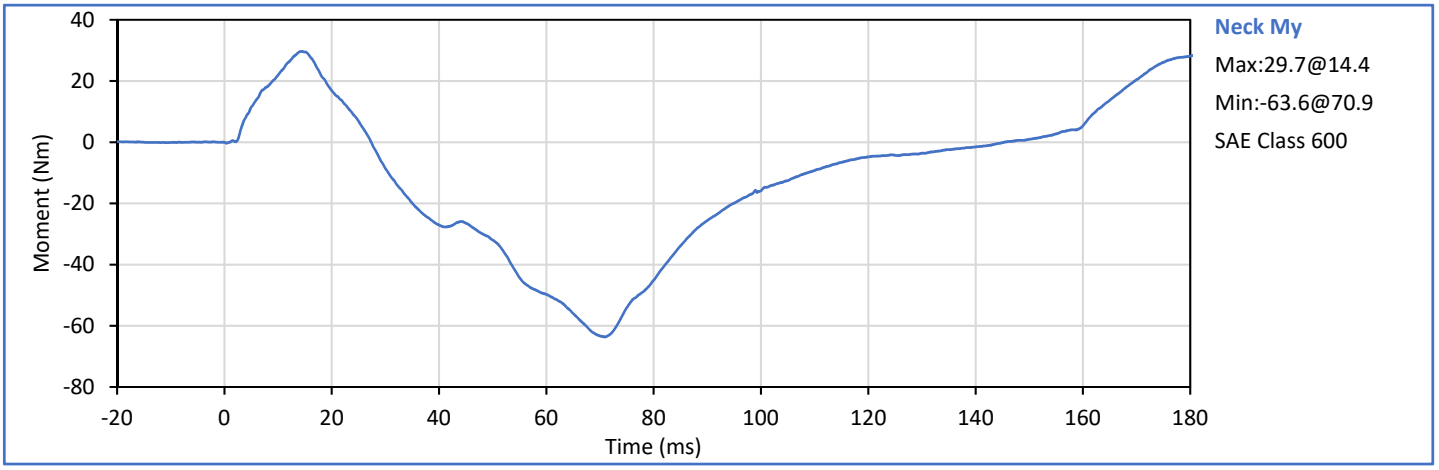
Approved By: P. Puzzuto

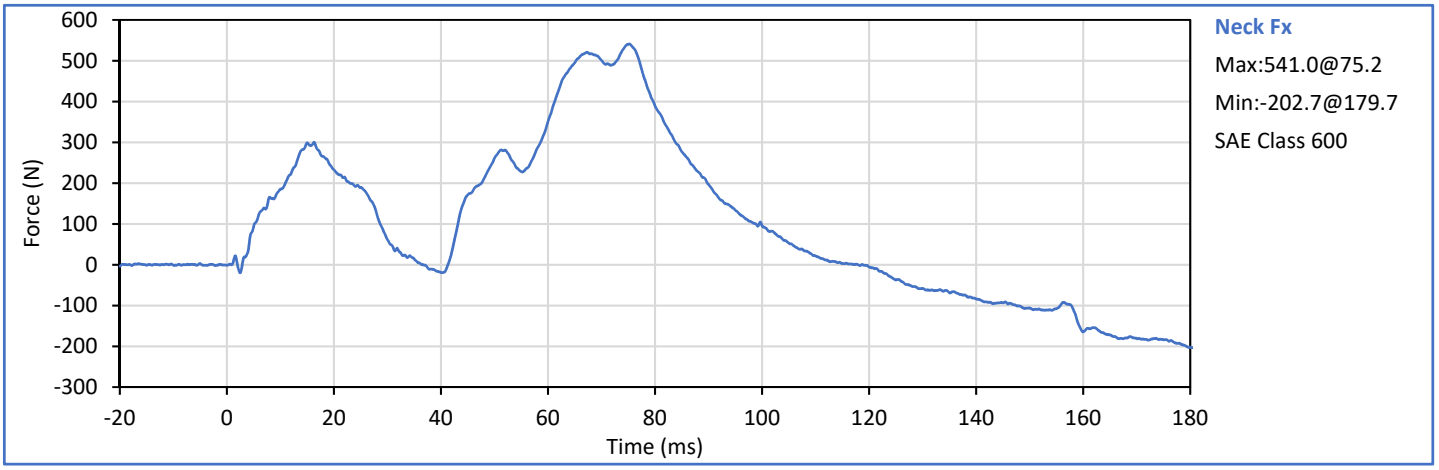
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Neck Extension Test

ATD Serial No.: 360 Test Date: 2021-03-25





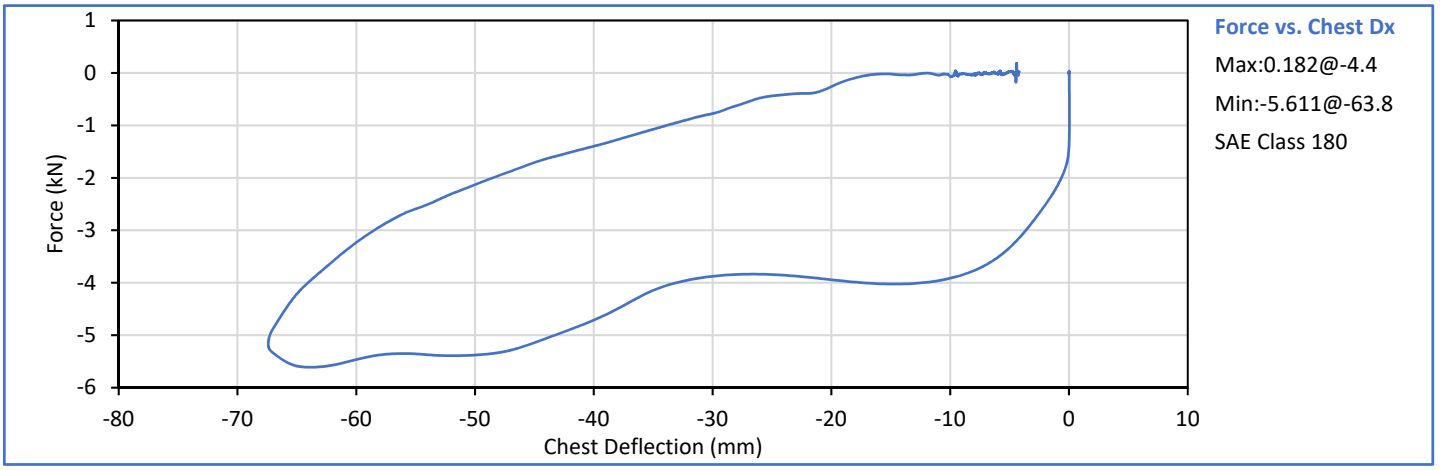


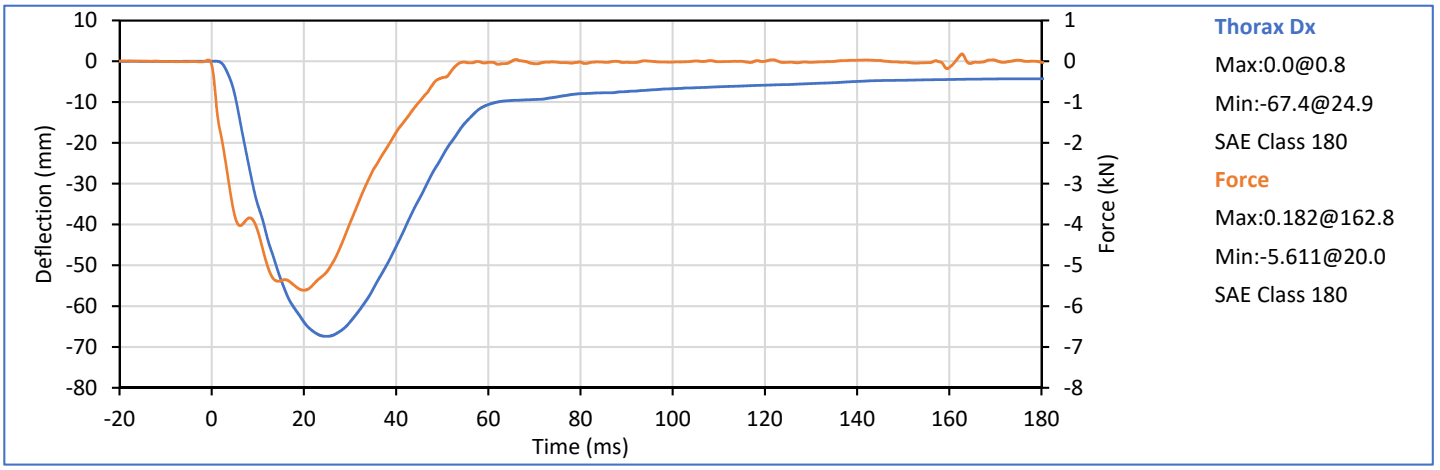
Applus IDIADA KARCO

Hybrid III 50th Percentile Male ATD
Thorax Impact

ATD Serial No.: 360 Test Date: 2021-03-26

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	29	Pass
Probe Velocity	m/s	6.58	6.82	6.68	Pass
Peak Chest Deflection	mm	-72.6	-63.5	-67.4	Pass
Peak Probe Force	kN	-5.893	-5.159	-5.611	Pass
Internal Hysterisis	%	69.0	85.0	70.0	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

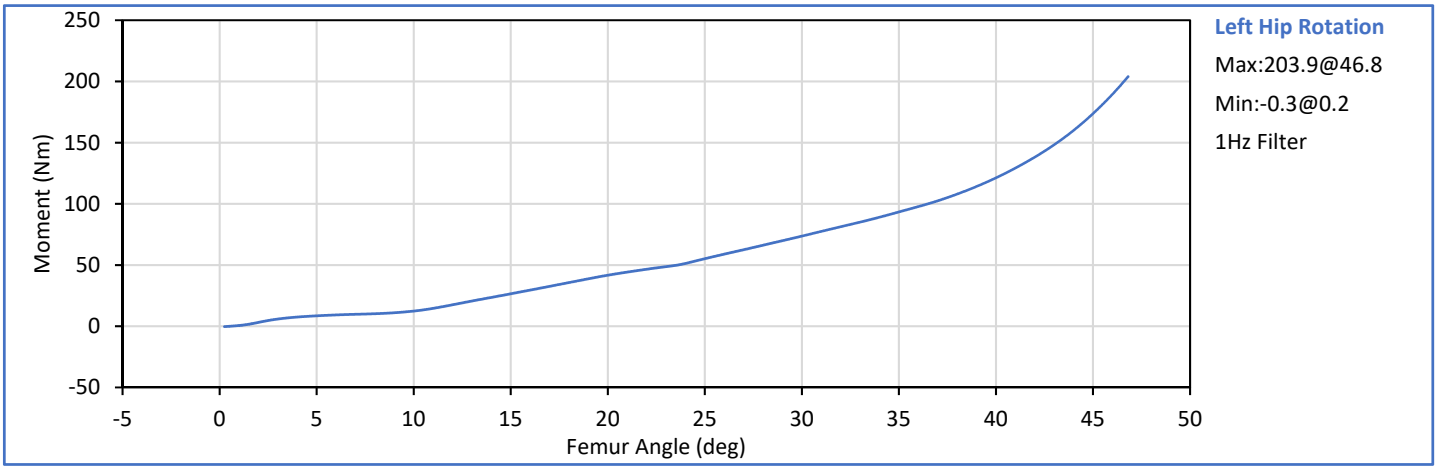
Applus IDIADA KARCO

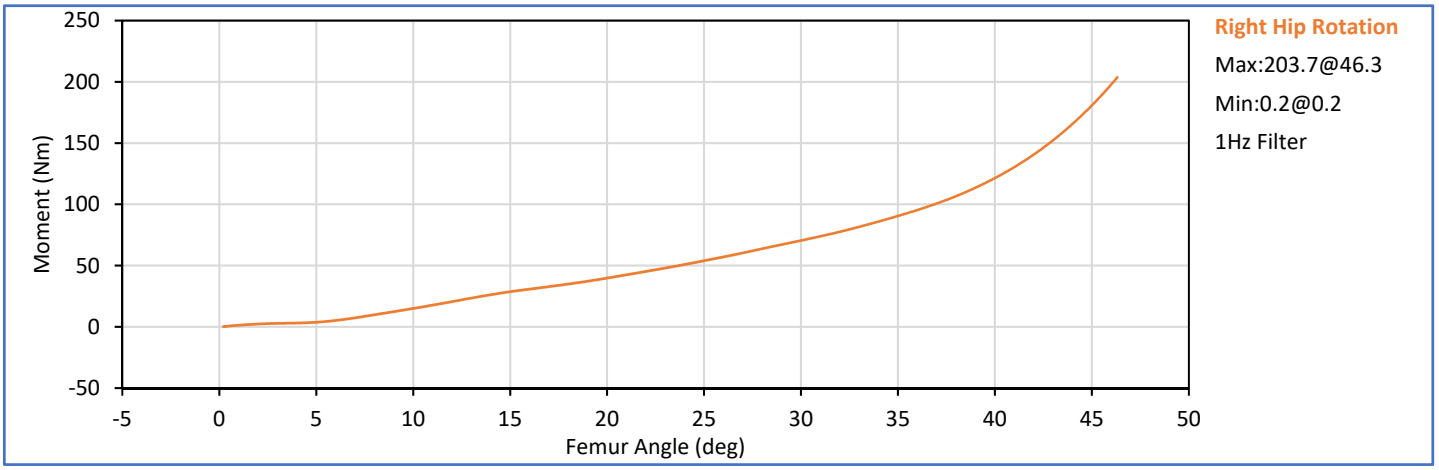
Hybrid III 50th Percentile Male ATD
Hip Flexion (Left/Right)

ATD Serial No.: 360

Test Date: 2021-03-25

	Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
	Laboratory Temperature	°C	18.9	25.6	21.2	Pass
	Laboratory Relative Humidity	%	10	70	21	Pass
Left Hip	Left Hip Rotation Rate	deg/s	5.0	10.0	5.8	Pass
	Left Femur Torque at 30°	Nm	0.0	95.0	73.7	Pass
	Left Hip Rotation at 203 Nm	deg	40.0	50.0	46.7	Pass
Right Hip	Right Hip Rotation Rate	deg/s	5.0	10.0	5.9	Pass
	Right Femur Torque at 30°	Nm	0.0	95.0	70.5	Pass
	Right Hip Rotation at 203 Nm	deg	40.0	50.0	46.3	Pass
				Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

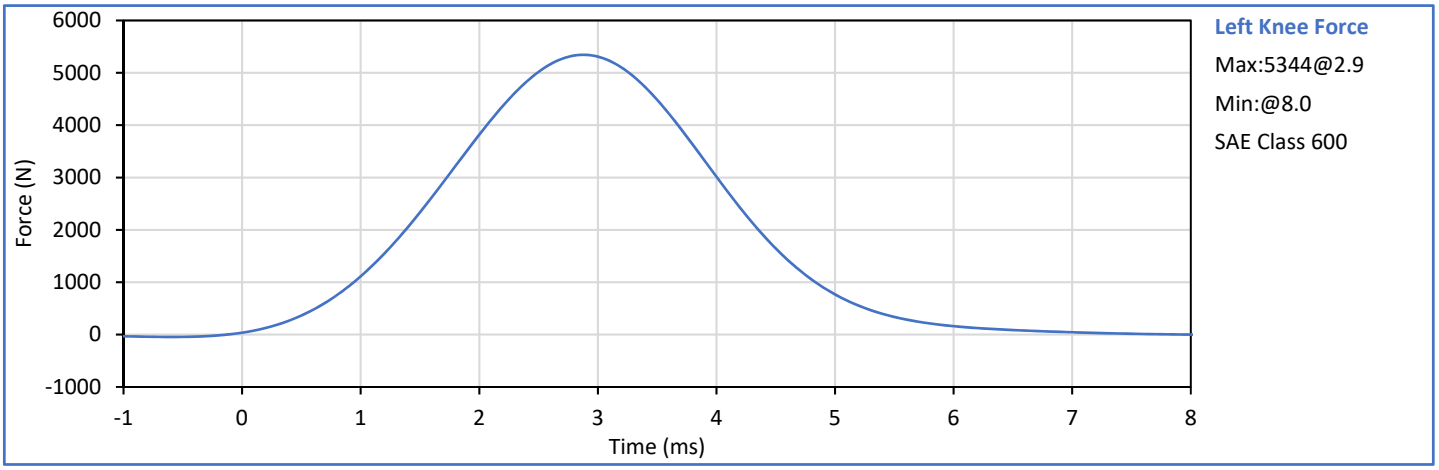
Applus IDIADA KARCO

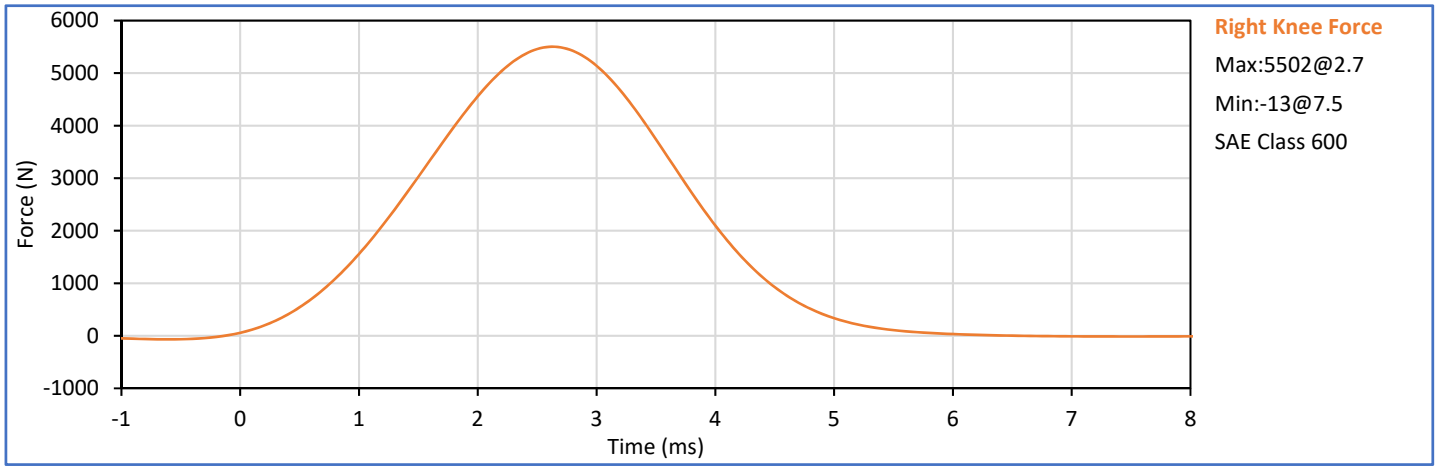
Hybrid III 50th Percentile Male ATD
Knee Impact (Left/Right)

ATD Serial No.: 360

Test Date: 2021-03-25

	Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
	Laboratory Temperature	°C	18.9	25.6	21.7	Pass
	Laboratory Relative Humidity	%	10	70	22	Pass
Left Knee	Probe Velocity	m/s	2.070	2.130	2.103	Pass
	Peak Resistive Force	N	4715	5782	5344	Pass
Right Knee	Probe Velocity	m/s	2.070	2.130	2.105	Pass
	Peak Resistive Force	N	4715	5782	5502	Pass
				Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

APPENDIX C
Post-Test ATD Qualification and Performance Verification
Hybrid III 5th Percentile Female ATD
S/N: DH1644

Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Damage Checklist

ATD Serial No.: DH1644 Test Date: 2021-03-24

Dummy Item	Inspect for	Comments	Damage	Okay
Entire ATD	Perform general cleaning			✓
Outer Skin	Gashes, rips, cracks			✓
Head	Ballast secure			✓
	General appearance			✓
Neck bracket	Upper neck firmly attached to lower bracket			✓
Neck	Broken or cracked rubber			✓
	Looseness at the condyle joint			✓
Nodding block	Cracked or out of position			✓
Lumbar Spine	Broken or cracked rubber			✓
Ribs	Broken or bent ribs			✓
	Broken or bent rib supports			✓
	Damping material separated or cracked			✓
	Rubber bumpers in place			✓
Chest Displ.	Bent shaft			✓
Assembly	Slider arm riding in track			✓
Sensors	Check cables for cuts, tears			✓
	Check for damaged insulation			✓
Accelerometer	Head mounting secure			✓
Mounting	Chest mounting secure			✓
Knees	Skin condition			✓
	Insert (do not remove)			✓
	Casting			✓
Limbs	Normal movement and adjustment			✓
Knee Sliders	Wires intact			✓
	Rubber returned to "resting" position			✓
Pelvis	Broken			✓
Other	Describe below as needed			✓

Describe any repairs or replacement of parts or other findings:

No Problems Found

Technician: J. Hernandez

Approved By: P. Puzzuto

Applus IDIADA
KARCO

Hybrid III 5th Percentile Female ATD
External Measurements

ATD Serial No.: DH1644 Test Date: 2021-03-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Relative Humidity	%	10	70	30	Pass
A - Total sitting height	mm	775	800	787	Pass
B - Shoulder pivot height	mm	432	457	445	Pass
C - 'H' point height	mm	81	86	85	Pass
D - 'H' point location from backline	mm	145	150	148	Pass
E - Shoulder pivot from backline	mm	69	84	79	Pass
F - Thigh clearance	mm	119	135	125	Pass
G - Back of elbow to wrist pivot	mm	244	259	254	Pass
H - Head back to backline	mm	41	46	42	Pass
I - Shoulder to elbow length	mm	277	297	285	Pass
J - Elbow rest height	mm	183	203	195	Pass
K - Buttock to knee length	mm	521	546	538	Pass
L - Popliteal length	mm	356	376	368	Pass
M - Knee pivot height	mm	394	419	408	Pass
N - Buttock popliteal length	mm	414	439	424	Pass
O - Chest depth without jacket	mm	175	191	187	Pass
P - Foot length	mm	219	234	232	Pass
R - Buttock to Knee Pivot Length	mm	457	483	472	Pass
S - Head Breadth	mm	137	147	141	Pass
T - Head Depth	mm	178	188	182	Pass
U - Hip Breadth	mm	300	315	309	Pass
V - Shoulder breadth	mm	351	366	357	Pass
W - Foot breadth	mm	79	94	89	Pass
X - Head circum.	mm	528	549	538	Pass
Y - Chest circum. (w/chest jacket)	mm	851	881	867	Pass
Z - Waist circum.	mm	760	790	778	Pass
AA - Location for chest circum.	mm	333	358	341	Pass
BB - Location for waist circum.	mm	160	170	168	Pass
			Overall Test Results		Pass

Technician: J. Hernandez

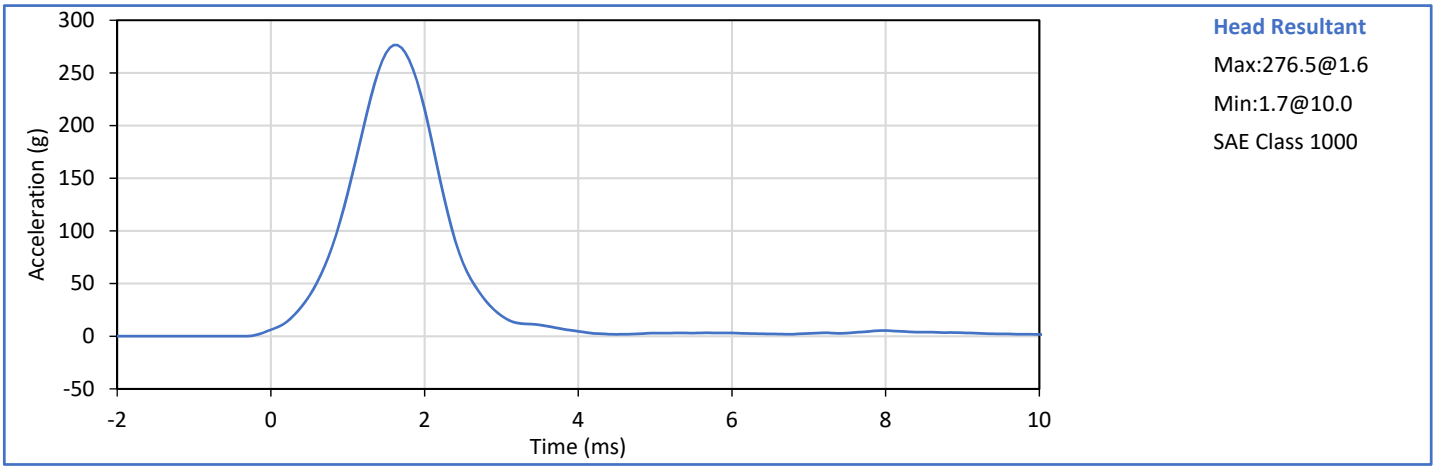
Approved By: P. Puzzuto

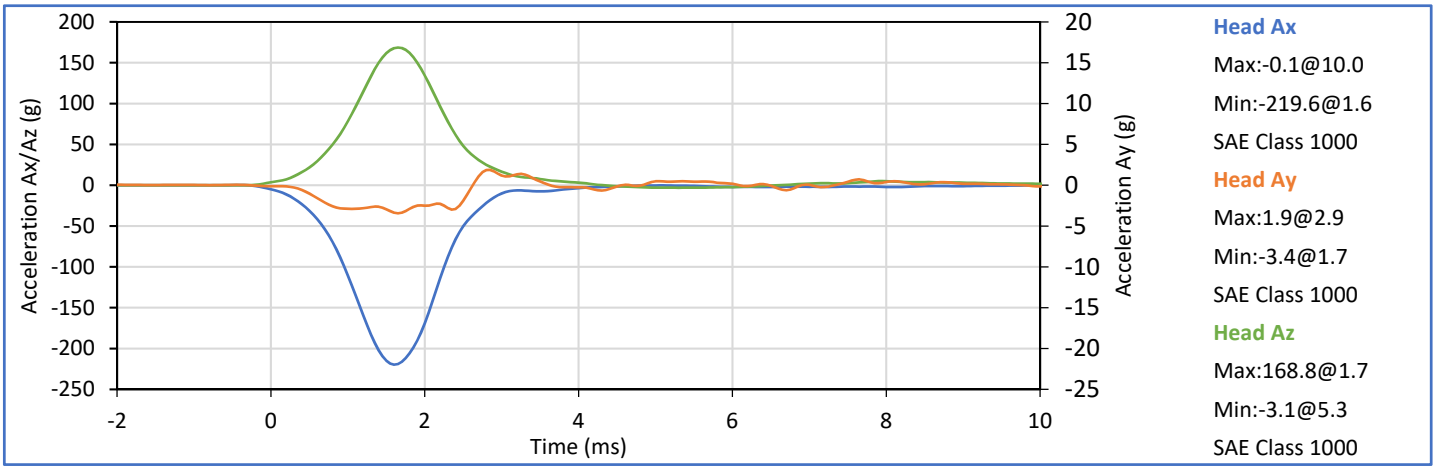
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Head Drop Test

ATD Serial No.: DH1644 Test Date: 2021-03-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	18.9	25.6	21.7	Pass
Laboratory Humidity	%	10	70	21	Pass
Peak Resultant Acceleration	g	250.0	300.0	276.5	Pass
Peak Lateral Acceleration	g	-15.0	15.0	-3.4	Pass
Oscillations After Main Pulse	%	0.0	10.0	2.0	Pass
Is Acceleration Unimodal?	Yes/No	Yes		Yes	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

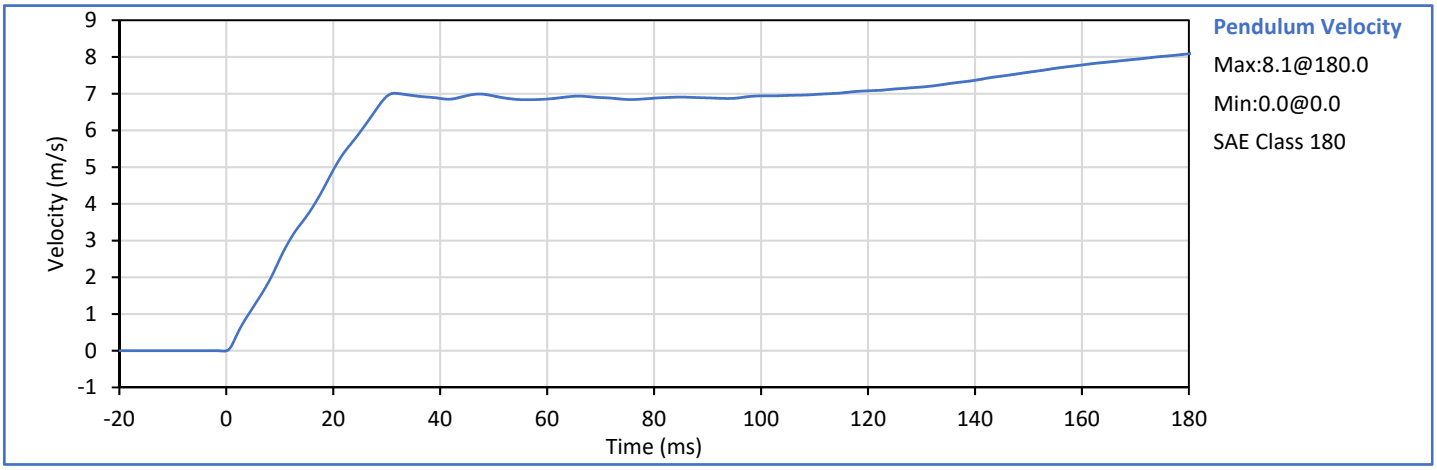
Approved By: P. Puzzuto

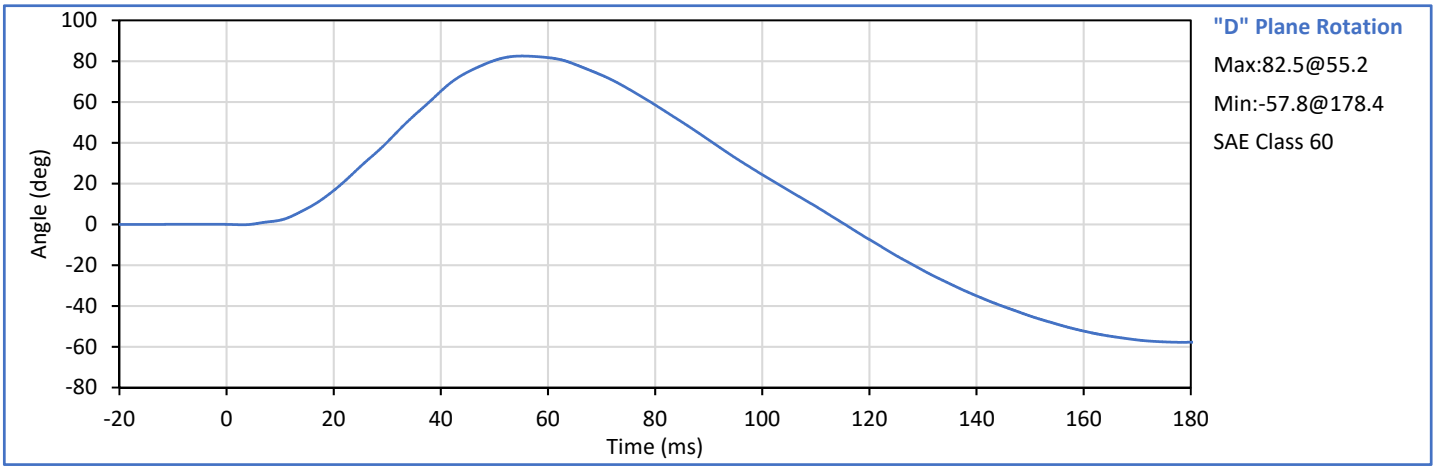
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Neck Flexion Test

ATD Serial No.: DH1644 Test Date: 2021-03-25

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Humidity	%	10	70	24	Pass
Pendulum Velocity	m/s	6.89	7.13	7.03	Pass
Pendulum Velocity at 10 ms	m/s	2.10	2.50	2.50	Pass
Pendulum Velocity at 20 ms	m/s	4.00	5.00	4.92	Pass
Pendulum Velocity at 30 ms	m/s	5.80	7.00	6.93	Pass
Peak "D" Plane Rotation	deg	77.0	91.0	82.5	Pass
Peak Moment in Rotation	Nm	69.0	83.0	79.5	Pass
Positive Moment Decay to 10 Nm	ms	80.0	100.0	83.3	Pass
			Overall Test Results		Pass



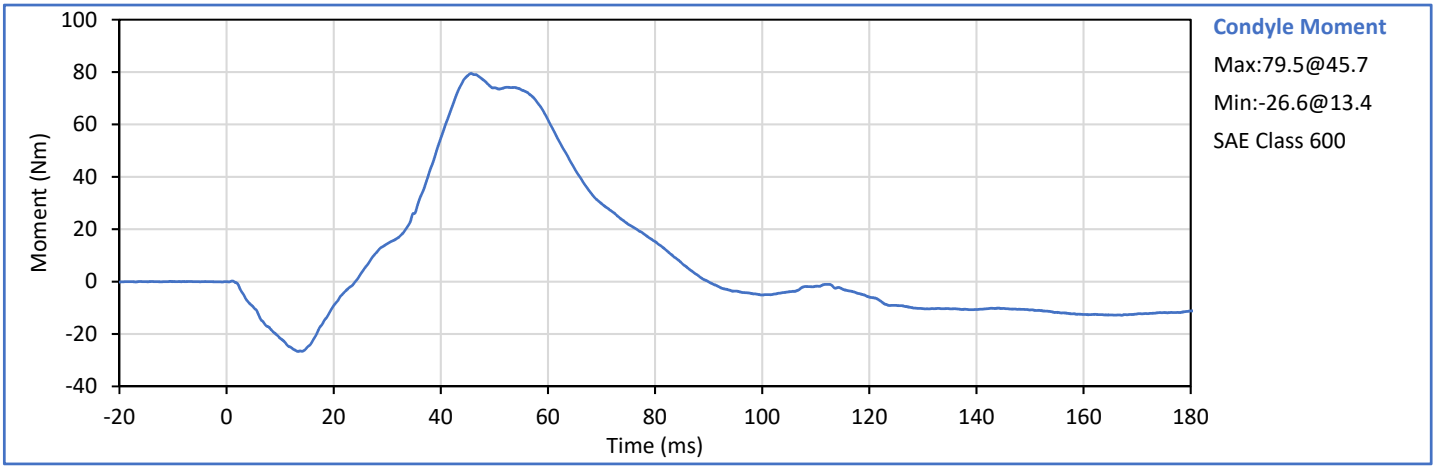


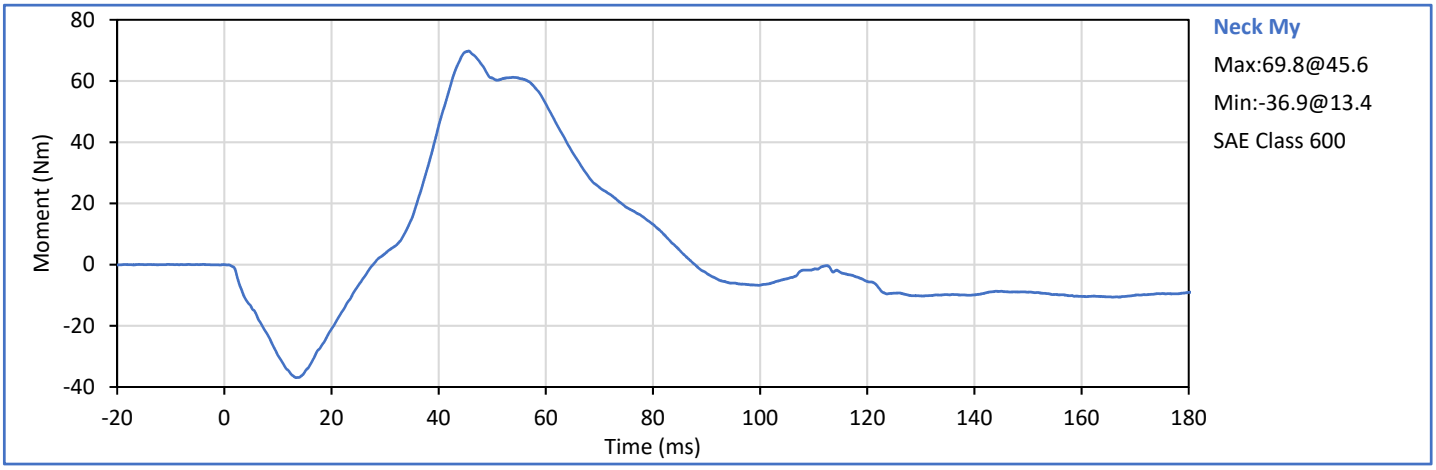
Technician: J. Hernandez

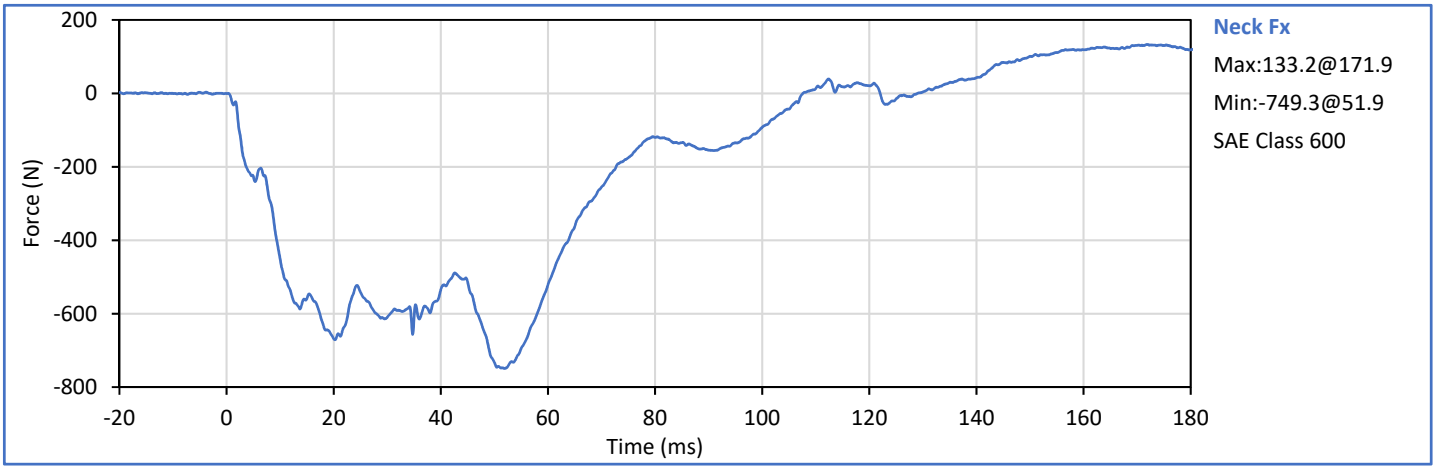
Approved By: P. Puzzuto

Hybrid III 5th Percentile Female ATD
Neck Flexion Test

ATD Serial No.: DH1644 Test Date: 2021-03-25





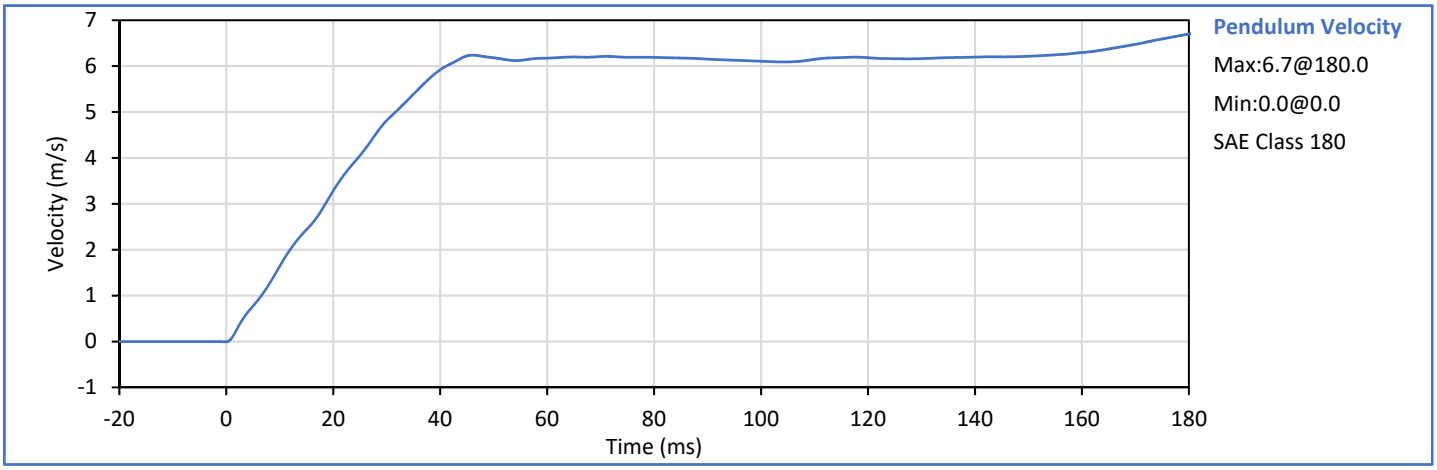


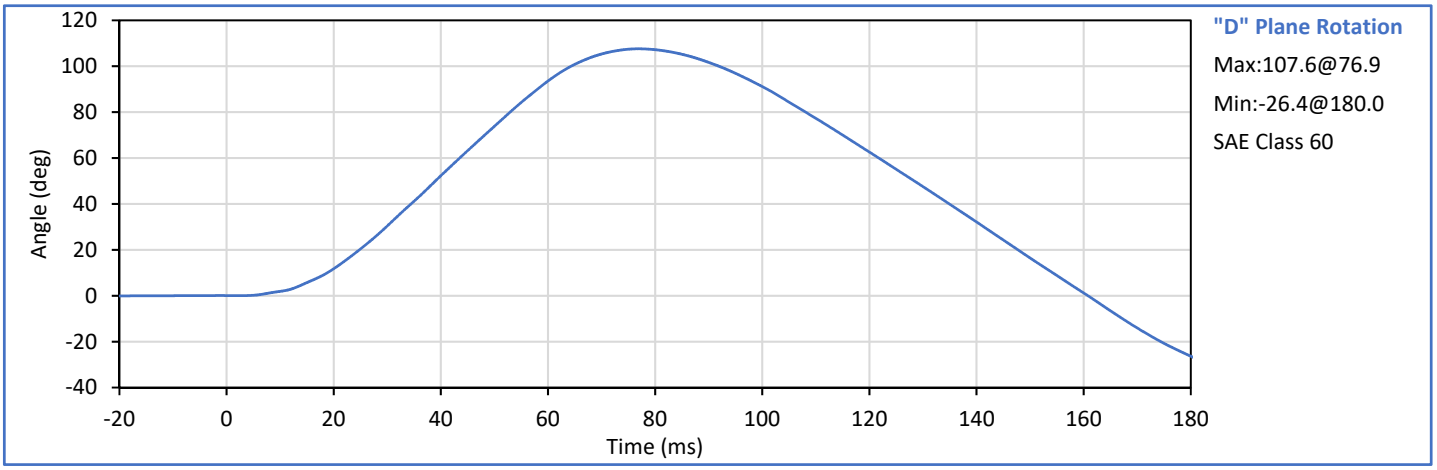
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Neck Extension Test

ATD Serial No.: DH1644 Test Date: 2021-03-25

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Humidity	%	10	70	24	Pass
Pendulum Velocity	m/s	5.95	6.19	6.01	Pass
Pendulum Velocity at 10 ms	m/s	1.50	1.90	1.64	Pass
Pendulum Velocity at 20 ms	m/s	3.10	3.90	3.28	Pass
Pendulum Velocity at 30 ms	m/s	4.60	5.60	4.82	Pass
Peak "D" Plane Rotation	deg	99.0	114.0	107.6	Pass
Peak Moment in Rotation	Nm	-65.0	-53.0	-56.6	Pass
Negative Moment Decay to -10 Nm	ms	94.0	114.0	105.2	Pass
			Overall Test Results		Pass



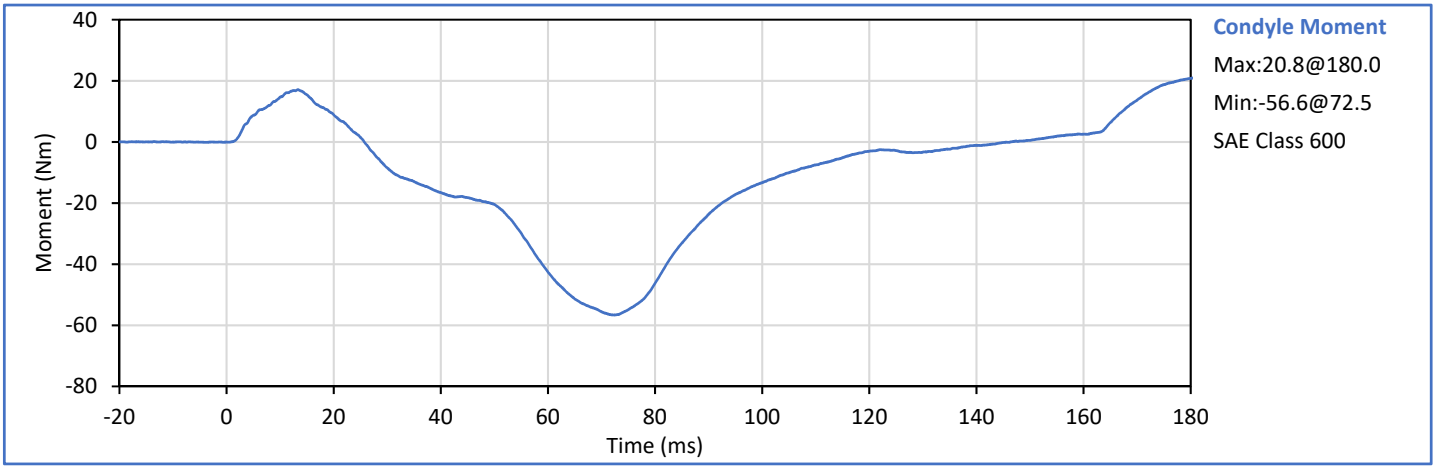


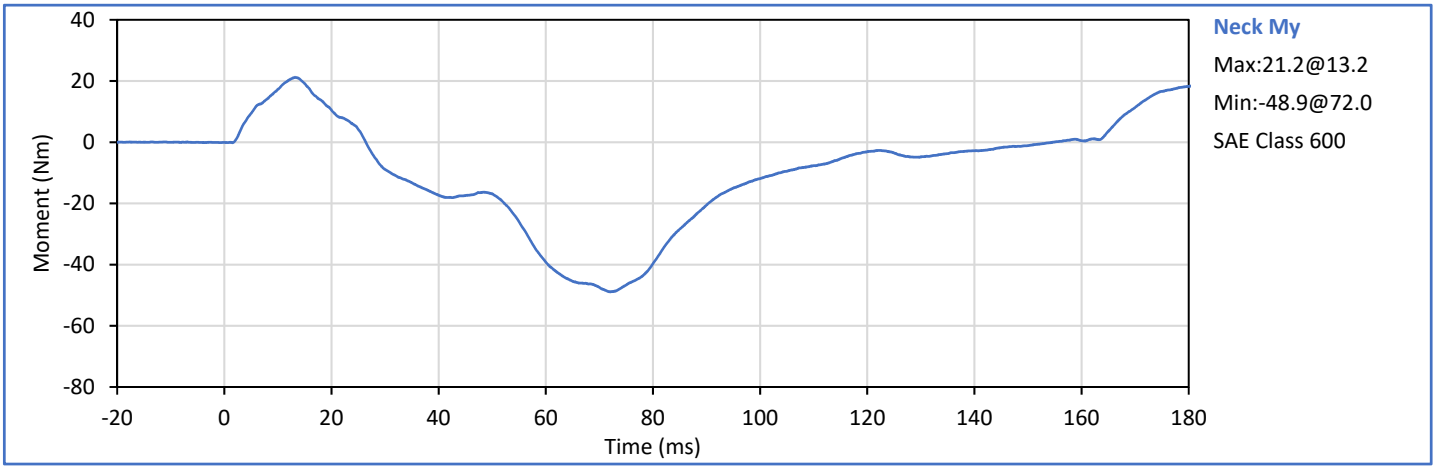
Technician: J. Hernandez

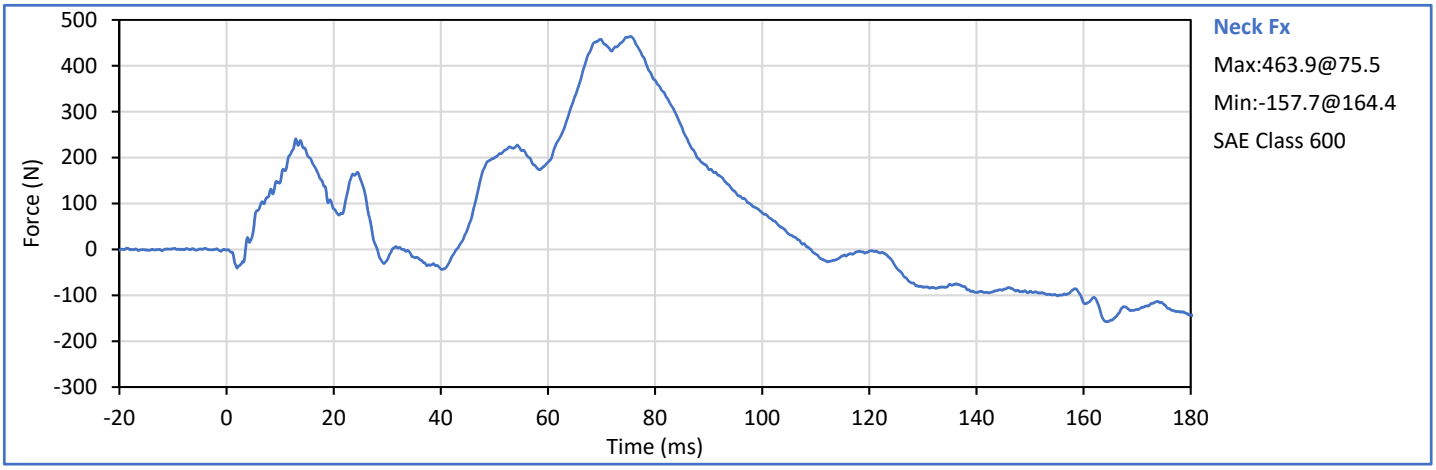
Approved By: P. Puzzuto

Hybrid III 5th Percentile Female ATD
Neck Extension Test

ATD Serial No.: DH1644 Test Date: 2021-03-25







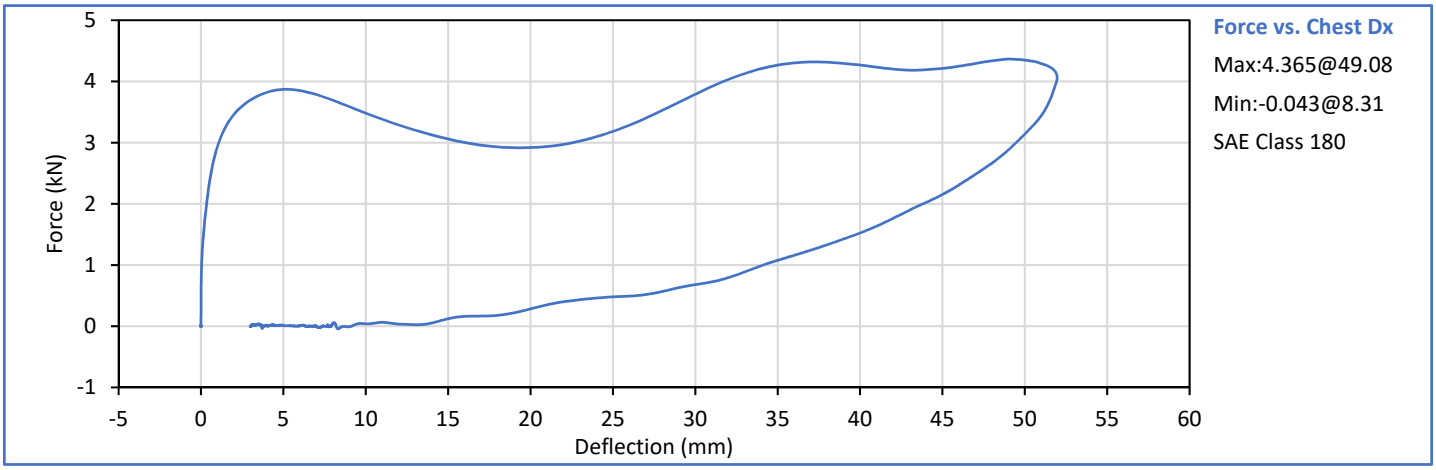
Applus IDIADA
KARCO

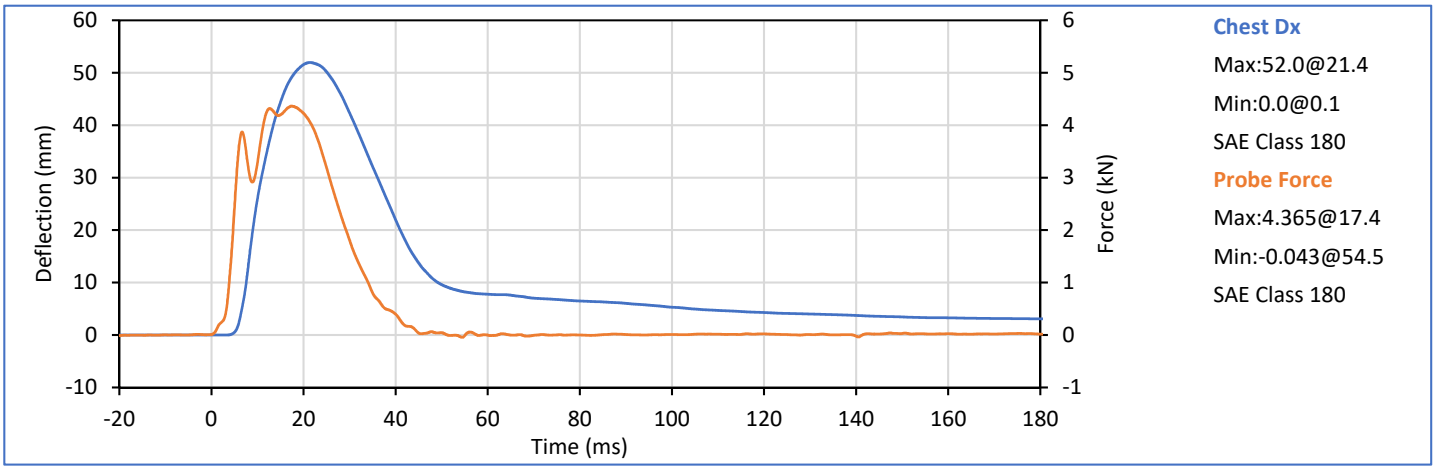
Hybrid III 5th Percentile Female ATD
Thorax Impact

ATD Serial No.: DH1644

Test Date: 2021-03-26

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	20.6	22.2	21.7	Pass
Laboratory Humidity	%	10	70	30	Pass
Probe Velocity	m/s	6.59	6.83	6.67	Pass
Peak Chest Deflection	mm	50.0	58.0	52.0	Pass
Peak Probe Force, 50 and 58 mm	kN	3.900	4.400	4.349	Pass
Peak Probe Force, 18 and 50 mm	kN	0.000	4.600	4.365	Pass
Internal Hysterisis	%	69.0	85.0	76.1	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

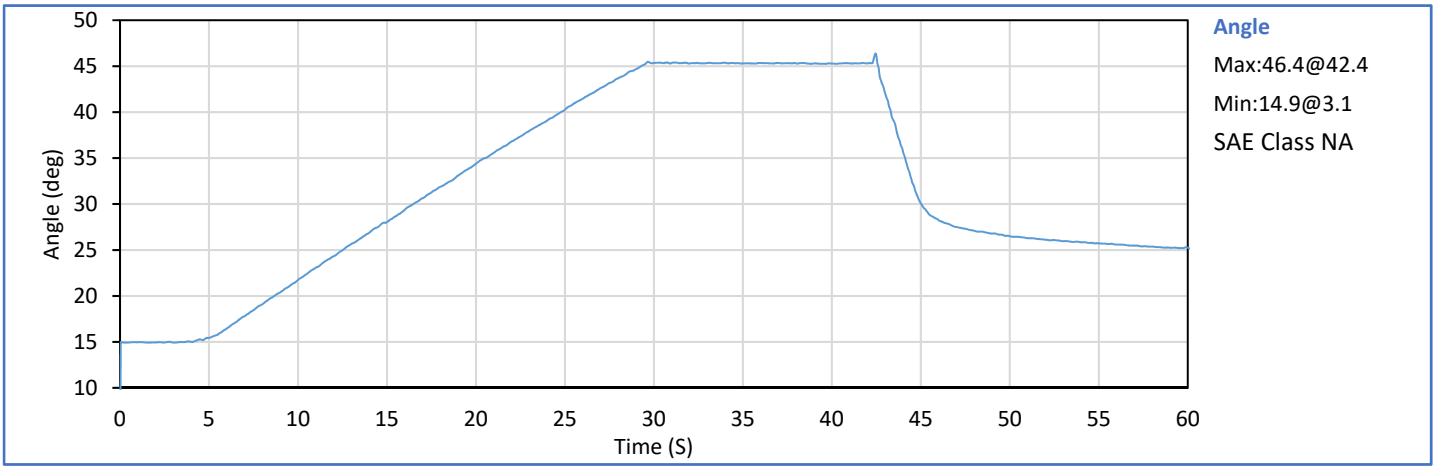
Applus IDIADA
KARCO

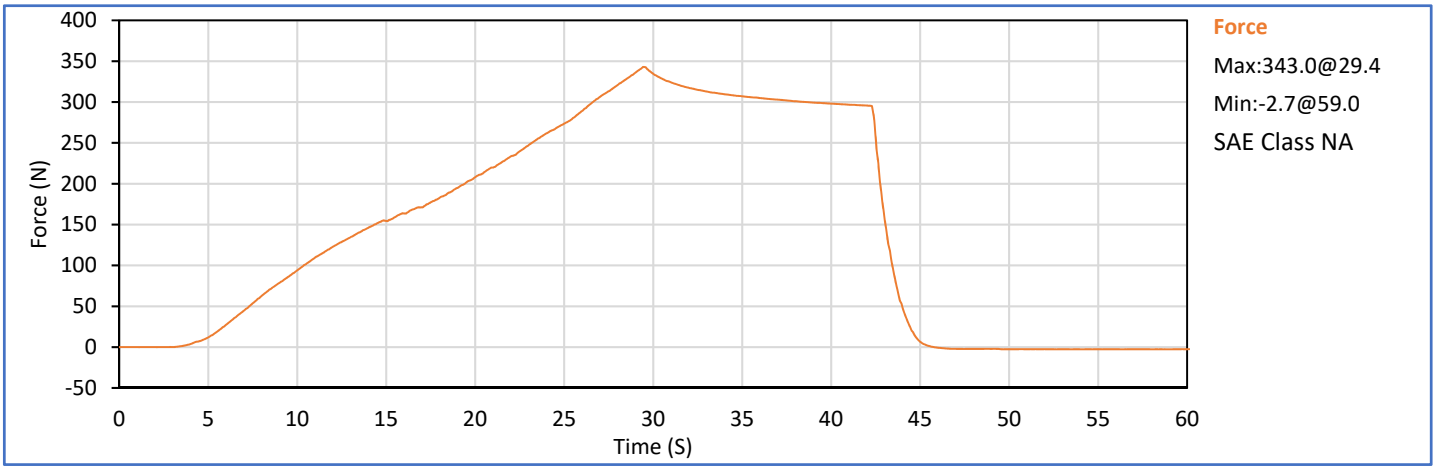
Hybrid III 5th Percentile Female ATD
Torso Flexion Test

ATD Serial No.: DH1644

Test Date: 2021-03-24

Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
Laboratory Temperature	°C	18.9	25.6	21.7	Pass
Laboratory Humidity	%	10	70	30	Pass
Orientation Angle	deg	0.0	20.0	15.1	Pass
Test Initial Angle	deg	11.0	19.0	15.0	Pass
Peak Force at 45° (+/-0.5°)	N	320.0	390.0	341.6	Pass
Torso Flexion Rate	deg/s	0.50	1.50	1.23	Pass
Final Reference Plane Angle	deg	-8.0	8.0	5.0	Pass
			Overall Test Results		Pass





Technician: J. Hernandez

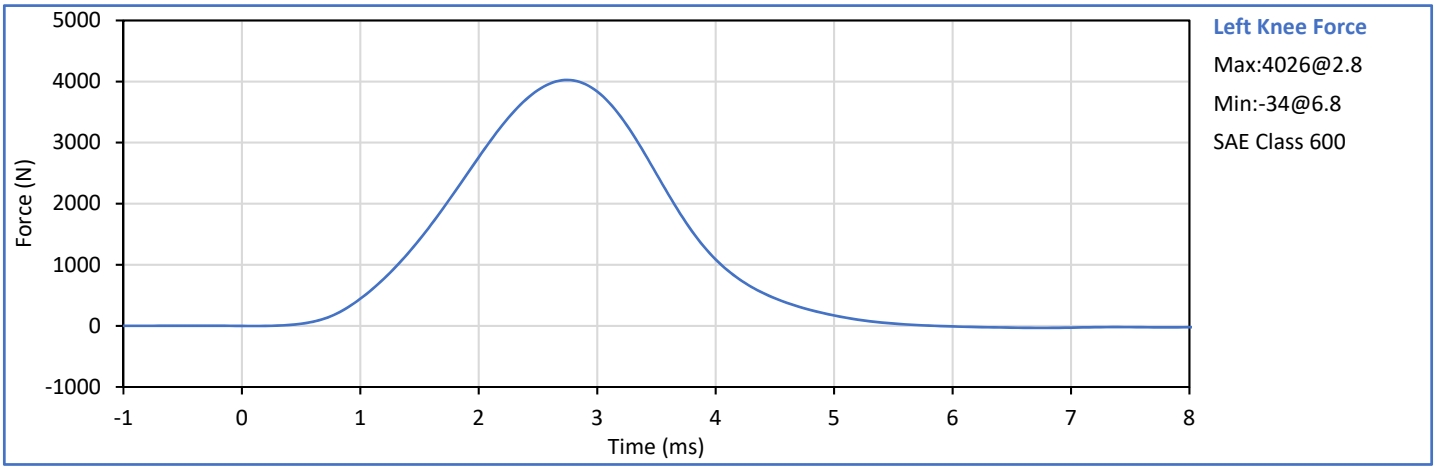
Approved By: P. Puzzuto

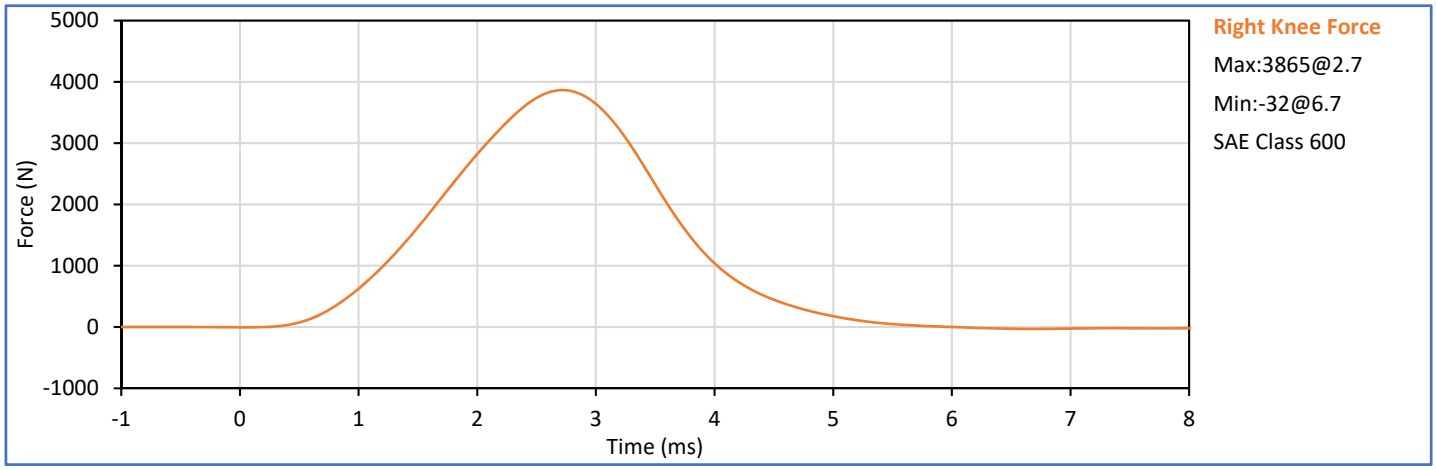
Applus IDIADA KARCO

Hybrid III 5th Percentile Female ATD
Knee Impact (Left/Right)

ATD Serial No.: DH1644 Test Date: 2021-03-25

	Tested Parameter	Units	Spec. Low	Spec. High	Result	Pass/Fail
	Laboratory Temperature	°C	18.9	25.6	21.7	Pass
	Laboratory Humidity	%	10	70	23	Pass
Left Knee	Probe Velocity	m/s	2.070	2.130	2.104	Pass
	Peak Resistive Force	N	3450	4060	4026	Pass
Right Knee	Probe Velocity	m/s	2.070	2.130	2.084	Pass
	Peak Resistive Force	N	3450	4060	3865	Pass
				Overall Test Results		Pass





Technician: J. Hernandez

Approved By: P. Puzzuto

APPENDIX D
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION

H3-50M ATD S/N: 360

Table 1 - Driver ATD Instrumentation

Sensor Location	Sensor S\N	Mfr	Model	Cal Date
Head Acceleration X Primary	P49209	Endevco	7264C-2k	2021-02-15
Head Acceleration Y Primary	P49228	Endevco	7264C-2k	2021-02-12
Head Acceleration Z Primary	P50101	Endevco	7264C-2k	2021-02-12
Head Acceleration X Redundant	P50103	Endevco	7264C-2k	2021-02-15
Head Acceleration Y Redundant	P49210	Endevco	7264C-2k	2021-02-12
Head Acceleration Z Redundant	P58713	Endevco	7264C-2k	2021-02-12
Head Rotation Rate X	ARS14943	DTS	ARS PRO-18k (2kHz)	2020-08-04
Head Rotation Rate Y	ARS14944	DTS	ARS PRO-18k (2kHz)	2020-08-04
Head Rotation Rate Z	ARS14954	DTS	ARS PRO-18k (2kHz)	2020-08-04
Upper Neck Force X	1633 Fx	R.A. Denton	1716A	2020-07-20
Upper Neck Force Y	1633 Fy	R.A. Denton	1716A	2020-07-20
Upper Neck Force Z	1633 Fz	R.A. Denton	1716A	2020-07-20
Upper Neck Moment X	1633 Mx	R.A. Denton	1716A	2020-07-20
Upper Neck Moment Y	1633 My	R.A. Denton	1716A	2020-07-20
Upper Neck Moment Z	1633 Mz	R.A. Denton	1716A	2020-07-20
Chest Acceleration X Primary	P52112	Endevco	7264C-2k	2021-02-11
Chest Acceleration Y Primary	P49208	Endevco	7264C-2k	2021-02-11
Chest Acceleration Z Primary	P51264	Endevco	7264C-2k	2021-02-12
Chest Acceleration X Redundant	P49461	Endevco	7264C-2k	2021-02-11
Chest Acceleration Y Redundant	P58774	Endevco	7264C-2k	2021-02-11
Chest Acceleration Z Redundant	P49168	Endevco	7264C-2k	2021-02-12
Chest Deflection	0606 (H3)	Servo	14CBI-3615	2021-02-15
Pelvis Acceleration X	P49238	Endevco	7264C-2k	2021-02-15
Pelvis Acceleration Y	P58877	Endevco	7264C-2k	2021-02-15
Pelvis Acceleration Z	P50087	Endevco	7264C-2k	2021-02-15
Left Femur Force Z	DS9756 (pri)	Humanetics	3821JLN2	2021-01-18
Right Femur Force Z	DS4141 (pri)	Humanetics	3821JLN2	2021-01-18
Left Femur Force Z Redundant	DS9756 (red)	Humanetics	3821JLN2	2021-01-18
Right Femur Force Z Redundant	DS4141 (red)	Humanetics	3821JLN2	2021-01-18
Left Upper Tibia Moment X	DH3309 Mx	FTSS	IF-857	2021-01-14
Left Upper Tibia Moment Y	DH3309 My	FTSS	IF-857	2021-01-14
Left Upper Tibia Force Z	DH3309 Fz	FTSS	IF-857	2021-01-14
Left Lower Tibia Moment X	DI4186 Mx	FTSS	IF-853	2021-01-14
Left Lower Tibia Moment Y	DI4186 My	FTSS	IF-853	2021-01-14
Left Lower Tibia Force Z	DI4186 Fz	FTSS	IF-853	2021-01-14
Right Upper Tibia Moment X	DG6679 Mx	FTSS	IF-857	2021-01-14
Right Upper Tibia Moment Y	DG6679 My	FTSS	IF-857	2021-01-14
Right Upper Tibia Force Z	DG6679 Fz	FTSS	IF-857	2021-01-14
Right Lower Tibia Moment X	405 Mx	R.A. Denton	3644	2021-01-14
Right Lower Tibia Moment Y	405 My	R.A. Denton	3644	2021-01-14
Right Lower Tibia Force Z	405 Fz	R.A. Denton	3644	2021-01-14
Left Ankle Acceleration X	03E20-N09	Entran	EGEB6Q-2k	2021-02-18
Left Ankle Acceleration Z	03D30-N13	Entran	EGEB6Q-2k	2021-02-18
Left Toe Acceleration Z	03H07-Z10	Entran	EGEB6Q-2k	2021-02-18
Right Ankle Acceleration X	03E29-N20	Entran	EGEB6Q-2k	2021-02-18
Right Ankle Acceleration Z	03E18-F02	Entran	EGEB6Q-2k	2021-02-18
Right Toe Acceleration Z	03D09-N01	Entran	EGEB6Q-2k	2021-02-18
Seat Belt Outside Lap Force	177	FTSS	IF-964	2020-10-02
Seat Belt Upper Diagonal Force	251	FTSS	IF-964	2020-10-02

Table 2 - Right Front Passenger ATD Instrumentation

Sensor Location	Sensor S\N	Mfr	Model	Cal Date
Head Acceleration X Primary	P51889	Endevco	7264C-2k	2021-01-15
Head Acceleration Y Primary	P51861	Endevco	7264C-2k	2021-01-15
Head Acceleration Z Primary	P52077	Endevco	7264C-2k	2021-01-15
Head Acceleration X Redundant	P58835	Endevco	7264C-2k	2021-01-15
Head Acceleration Y Redundant	P51703	Endevco	7264C-2k	2021-01-15
Head Acceleration Z Redundant	P52096	Endevco	7264C-2k	2021-01-15
Head Rotation Rate X	ARS14907	DTS	ARS PRO-18k (2kHz)	2020-08-04
Head Rotation Rate Y	ARS14935	DTS	ARS PRO-18k (2kHz)	2020-08-04
Head Rotation Rate Z	ARS14936	DTS	ARS PRO-18k (2kHz)	2020-08-04
Upper Neck Force X	2185 Fx	R.A. Denton	1716ATF	2021-01-18
Upper Neck Force Y	2185 Fy	R.A. Denton	1716ATF	2021-01-18
Upper Neck Force Z	2185 Fz	R.A. Denton	1716ATF	2021-01-18
Upper Neck Moment X	2185 Mx	R.A. Denton	1716ATF	2021-01-18
Upper Neck Moment Y	2185 My	R.A. Denton	1716ATF	2021-01-18
Upper Neck Moment Z	2185 Mz	R.A. Denton	1716ATF	2021-01-18
Chest Acceleration X Primary	P58860	Endevco	7264C-2k	2021-01-15
Chest Acceleration Y Primary	P51876	Endevco	7264C-2k	2021-01-15
Chest Acceleration Z Primary	P58711	Endevco	7264C-2k	2021-01-15
Chest Acceleration X Redundant	P52049	Endevco	7264C-2k	2021-01-15
Chest Acceleration Y Redundant	P51862	Endevco	7264C-2k	2021-01-15
Chest Acceleration Z Redundant	P52048	Endevco	7264C-2k	2021-01-15
Chest Deflection	0724 (HF)	Servo	14CBI-3615	2021-01-19
Pelvis Acceleration X	P52090	Endevco	7264C-2k	2021-01-15
Pelvis Acceleration Y	P58849	Endevco	7264C-2k	2021-01-15
Pelvis Acceleration Z	P58756	Endevco	7264C-2k	2021-01-15
Left Femur Force Z	DS4137 (pri)	Humanetics	3821JLN2	2021-01-18
Right Femur Force Z	DS4139 (pri)	Humanetics	3821JLN2	2021-01-18
Left Femur Force Z Redundant	DS4137 (red)	Humanetics	3821JLN2	2021-01-18
Right Femur Force Z Redundant	DS4139 (red)	Humanetics	3821JLN2	2021-01-18
Left Upper Tibia Moment X	415 Mx	R.A. Denton	3643	2021-01-29
Left Upper Tibia Moment Y	415 My	R.A. Denton	3643	2021-01-29
Left Upper Tibia Force Z	415 Fz	R.A. Denton	3643	2021-01-29
Left Lower Tibia Moment X	365 Mx	R.A. Denton	3644	2021-01-29
Left Lower Tibia Moment Y	365 My	R.A. Denton	3644	2021-01-29
Left Lower Tibia Force Z	365 Fz	R.A. Denton	3644	2021-01-29
Right Upper Tibia Moment X	465 Mx	R.A. Denton	3643	2021-01-29
Right Upper Tibia Moment Y	465 My	R.A. Denton	3643	2021-01-29
Right Upper Tibia Force Z	465 Fz	R.A. Denton	3643	2021-01-29
Right Lower Tibia Moment X	493 Mx	R.A. Denton	3644	2021-01-29
Right Lower Tibia Moment Y	493 My	R.A. Denton	3644	2021-01-29
Right Lower Tibia Force Z	493 Fz	R.A. Denton	3644	2021-01-29
Left Ankle Acceleration X	P52057	Endevco	7264C-2k	2021-01-15
Left Ankle Acceleration Z	03E18-F07	Entran	EGEB6Q-2k	2021-01-15
Left Toe Acceleration Z	P49224	Endevco	7264C-2k	2021-01-15
Right Ankle Acceleration X	P52019	Endevco	7264C-2k	2021-01-15
Right Ankle Acceleration Z	P58755	Endevco	7264C-2k	2021-01-15
Right Toe Acceleration Z	P52076	Endevco	7264C-2k	2021-01-15
Seat Belt Outside Lap Force	300	FTSS	IF-964	2020-10-02
Seat Belt Upper Diagonal Force	313	FTSS	IF-964	2020-10-02

Table 3 - Vehicle Instrumentation

Sensor Location	Sensor S\N	Mfr	Model	Cal Date
Left Rear Primary Ax	A361329	MSI	52F-2k	2020-10-21
Right Rear Primary Ax	A361316	MSI	52F-2k	2020-10-21
Engine Top Ax	A361488	MSI	52F-2k	2020-10-19
Engine Bottom Ax	A361326	MSI	52F-2k	2020-10-21
Left Rear Az	A361347	MSI	52F-2k	2020-10-21
Right Rear Az	A361503	MSI	52F-2k	2020-10-19
Left Rear Redundant Ax	A361325	MSI	52F-2k	2020-10-20
Right Rear Redundant Ax	A361321	MSI	52F-2k	2020-10-21