

**Frontal Oblique Offset Test**  
**90.1 kph, 15 degree angle, 35% overlap**  
**Research Vehicle 6359**

**NHTSA Code:** M1V2T1P  
**Report Number:** R&D-CAL-13-05  
**Report Date:** September 27, 2013

**Contract Number:** V081313H  
**Test Number:** CAL2650  
**Test Date:** September 24, 2013

**Test Conducted By:**  
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Date: March 9, 2015

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Transportation Test Operations

Date: March 9, 2015

**TECHNICAL REPORT DOCUMENTATION PAGE**

<b>Report No.:</b> R&D-CAL-13-05	<b>Report Date:</b> 3/9/2015	<b>Customer PO or Contract No.:</b> V081313H
<b>Test Type and Vehicle:</b> Report for Frontal Oblique Offset Program Testing of a Research Vehicle 6359 Test No.: CAL2650		<b>Author(s):</b> Vanessa Walsh, Project Engineer Edward Dutton, Senior Test Engineer
<b>Performed By:</b> Calspan Corporation 4455 Genesee Street Buffalo, New York 14225		<b>Calspan Internal Charge No.:</b>  CV0164.0000
<p><b>16. Abstract</b></p> <p>A test was conducted in accordance with Contract No. V081313H. The test consisted of a research moving deformable barrier (RMDB) traveling at a target speed of 90.12 kph into a stationary SUV. The struck vehicle was positioned 15 degrees relative to the moving deformable barrier and impacted 35% of the left side of the vehicle. The test was conducted to obtain data indicant of the NHTSA R&amp;D Oblique test procedure, FMVSS 208, 212, 219 (partial), 301, and foot well intrusion performance. The test was conducted at Calspan Corporation’s Transportation Test Operation’s facility in Buffalo, New York on September 24, 2013.</p> <p>The impact velocity of the vehicle was 90.32 kph and the ambient temperature at the barrier face at the time of impact was 21°C. The target vehicle post-test maximum crush was 368 mm.</p>		
<p align="right"><b>Number of Pages: 80</b></p>		

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 Test Program: R&D 90.1kph, 15° angle, 35% overlap

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**SECTION 1  
PURPOSE OF TEST**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% overlap

Test No.: CAL2650  
Test Date: 09/24/2013

This 90.12 kph (56 mph) Research Moving Deformable Barrier (RMDB) into a test vehicle is part of the Frontal Offset Program sponsored by the National Highway Traffic Safety Administration (TEST) under Contract No. V081313H. The purpose of this test is to obtain vehicle crashworthiness and occupant restraint system performance data for consumer information purposes.

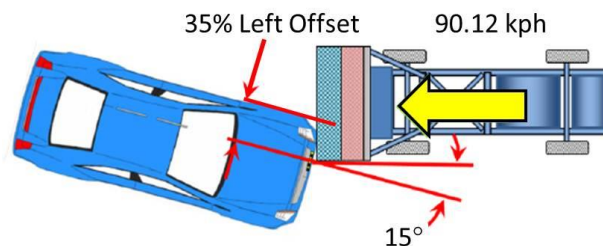
This test was conducted in accordance with the instructions set forth for a 15° angle, 35% offset moving barrier to vehicle impact, outlined in Contract No. V081313H. Data was obtained indicant of Federal Motor Vehicle Safety Standard FMVSS 208-Occupant Crash Protection, FMVSS 212 – Windshield Mounting, FMVSS 219 (partial) – Windshield Zone Intrusion, and FMVSS 301 – Fuel System Integrity, in addition to the requirements of Contract No. V081313H.

## SECTION 2 SUMMARY OF TEST

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

A Research Vehicle 6395 was impacted on the left front corner by a Research Moving Deformable Barrier (RMDB). This test vehicle was stationary and positioned at a target angle of 15° and at a target offset of 35% to the forward line of motion of the RMDB. The RMDB was towed down the test track in a full forward direction, without any crabbing, and at the targeted impact velocity of 90.12 kph (56.0 mph) into the test vehicle. The test vehicle's mass was 1,892.0 kg (4,171.1 lbs), and the RMDB's mass was 2,490.7 kg (5,491 lbs). The test was conducted by Calspan Corporation on September 24, 2013.



The test was documented by two (2) real time and fourteen (14) high-speed video cameras. Camera locations and other pertinent data are located in Data Sheet No. 6 of this report. Pre and post – test photographs of the test vehicle, RMDB, and test setup were taken using a digital still camera. Photographic documentation of the test is presented in Appendix A of this report.

One Hybrid III 50th adult male Anthropomorphic Test Device (ATD) (Serial No. 116) was seated in the left, front (P1 -Driver's) seating position and one Hybrid III 50th adult male ATD (Serial No. 366) was seated in the right front passenger seating position (P2). The Hybrid III 50th adult male driver and passenger were positioned according to instructions specified in laboratory Test procedures FMVSS 208-14, "Occupant Crash Protection", TP208-14, July 27, 2006.

The driver was restrained with a 3 – point seat belt, a front airbag, curtain airbag, torso airbag, and knee airbag. The passenger was restrained with a 3 – point seat belt, and a front airbag. The passenger's curtain and torso/pelvis airbags were disabled.

## CRASH VEHICLE SUMMARY

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

One hundred and eighty (180) channels of data from the two ATD's, Test vehicle and RMDB were collected using Kayser – Threde and DTS data acquisition systems. Appendix B contains vehicle and RMDB response data plots.

There was 91.6% total windshield retention, with 83.3% and 100% retention on the left and right sides, respectively. There appeared to be no intrusion into the protected zone of the windshield during any portion of the impact event. The maximum crush of the structural bumper beam was 368 mm at B1, to the left of the vehicle's centerline. Additional information pertaining to static crush measurements can be found on Data Sheet No.12 of this report.

All four vehicle doors remained closed and latched during the test. The left front door was deformed as a result of the impact causing it to be non-operational. The remaining doors all remained operational after the Test.

Structure observations include the following:

- Driver's side A-Pillar buckled rearward. (See Photo No.061 in Appendix A)
- Windshield cracked throughout; however there was no penetration observed in the protected zone.
- Hood of the vehicle bent upwards exposing part of the engine compartment.

## CRASH VEHICLE SUMMARY

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

### Primary Impact Data

Measured Parameter	Units	Value
RMDB Velocity at Impact	kph	90.32
RMDB Test Weight	kg	2,490.7
RMDB Maximum Static Crush	mm	293.5
Vehicle Test Weight	kg	1,892.0
Actual Vehicle Angle	degrees	15
Vehicle Maximum Static Crush	mm	368
Vertical Offset from Target Point (+ down / - up)*	mm	-10
Lateral Offset from Target Point (+ left / - right)*	mm	+20
Number of Data Channels		180
Number of Real-Time Cameras		2
Number of High-Speed Cameras		14

\*Offsets are in relation to the vehicle coordinate system.

### Dummy Contacts

	Driver	Picture Ref.	Passenger	Picture Ref.
Dummy Type	Hybrid III 50 <sup>th</sup> Adult Male 116		Hybrid III 50 <sup>th</sup> Adult Male 366	
Head Contact				
Upper Torso Contact				
Lower Torso Contact				
Left Knee Contact				
Right Knee Contact				

### Data Anomalies:

- None

**SECTION 3  
DATA SHEETS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

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**DATA SHEET NO. 1  
GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**VEHICLE INFORMATION**

Test No.	CAL2650
Model Year	
Make	
Model	
Body Style	Utility Vehicle
VIN	
Body Color	Red
Odometer Reading (km/mi)	560.1 km / 348 mi
Engine Displacement. (L)	2.4
Type/No. Cylinders	I4
Engine Placement	Inline
Transmission Type	Automatic
Transmission Speeds	6-speed
Overdrive	Yes
Final Drive	FWD
Roof Rack	Yes
Sunroof/T-Top	No
Running Boards	No
Tilt Steering Wheel	Yes
Power Seats	Yes
Anti-Lock Brakes (ABS)	Yes
All-Wheel Drive (AWD)	No
Traction Control System (TCS)	Yes

**VEHICLE OPTIONS**

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

Does owner's manual provide instructions to turn off automatic door locks?

**Yes**

**DATA FROM CERTIFICATION LABEL**

Manufactured By	
Date of Manufacture	

GWR (kg)	2205
GAWR Front (kg)	1353
GAWR Rear (kg)	1398

**VEHICLE SEATING AND WEIGHT CAPACITY**

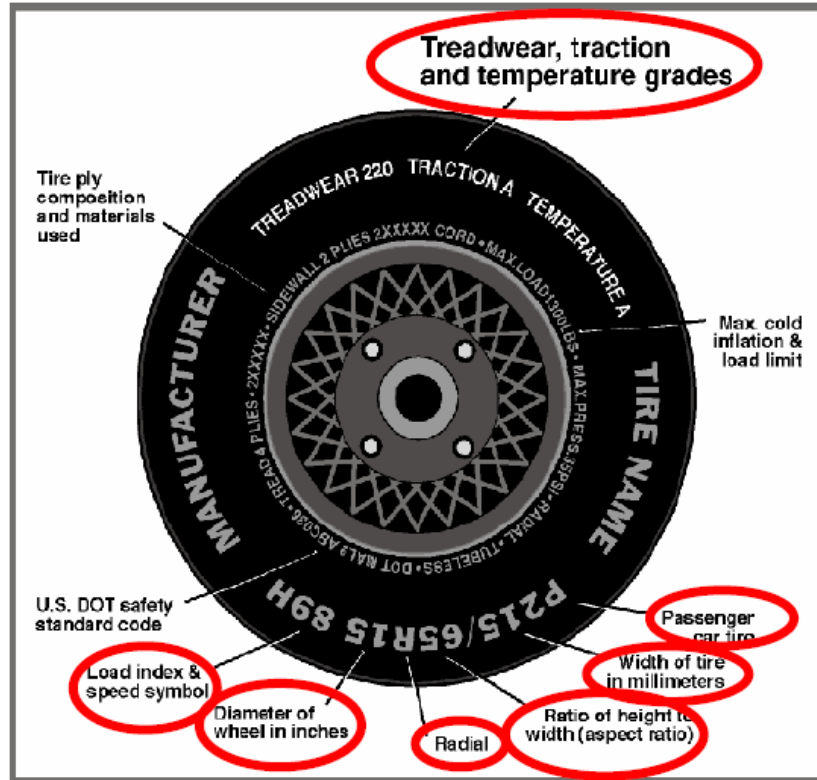
Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench	N/A	
Number of Occupants	2	3	N/A	5
Capacity Wt. (VCW) (kg)				420.0
Cargo Wt. (RCLW) (kg)				79.8

**DATA SHEET NO. 1 (CONTINUED)**  
**GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

Collect items circled in red, tire manufacturer, and tire name.



Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	230	230
Recommended Tire Size	P235/65R17	P235/65R17
Tire Size on Vehicle	P235/65R17	P235/65R17
Tire Manufacturer	Kumho	Kumho
Tire Model	Solus KL21	Solus KL21
Treadwear	500	500
Traction	A	A
Temperature Grades	A	A
Tire Plies Sidewall	2 Polyester	2 Polyester
Tire Plies Body	2 Steel, 2 Polyester, 1 Nylon	2 Steel, 2 Polyester, 1 Nylon
Load Index/Speed Symbol	103T	103T
Tire Material	Rubber	Rubber
DOT Safety Code Right	H2B9YPL91613	H2B9YPL91613
DOT Safety Code Left	H2B9YPL9	H2B9YPL9

**DATA SHEET NO. 1 (CONTINUED)**  
**GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**TEST VEHICLE WEIGHTS**

	Units	As Delivered (UVW) (Axle)			As Tested (ATW) (Axle)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	471	371		508	458	
Right	kg	477	328		508	418	
Ratio	%	57.5	42.5		53.7	46.3	
Totals	kg	948	699	1647	1061	876	1892

**TARGET TEST WEIGHT CALCULATION**

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1647
Weight of 2 Hybrid III 50 <sup>th</sup> Adult Male ATDs	kg	172.41
Rated Cargo/Luggage Weight (RCLW)	kg	79.80
Calculated Vehicle Target Weight (TVT <sub>W</sub> )	kg	1900.21

**TEST VEHICLE ATTITUDES AND CG**

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	795	797	800	804	1145
As Tested	mm	786	786	769	774	1249
Post Test	mm	925	778	705	719	

**GENERAL TEST VEHICLE DATA**

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2698
Total Vehicle Length at Left Side	mm	4555
Total Vehicle Length at Centerline	mm	4690
Total Vehicle Length at Right Side	mm	4555
Weight of Ballast in Cargo Area	kg	36.4
Weight of Vehicle Components Removed	kg	20.8
Amount of Stoddard Solvent in Fuel Tank	L	61.36

**LIST OF COMPONENTS REMOVED TO MEET TEST WEIGHT:**

Trunk carpeting, spare tire, jack  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**DATA SHEET NO.1 (CONTINUED)**  
**GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

TEST No.: CAL2650  
 Test Date: 09/24/2013

**TARGET VEHICLE STRUCTURAL MEASUREMENT**

	Elements		Pre-Test
1	Total Length	mm	4690
2	Total Width	mm	1850
3	Bumper Top Height	mm	588
4	Bumper Bottom Height	mm	489
5	Longitudinal Member Top Height	mm	590
6	Distance Between Longitudinal Members	mm	1062
7	Longitudinal Member Width	mm	74
8	Engine Top Height	mm	944
9	Engine Bottom Height	mm	256
10	Engine and Gearbox Width	mm	565
11	Front Bumper-Engine Distance	mm	434
12	Front Shock Absorber Fixing Height	mm	1002
13	Bonnet Leading Edge Height	mm	892
14	Front Shock Absorber Fixing Width	mm	1204
15	Front Bumper – Front Axle Distance	mm	933
16	Front Axle – A Pillar Distance	mm	552
17	A-Pillar – B-Pillar Distance	mm	1045
18	B-Pillar – Rear Axle Distance	mm	1100
19	B-Pillar – C-Pillar Distance	mm	958
20	Roof Sill Bottom Height	mm	1552
21	Roof Sill Top Height	mm	1672
22	Floor Sill Bottom Height	mm	398
23	Floor Sill Top Height	mm	472

\*Note: Height measurements are in reference to the ground.

**DATA SHEET NO. 2**  
**SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

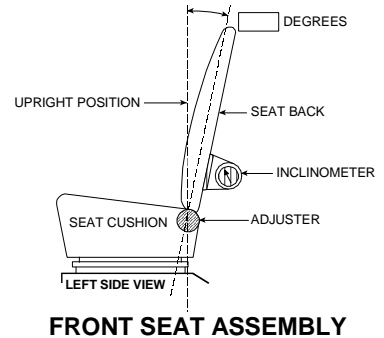
TEST No.: CAL2650  
 Test Date: 09/24/2013

**NORMAL DESIGN RIDING POSITION**

*For adjustable driver and passenger seat backs. Please describe how to position the inclinometer to measure the seat back angle. Include description of the location of the adjustment latch detent, if applicable.*

**Driver seat:** The driver seat back was positioned according to the Nominal Design Riding position listed in FORM 1

**Passenger Seat:** The passenger seat back was positioned according to the Nominal Design Riding position listed in FORM 1.



	Deg.
Driver Seat Back Angle	12.6
Passenger Seat Back Angle	12.2

**SEAT FORE/AFT POSITIONS**

*Describe the method used of determining seat fore/aft positions.* \_\_\_\_\_

The driver's seat was positioned at its lowest position and at the mid-point of fore/aft travel.

The passenger's seat was positioned at the mid-point of fore/aft travel.

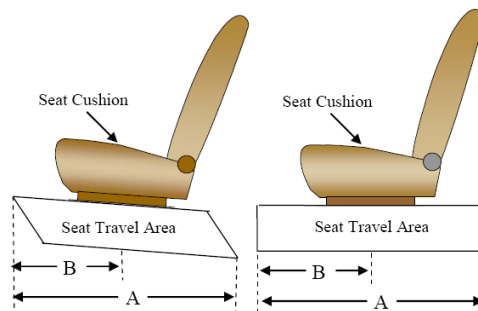
	Total Fore/Aft Travel	Placed in Position #
Driver Seat	284	142
Passenger Seat	24	12

**SEAT BELT UPPER ANCHORAGES**

*Describe the method of positioning seat belt upper anchorages.* Belt anchorages were moved along the full range of motion, and marked on the B-Pillar to their respective possible positions.

Photographic evidence can be found in Appendix A of this report. Zero is defined as the upper-most position.

	Total # of Positions	Placed in Position #
Driver Seat	4	0
Passenger Seat	4	0



**DATA SHEET NO. 2 (CONTINUED)**  
**SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

TEST No.: CAL2650  
 Test Date: 09/24/2013

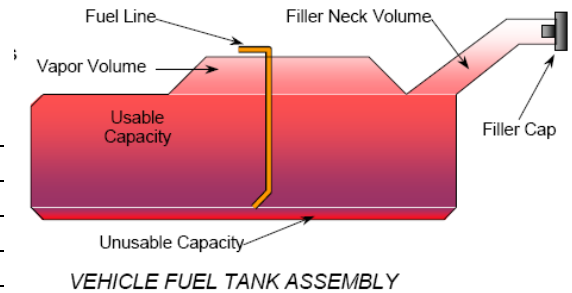
**FUEL TANK CAPACITY**

	<b>Liters</b>
Usable Capacity of "Standard Tank"	65.98
Usable Capacity of "Optional Tank"	
93% of Usable Capacity	61.36
Actual Amount of Solvent Used	61.36
1/3 of Usable Capacity	21.99

**FUEL PUMP**

*Describe the fuel system - what type of fuel pump, details about how it operates, etc.*

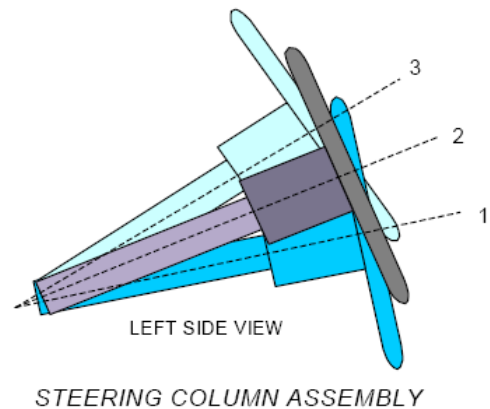
Fuel evacuated according to the specifications provided by the manufacturer in Form 1. Electric fuel pump operates when the ignition is in the 'on' position and the engine is running. The fuel filler neck is located above the left rear wheel.



**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. Describe how this measurement was taken.*

The steering wheel was adjusted to the midpoint of tilt angle range and the midpoint of the telescoping travel (if applicable)



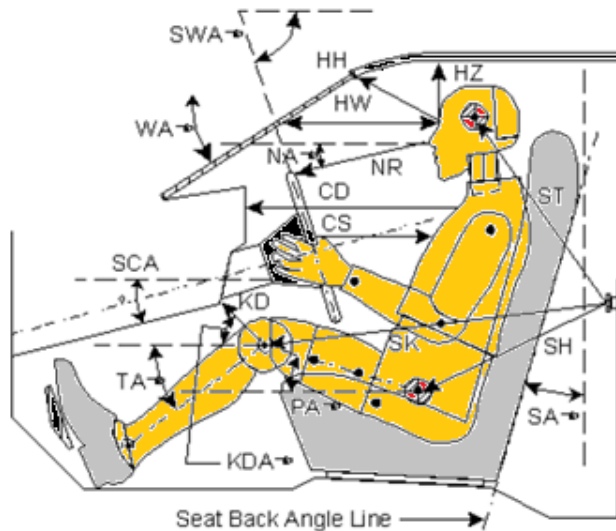
**STEERING COLUMN POSITIONS**

	<b>Tilt (degrees)</b>	<b>Fore/Aft Position (mm)</b>
Lowermost position No. 1	23.4	
Geometric center position No. 2	25.5	
Uppermost position No. 3	27.7	
Telescoping Steering Wheel Travel		40
Test Position	25.5	20

**DATA SHEET NO. 3**  
**DUMMY LONGITUDINAL CLEARANCE DIMENSIONS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013



Code	Measurement Description	Driver (Serial # 116)		Passenger (Serial # 366)	
		Length (mm)	Angle(°)	Length (mm)	Angle (°)
WA°	Windshield Angle				
SWA°	Steering Wheel Angle				
SCA°	Steering Column Angle				
SA°	Seat Back Angle (on headrest post)				
HZ	Head to Roof (Z)				
HH	Head to Header				
HW	Head to Windshield				
NR	Nose to Rim/Dash				
CD	Chest to Dash				
CS	Chest to Steering Hub				
RA	Rim to Abdomen				
KDL	Left Knee to Dash				
KDR	Right Knee to Dash				
PA°	Pelvic Angle				
TA°	Tibia Angle				
SK	Striker to Knee				
ST	Striker to Head				
SH	Striker to H-Point				
HAX°	Head Angle (X)				
HAY°	Head Angle (Y)				
NAX°	Neck Angle (X)				
NAY°	Neck Angle (Y)				
TAX°	T6 Angle (X)				
TAY°	T6 Angle (Y)				
LAX°	Lumbar Angle (X)				
LAY°	Lumbar Angle (Y)				

**DATA SHEET NO.3 (CONTINUED)  
DUMMY CMM MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

Dummy Measurements	Driver (mm)			Passenger		
	X	Y	Z	X	Y	Z
Striker	1430	-820	688	1428	818	691
Head CG						
Bridge of Nose						
Tip of Nose						
Shoulder Bolt						
Tip of Chin						
H-Point						
Left Knee						
Right Knee						
Left Ankle						
Right Ankle						
Left Heel						
Right Heel						
Driver's Outboard Seat Anchor Bolt	1939	-633	1173	1428	818	691
Outboard Head Restraint Post	1309	-460	386	1290	460	381
Top of Head Restraint	1355	-389	129	1333	382	123
Center of Steering Wheel	1998	-388	566			

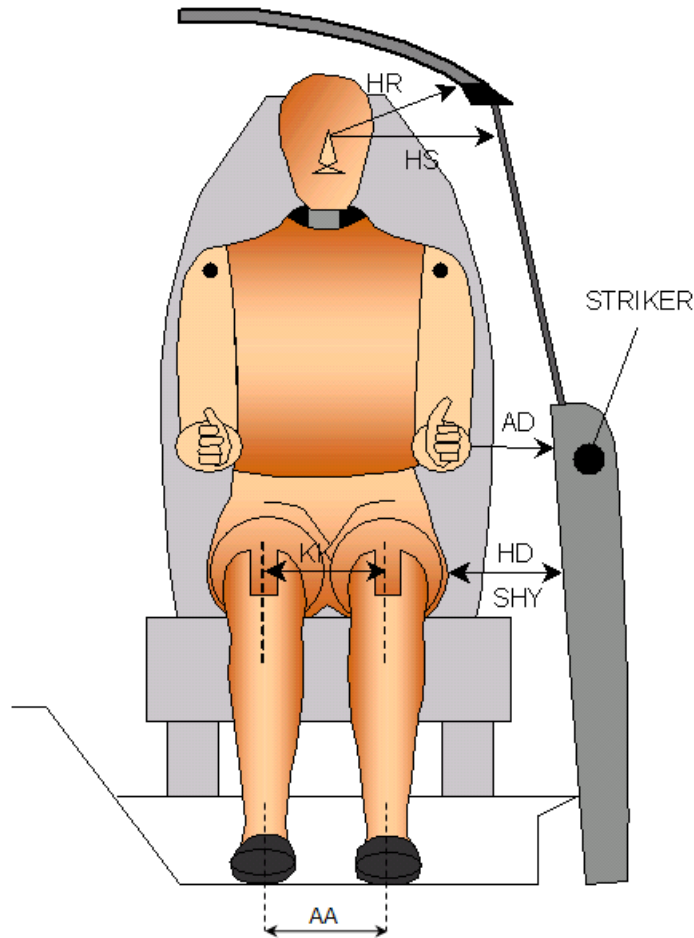
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO. 4**  
**DUMMY LATERAL CLEARANCE DIMENSIONS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

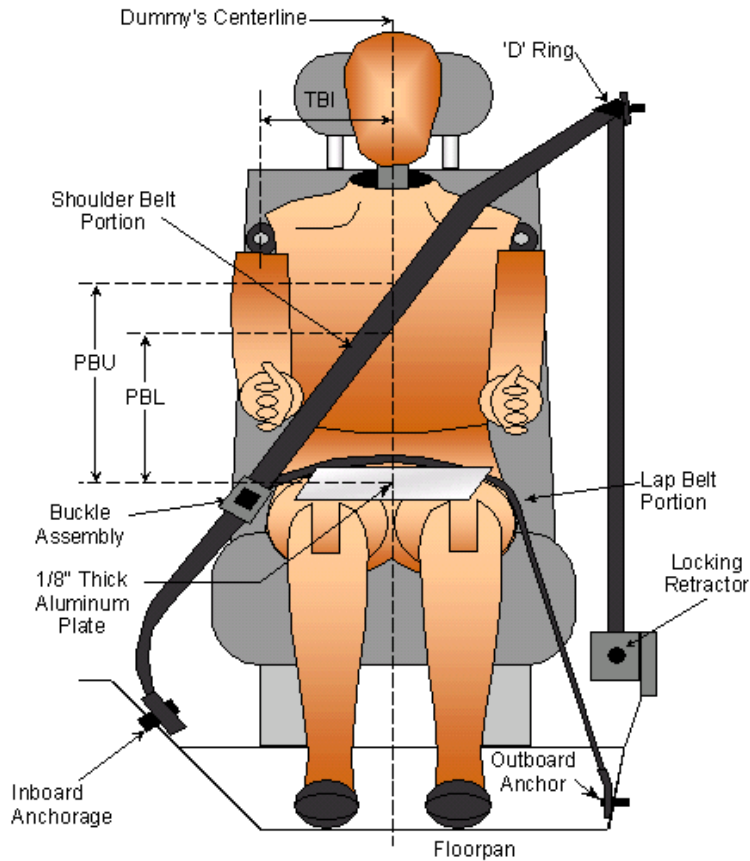


Code	Description	Units	Driver	Passenger
AD	Arm to Door	mm		
HD	H-Point to Door	mm		
HR	Head to Side Header	mm		
HS	Head to Side Window	mm		
KK	Knee to Knee	mm		
SHY	Striker to H-Point (Y Direction)	mm		
AA	Ankle to Ankle	mm		

**DATA SHEET NO. 5  
SEAT BELT POSITIONING DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

TEST No.: CAL2650  
 Test Date: 09/24/2013



**SEAT BELT POSITIONING MEASUREMENTS**

Measurement Description	Units	Driver	Passenger
<b>PBU</b> — Top surface of reference to belt upper edge	mm		
<b>PBL</b> — Top surface of reference to belt lower edge	mm		

**BELT LENGTH DATA**

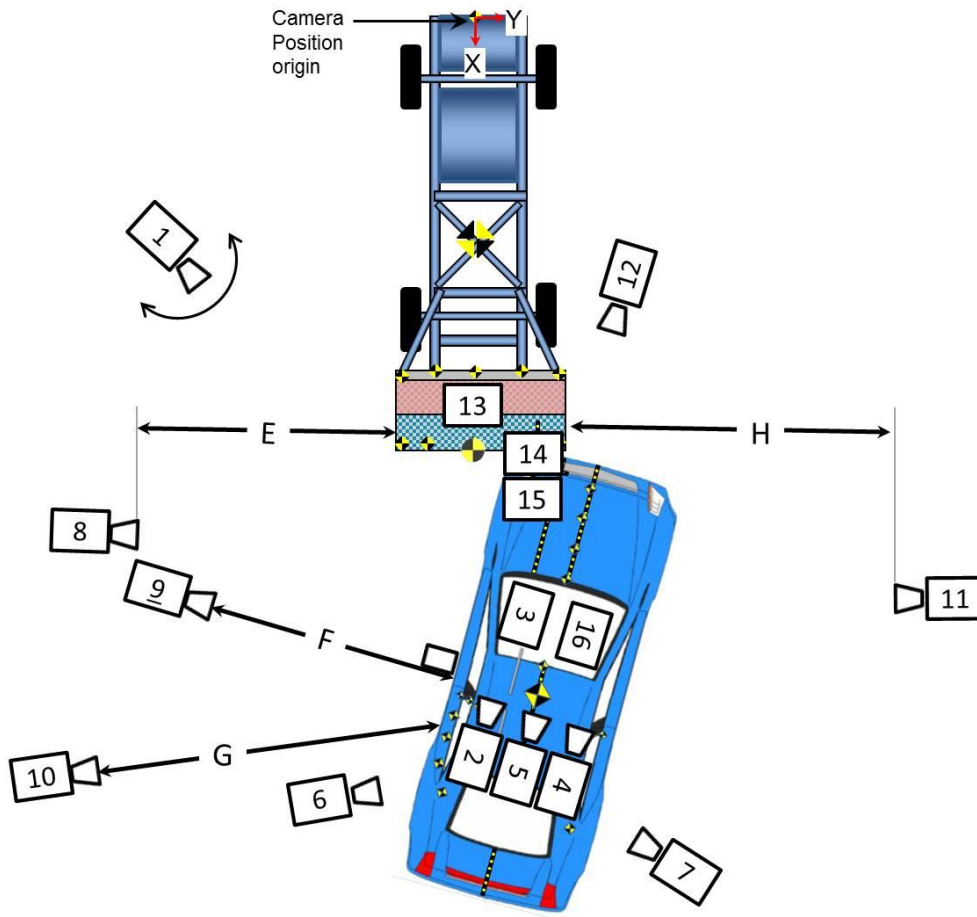
Measurement Description	Units	Driver	Passenger
Shoulder belt length as measured on ATD	mm		
Lap Belt Length as measured on ATD	mm		
Remainder of belt on reel	mm		
Total belt length for continuous webbing systems	mm		

**DATA SHEET NO. 6**  
**HIGH-SPEED CAMERA LOCATIONS AND DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

TEST No.: CAL2650  
 Test Date: 09/24/2013

**HORIZONTAL LOCATION**



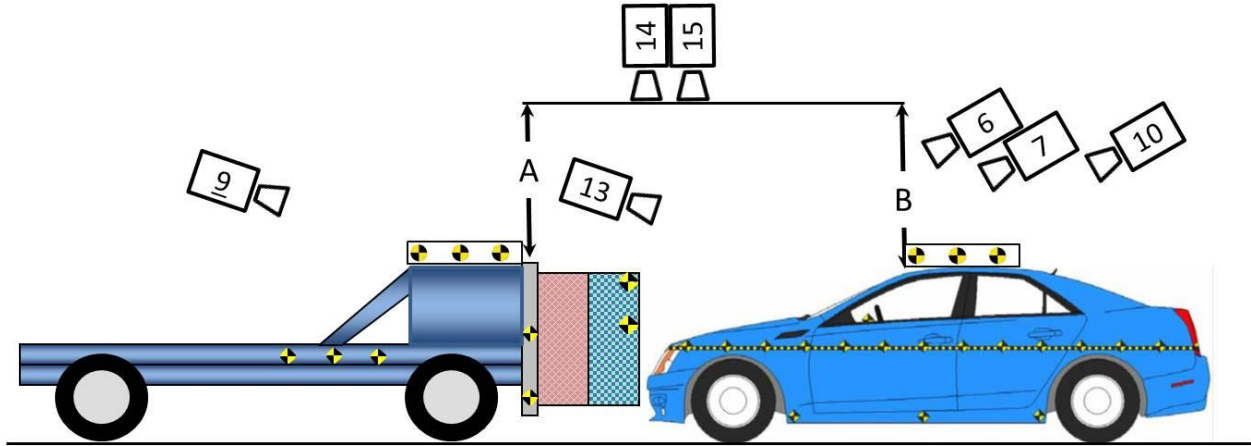
E	mm	8127
F	mm	6698
G	mm	9496
H	mm	8405

**DATA SHEET NO. 6 (CONTINUED)**  
**HIGH-SPEED CAMERA LOCATIONS AND DATA**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

TEST No.: CAL2650  
Test Date: 09/24/2013

**VERTICAL LOCATION**



A	mm	4209
B	mm	3714

**DATA SHEET NO. 6 (CONTINUED)**  
**HIGH-SPEED CAMERA LOCATIONS AND DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**CAMERA LOCATIONS**

No.	Camera View	Location (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Side	--	--	--	--	60
2	Onboard Passenger Movement	7317	-228	1486	12.5	1000
3	Onboard Driver Lower Leg	6149	-515	444	6.5	1000
4	Onboard Driver Movement	7757	-1021	1479	12.5	1000
5	Onboard Centerline	7839	-364	1422	12.5	1000
6	Driver Interaction	7254	2616	3683	24	1000
7	Passenger Interaction	11011	-8766	2662	24-70	1000
8	Target Vehicle Left Side Perpendicular (High)	4839	-9385	1029	28	1000
9	Target Vehicle Driver Motion	6116	6743	1079	24	1000
10	Target Vehicle Passenger Motion	10201	9016	3437	24-70	1000
11	Target Vehicle Right Side	4625	-9592	1465	28	1000
12	Target Vehicle Left Side (High)	1367	-2014	974	24	1000
13	RMDB/Target Vehicle Interaction	4681	-1200	4730	28	1000
14	Close-up Impact Point	6563	-1129	5302	15	1000
15	Overall Impact	4663	-1129	5386	15	1000

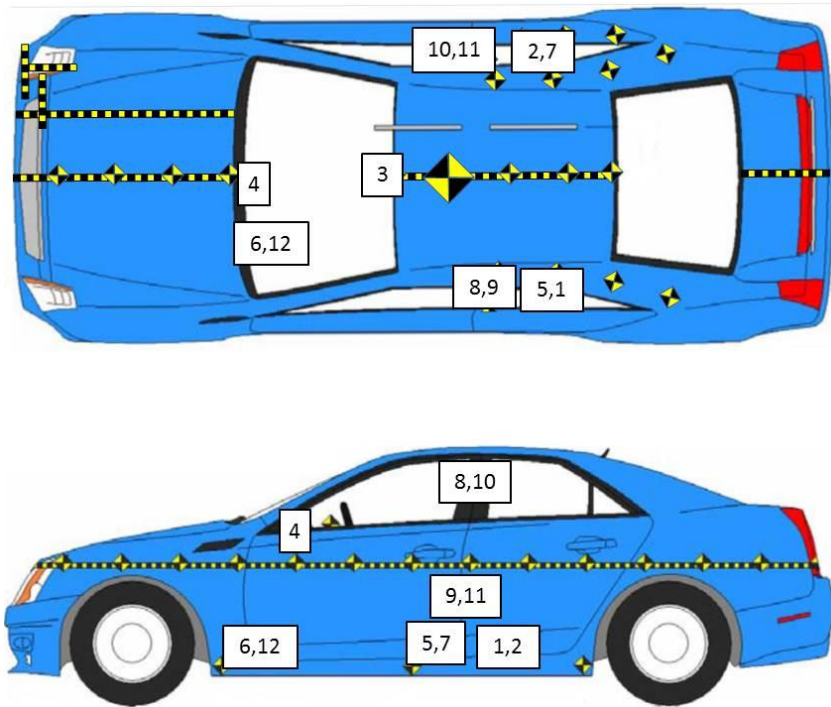
Reference Point: Center most rearward point of the RMDB when in contact with the target vehicle:

- +X – From back of RMDB to front of RMDB
- +Y – Right of monorail center
- +Z – Up from ground

**DATA SHEET NO. 7  
VEHICLE INSTRUMENTATION DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



**VEHICLE ACCELEROMETER PRE-TEST LOCATIONS**

No.	Accelerometer Location	Axes	Units	Measurements (mm)		
				X	Y	Z
1	Left Rear Sill	X,Y	mm	1253	-679	1221
2	Right Rear Sill	X,Y	mm	1247	677	1223
3	Vehicle CG	X,Y,Z	mm	2089	141	1143
4	Instrument Panel	X	mm	2119	-3	640
5	Driver Seat Track	X,Y,Z	mm	1395	-629	1239
6	Behind Brake Pedal	X,Y,Z	mm	2698	-402	1119
7	Passenger Seat Track	X,Y,Z	mm	1393	635	1243

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO. 7 (CONTINUED)  
VEHICLE INSTRUMENTATION DATA**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

**VEHICLE INSTRUMENTATION DATA**

Loc.	Description	Axes	Units	Positive Direction		Negative Direction	
				Max	Time (ms)	Max	Time (ms)
1	Left Rear Sill	X	g	2.16	154.25	-24.40	57.80
		Y	g	18.99	44.85	-2.08	111.15
2	Right Rear Sill	X	g	2.37	113.65	-38.32	44.55
		Y	g	21.36	44.75	-2.39	6.30
3	Vehicle CG	X	g	1.70	157.70	-31.18	58.70
		Y	g	3.07	4.70	-26.29	44.50
		Z	g	25.59	40.00	-19.02	61.40
4	Instrument Panel	X	g	411.89	69.55	-727.33	135.25
5	Driver Seat Track	X	g	2.32	154.45	-24.10	58.10
		Y	g	22.94	44.90	-2.68	70.65
		Z	g	16.05	47.30	-13.79	79.90
6	Behind Brake Pedal	X	g	60.12	44.90	-143.62	38.65
		Y	g	41.75	40.65	-6.54	69.00
		Z	g	18.23	44.10	-12.67	65.65
7	Passenger Seat Track	X	g	1.96	150.20	-38.49	44.15
		Y	g	22.94	45.00	-3.35	70.80
		Z	g	8.23	90.50	-5.44	56.90
8	Driver Shoulder Belt		N				
9	Driver Lap Belt		N				
10	Passenger Shoulder Belt		N				
11	Passenger Lap Belt		N				
12	Driver Floor Pan String Pot		mm	0.10	-50.00	-256.12	292.50

**TIME TO FIRE RESTRAINT TIMING**

Loc.	Description	Axes	Units	Time to Fire (ms)
1	Driver Air Bag Squib 1	*	V	
2	Driver Air Bag Squib 2	*	V	
3	Driver Curtain Airbag	*	V	
4	Driver Torso Airbag	*	V	
5	Driver Knee Airbag	*	V	
6	Driver Pretensioner	*	V	
7	Passenger Air Bag Squib 1	*	V	
8	Passenger Air Bag Squib 2	*	V	
9	Passenger Curtain Airbag	*	V	
10	Passenger Torso Airbag	*	V	
11	Passenger Knee Airbag	*	V	
12	Passenger Pretensioner	*	V	

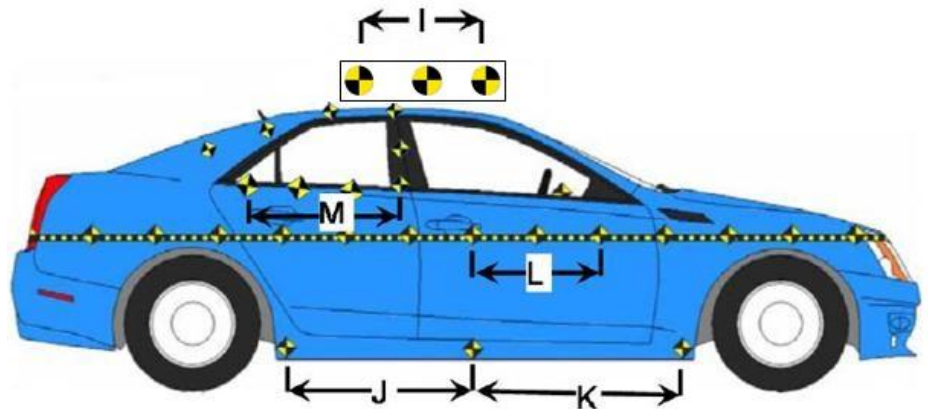
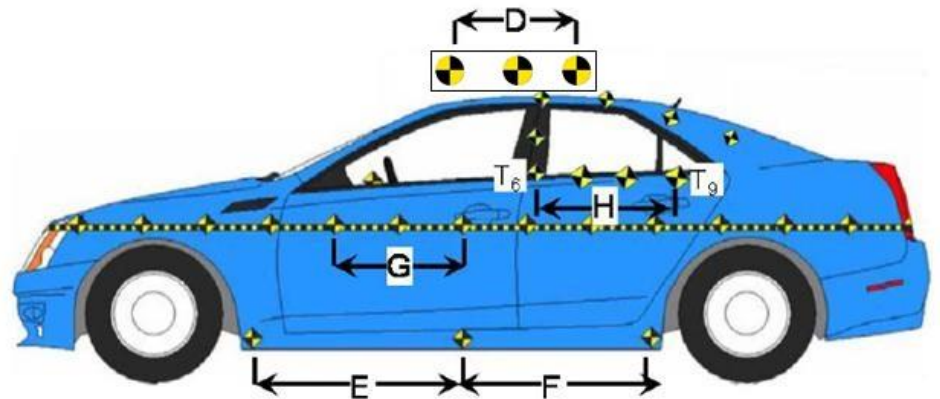
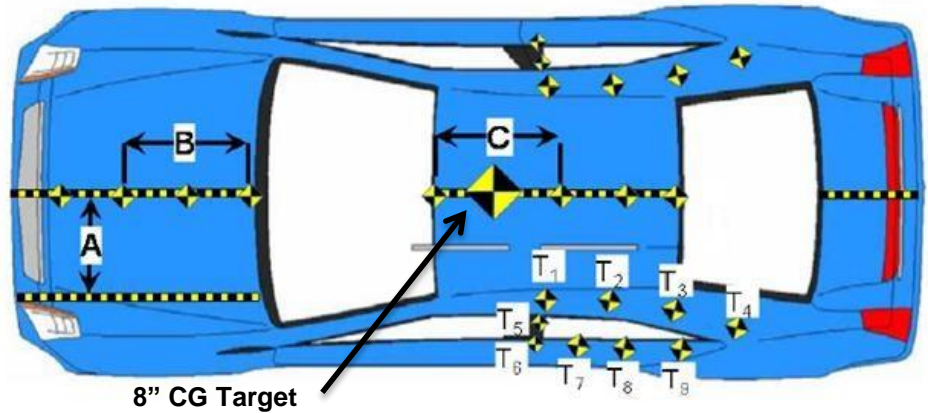
\* The measurement indicates the time the voltage changed – See Appendix B for airbag data traces

**DATA SHEET NO. 8**  
**PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

Item	Units	Value
A	mm	282
B	mm	900
C	mm	900
D	mm	900
E	mm	N/A
F	mm	N/A
G	mm	900
H	mm	N/A
I	mm	900
J	mm	N/A
K	mm	N/A
L	mm	900
M	mm	N/A

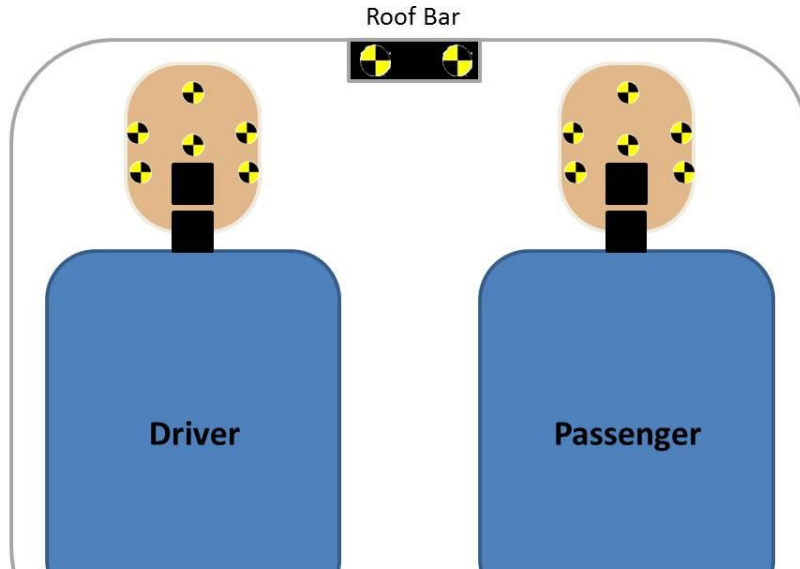


**Note: All 6" targets on the centerline of the hood and roof are 450mm apart**

**DATA SHEET NO. 8 (CONTINUED)**  
**PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



Point	Pre-Test		
	X	Y	Z
Roof Bar Driver	1838	-69	162
Roof Bar Passenger	1844	55	163

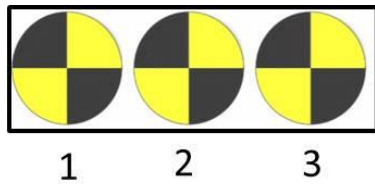
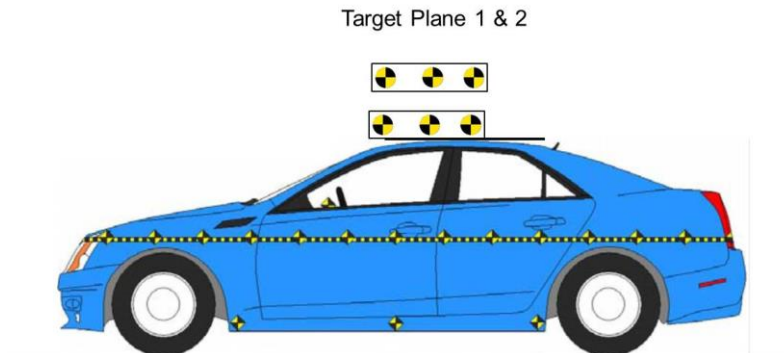
162.6323Reference point: Front axle as requested by OEM  
 +X – From the rear of the vehicle to the front of the vehicle  
 +Y – From the left side of the vehicle to the right side of the vehicle  
 +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO. 8 (CONTINUED)**  
**PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

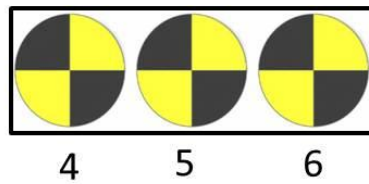
Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**OVERHEAD TARGET BARS**



Vertical Target  
 Plane 1  
 (Driver's Side)



Vertical Target  
 Plane 2  
 (Passenger Side)

Target	Units	X	Y	Z
1	mm	1832	-418	-352
2	mm	1382	-402	-352
3	mm	928	-387	-350
4	mm	1844	406	-339
5	mm	1394	381	-348
6	mm	940	354	-355

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

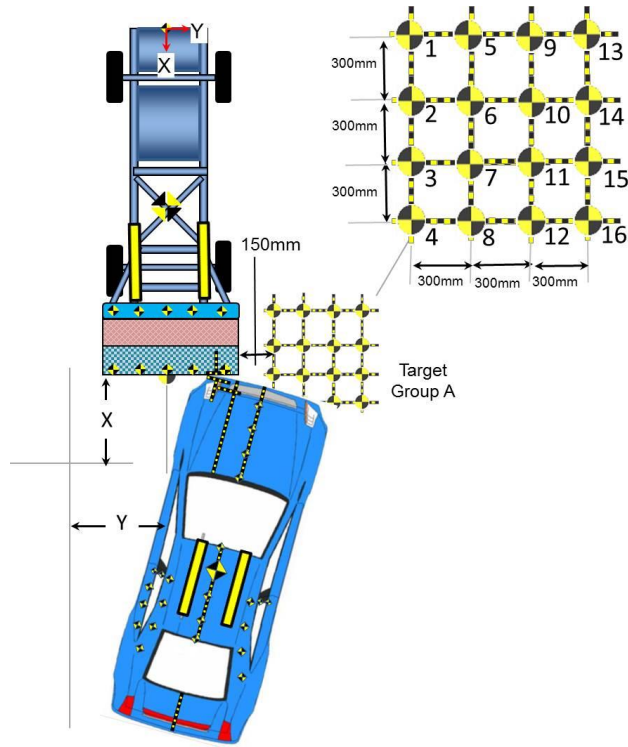
- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO. 8 (CONTINUED)**  
**PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**GROUND TARGETS**

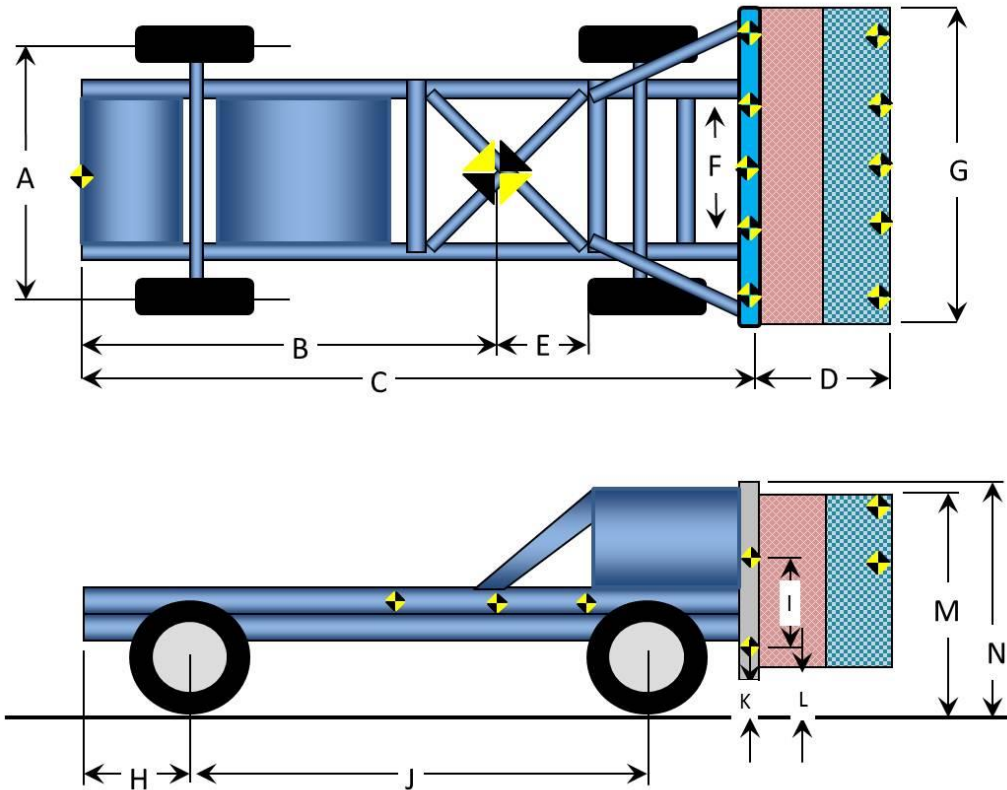


Target	Units	X	Y
1	mm	-600	1260
2	mm	-300	1260
3	mm	0	1260
4	mm	300	1260
5	mm	-600	1560
6	mm	-300	1560
7	mm	0	1560
8	mm	300	1560
9	mm	-600	1860
10	mm	-300	1860
11	mm	0	1860
12	mm	300	1860
13	mm	-600	2160
14	mm	-300	2160
15	mm	0	2160
16	mm	300	2160

**DATA SHEET NO. 8 (CONTINUED)**  
**RMDB PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



Item	Units	Value	Item	Units	Value
A	mm	1930	H	mm	800
B	mm	2451	I	mm	450
C	mm	3995	J	mm	2555
D	mm	605	K	mm	77
E	mm	904	L	mm	71
F	mm	900	M	mm	1024
G	mm	2205	N	mm	1177

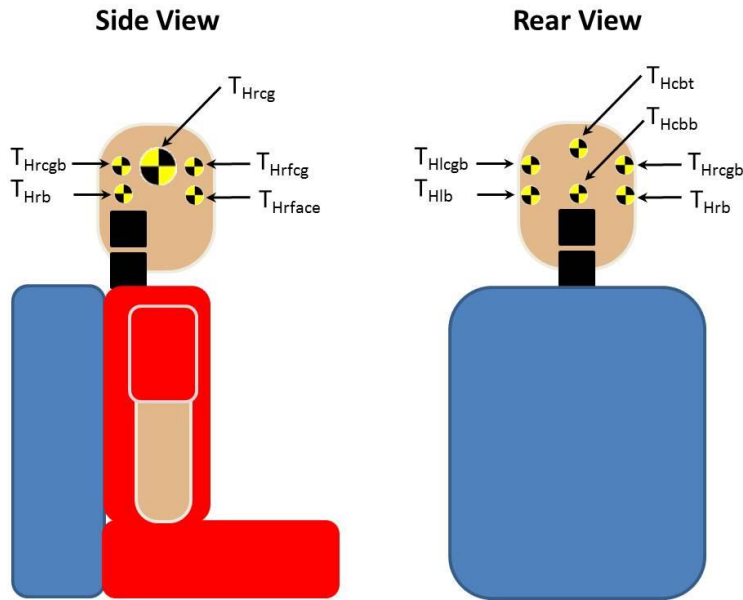
	Units	Front Axle	Rear Axle	Total
Left	kg	802.0	453.6	1255.6
Right	kg	807.4	427.7	1235.1
Ratio	%	65	35	100
Total	kg	1609.4	881.3	2490.7
CG Aft of Front Axle	mm			904

Note: All targets on the RMDB honeycomb are 450mm apart

**DATA SHEET NO. 8 (CONTINUED)**  
**DUMMY PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



**Driver Dummy Head Targets (Hybrid III 50<sup>th</sup> Adult Male 116)**

Measurement	Units	Value
Distance between T <sub>Hrcg</sub> & T <sub>Hrfcg</sub>	mm	42
Distance between T <sub>Hrcg</sub> & T <sub>Hrcgb</sub>	mm	42
Distance between T <sub>Hrcgb</sub> & T <sub>Hrb</sub>	mm	25
Distance between T <sub>Hrfcg</sub> & T <sub>Hrface</sub>	mm	70
Distance between T <sub>Hlfcg</sub> & T <sub>Hlfcg</sub>	mm	42
Distance between T <sub>Hlfcg</sub> & T <sub>Hlfcgb</sub>	mm	42
Distance between T <sub>Hlfcgb</sub> & T <sub>Hlfb</sub>	mm	25
Distance between T <sub>Hlfcg</sub> & T <sub>Hlface</sub>	mm	70
Distance between T <sub>Hlcbt</sub> & T <sub>Hlcbb</sub>	mm	98

**Passenger Dummy Head Targets (Hybrid III 50<sup>th</sup> Adult Male 366)**

Measurement	Units	Value
Distance between T <sub>Hrcg</sub> & T <sub>Hrfcg</sub>	mm	42
Distance between T <sub>Hrcg</sub> & T <sub>Hrcgb</sub>	mm	42
Distance between T <sub>Hrcgb</sub> & T <sub>Hrb</sub>	mm	25
Distance between T <sub>Hrfcg</sub> & T <sub>Hrface</sub>	mm	70
Distance between T <sub>Hlfcg</sub> & T <sub>Hlfcg</sub>	mm	42
Distance between T <sub>Hlfcg</sub> & T <sub>Hlfcgb</sub>	mm	42
Distance between T <sub>Hlfcgb</sub> & T <sub>Hlfb</sub>	mm	25
Distance between T <sub>Hlfcg</sub> & T <sub>Hlface</sub>	mm	70
Distance between T <sub>Hlcbt</sub> & T <sub>Hlcbb</sub>	mm	98

**DATA SHEET NO. 9**  
**TEST VEHICLE SUMMARY OF RESULTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**INSTRUMENTATION**

Instrumentation	Number of Channels Collected
Driver Dummy Accelerometers	40
Passenger Dummy Accelerometers	40
Vehicle Structure Accelerometers	94
RMDB Cart Accelerometers	6
<b>Total</b>	<b>180</b>

**CAMERA COVERAGE**

Type of Camera	Number Used in this Test
High-Speed Vehicle Onboard	4
High-Speed Off-board	10
Real-Time Panning	2
<b>Total</b>	<b>16</b>

### DATA SHEET NO. 10 - POST TEST OBSERVATIONS

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

#### TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Right Front Passenger
Dummy Type/Serial No.	50 <sup>th</sup> Male - S/N:116	50 <sup>th</sup> Male - S/N:366
Lower Leg Type		
Lower Leg Serial No.		
Head Contact		
Upper Torso Contact		
Lower Torso Contact		
Left Knee Contact		
Right Knee Contact		

#### DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Right Front Passenger
Locked/Unlocked Doors	Unlocked	Unlocked
Front Door Opening	Jammed and latched	Closed and operational
Rear Door Opening	Closed and operational	Closed and operational
Seat Track Shift (mm)	5mm	0mm
Seat Back Failure	No	No
Glazing Damage	None	None

#### POST TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions	Photo Taken (Y/N)
Pillar Performance	Driver's side A-Pillar buckled rearward	Y
Windshield Damage	Cracks throughout with minor separation	Y
Window Damage	None	Y
Other Notable Effects	None	--

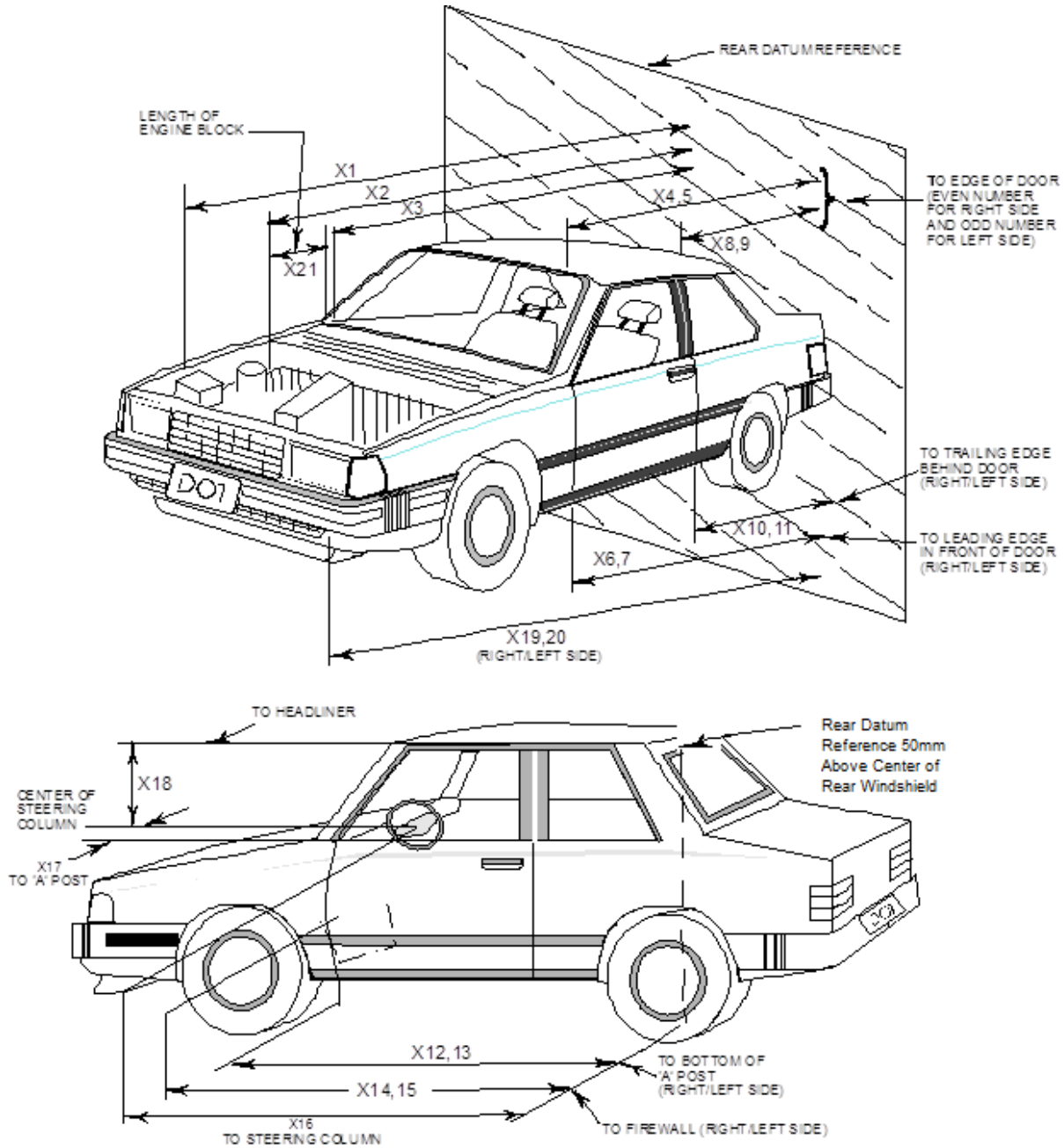
#### SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Driver (Occupant 1)		Right Front Passenger (Occupant 2)	
	Installed	Deployed	Installed	Deployed
Front Airbag	Yes	Yes	Yes	Yes
Curtain Airbag	Yes	Yes	Yes	Disabled
Torso/Pelvis Airbag	Yes	Yes	Yes	Disabled
Knee Airbag	Yes	Yes	No	N/A
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes	Yes	Yes	Yes
Other				

**DATA SHEET NO. 11  
VEHICLE PROFILE MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



**DATA SHEET NO. 11 (CONTINUED)  
VEHICLE PROFILE MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	mm			181
2	Rear Surface of Vehicle (RSOV) to Front of Engine	mm			157
3	RSOV to Firewall	mm			72
4	RSOV to Upper Leading Edge of Right Door	mm			-4
5	RSOV to Upper Leading Edge of Left Door	mm			10
6	RSOV to Lower Leading Edge of Right Door	mm			-2
7	RSOV to Lower Leading Edge of Left Door	mm			10
8	RSOV to Upper Trailing Edge of Right Door	mm			-4
9	RSOV to Upper Trailing Edge of Left Door	mm			8
10	RSOV to Lower Trailing Edge of Right Door	mm			-5
11	RSOV to Lower Trailing Edge of Left Door	mm			6
12	RSOV to Bottom of "A" Post of Right Side	mm			-3
13	RSOV to Bottom of "A" Post of Left Side	mm			48
14	RSOV to Firewall, Right Side	mm			6
15	RSOV to Firewall, Left Side	mm			251
16	RSOV to Steering Column	mm			58
17	Center of Steering Column to "A" Post	mm			20
18	Center of Steering Column to Headliner	mm			-34
19	RSOV to Right Side of Front Bumper	mm			-49
20	RSOV to Left Side of Front Bumper	mm			3813
21	Length of Engine Block	mm			-7
RD	RSOV to Right Side of Dash Panel	mm			2
CD	RSOV to Center of Dash Panel	mm			47
LD	RSOV to Left Side of Dash Panel	mm			55

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO. 12**  
**ACCIDENT INVESTIGATION DIVISION DATA**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

**VEHICLE INFORMATION**

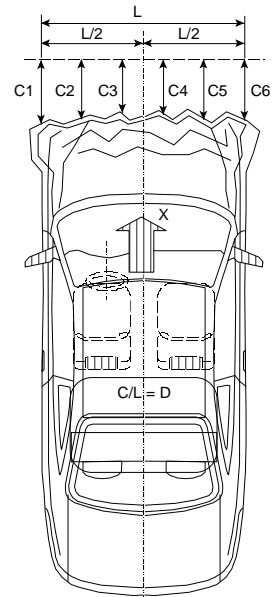
VIN: N/A Wheelbase (mm): 2698  
Vehicle Size Category: Passenger Test Weight (kg): 1892.0

**ACCELEROMETER DATA**

Accelerometer Locations: As Described in Data Sheet No. 7  
Cal. Procedure/Interval: Calspan Procedure / 6 month  
Integration Algorithm: Trapezoidal  
Linearity: > 99%  
Impact Velocity (kph): 89.66  
Velocity Change (kph): 89.66

**CRUSH PROFILE**

Midpoint of Damage: C2  
Damage Region Length (mm): 1058  
Impact Mode: 15° angle, 35% offset



**Crush Measurements: Bumper Cover**

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm			UR*
C2	Crush zone 2 at left side	mm			UR*
C3	Crush zone 3 at left side	mm			UR*
C4	Crush zone 4 at right side	mm			128
C5	Crush zone 5 at right side	mm			32
C6	Crush zone 6 at right side	mm			-72
L	C1 to C6	mm			674

UR = Unrecoverable data point

**Crush Measurements: Bumper Cover Removed**

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
B1	Bumper Beam 1 at left side	mm			-368
B2	Bumper Beam 2 at left side	mm			-388
B3	Bumper Beam 3 at left side	mm			-278
B4	Bumper Beam 4 at left side	mm			-213
B5	Bumper Beam 5 at right side	mm			-147
B6	Bumper Beam 6 at right side	mm			-82
B7	Bumper Beam 7 at right side	mm			-15
B8	Bumper Beam 8 at right side	mm			48
B9	Bumper Beam 9 at right side	mm			110
L	B1 to B9	mm			-114

**DATA SHEET NO. 13  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

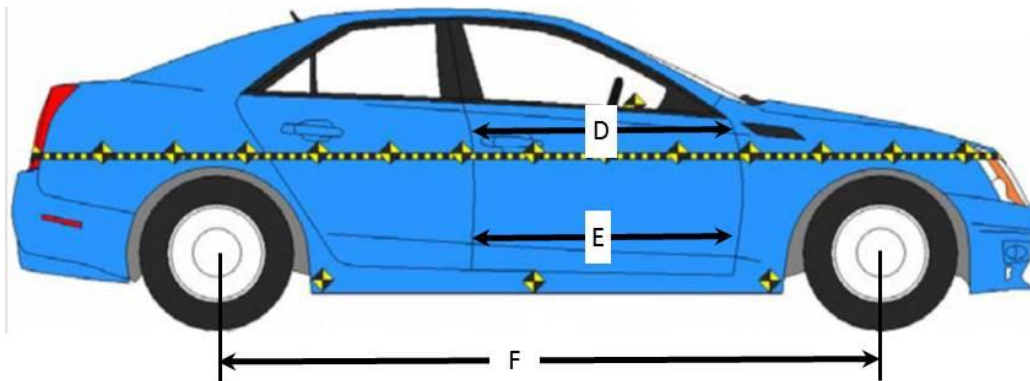
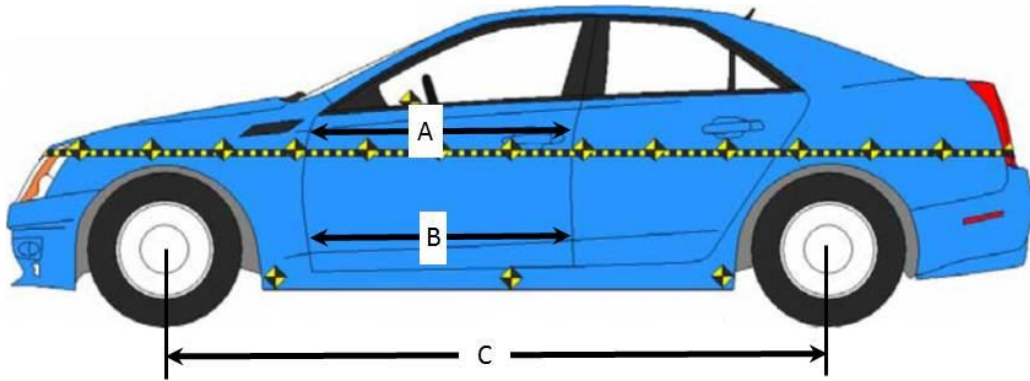
Test No.: CAL2650  
 Test Date: 09/24/2013

**DOOR OPENING WIDTH**

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm			-28
B	Left Side Lower	mm			-16
D	Right Side Upper	mm			0
E	Right Side Lower	mm			-1

**WHEELBASE MEASUREMENTS**

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm			-141
F	Right Side Wheelbase	mm			25



**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

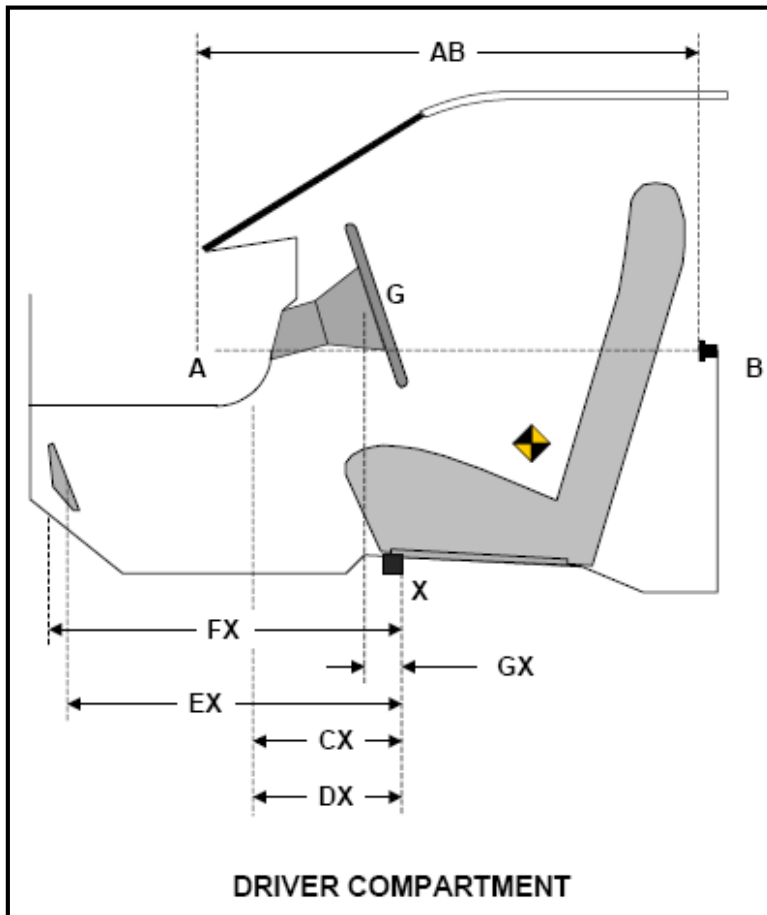
Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**DRIVER COMPARTMENT INTRUSION**

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm			-1
CX	Left Knee Bolster to X	mm			-53
DX	Right Knee Bolster to X	mm			-54
EX	Brake Pedal to X	mm			-128
FX	Foot Rest to X	mm			-26
GX	Center of Steering Column Wheel Hub to X	mm			-58

*X = Front of Seat Track (Stationary)*

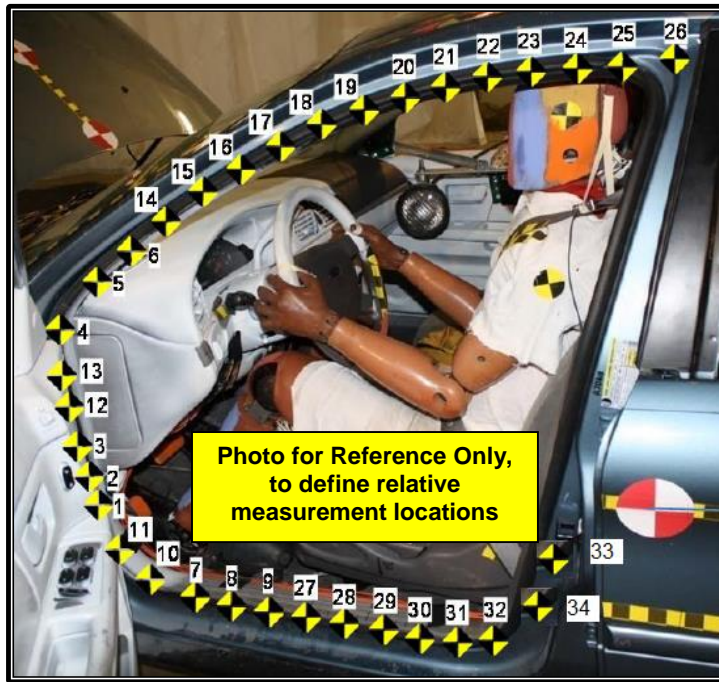


**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**DRIVER SIDE DOOR SILL INTRUSIONS**



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
1							-12	-1	-1
2							-21	-8	-2
3							-27	-12	-4
4							-22	-17	-4
5							-20	-14	-4
6							-14	-14	-6
7							-1	7	-2
8							1	9	-1
9							1	8	-2
10							-4	0	-1
11							-8	0	-2
12							-28	-15	-3
13							-25	-16	-4
14							-6	-16	-9
15							-2	-9	-3
16							-2	-7	-4

**DATA SHEET NO.13 (CONTINUED)**  
**VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
17							-2	-5	-3
18							-1	-5	-3
19							-2	-4	-4
20							-2	-4	-5
21							-1	-3	-4
22							-1	-2	-3
23							0	-2	-3
24							0	-2	-4
25							0	-2	-3
26							0	-1	-3
27							0	8	-2
28							1	9	-3
29							1	8	-2
30							1	7	-2
31							2	7	-3
32							0	7	-3
33							1	4	-3
34							1	5	-3

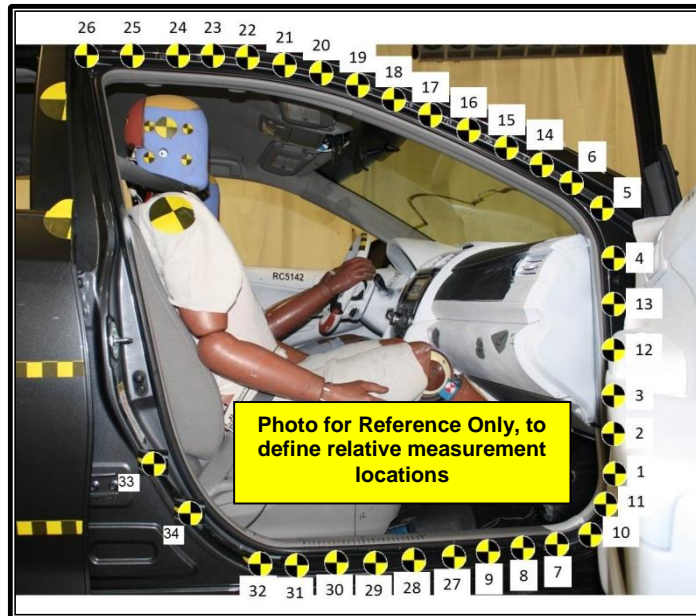
Note: See Appendix D for detailed procedure on how to measure the required door sill intrusions.

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**PASSENGER SIDE DOOR SILL INTRUSIONS**



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
1							0	7	-2
2							-1	6	-1
3							0	7	-2
4							0	6	-2
5							0	4	0
6							0	4	-2
7							-1	8	-1
8							0	8	-1
9							0	7	0
10							1	8	-2
11							-1	4	-3
12							0	6	-3
13							-1	6	-3
14							0	3	-2
15							-1	3	-3
16							-1	2	-1

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

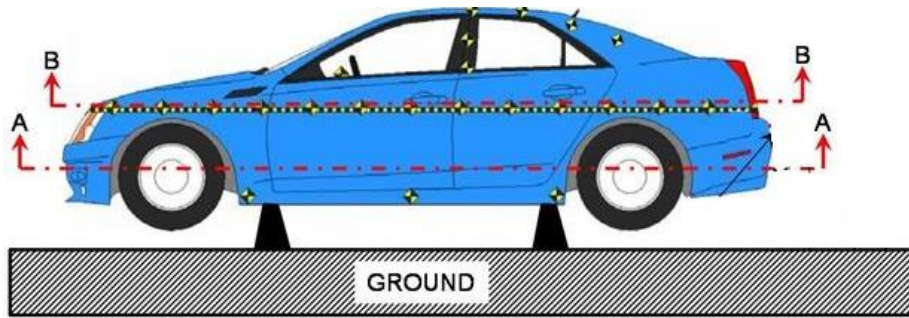
Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
17							0	1	-1
18							0	1	-1
19							0	-1	0
20							-1	-1	-1
21							0	-1	0
22							-1	-1	0
23							0	0	0
24							-1	0	0
25							0	0	1
26							0	0	0
27							-1	6	-1
28							-1	7	-1
29							-1	5	-1
30							0	5	-1
31							-1	4	0
32							0	6	-1
33							-1	3	-1
34							-1	5	-1

Note: See Appendix D for detailed procedure on how to measure the required door sill intrusions.

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**VEHICLE EXTERIOR CRUSH PROFILE  
SECTION A-A**

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
1	3358	-924		1	2998	-733	
2	3411	-919		2	3085	-715	
3	3451	-914		3	3348	-311	
4	3495	-898		4	3485	-180	
5	3568	-858		5	3555	-168	
6	3610	-812		6	3611	-73	
7	3681	-721		7	3662	31	
8	3729	-639		8	3705	134	
9	3773	-544		9	3725	242	
10	3786	-510		10	3729	342	
11	3809	-450		11	3732	397	
12	3835	-353		12	3770	544	
13	3854	-240		13	3745	586	
14	3867	-97		14	3333	693	
15	3869	-13		15	3351	781	
16	3866	99		16	3352	862	
17	3858	196		17	3339	944	
18	3846	293		18	3279	1016	
19	3828	379		19	3113	999	
20	3811	441		20	2953	965	
21	3782	518		21	2776	939	
22	3738	616		22	2527	946	
23	3655	751		23	2429	938	
24	3585	828		24	2212	930	
25	3560	859		25	1925	931	

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**VEHICLE EXTERIOR CRUSH PROFILE  
SECTION A-A (Continued)**

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
26	3483	901		26	1793	931	
27	3459	911		27	1401	927	
28	3375	920		28	1251	926	
29	3349	922		29	1072	924	
30	2535	933		30	862	928	
31	2488	934		31	750	936	
32	2427	930		32	663	940	
33	2315	919		33	-151	944	
34	2079	921		34	-228	927	
35	1922	921		35	-282	916	
36	1755	921		36	-375	878	
37	1577	920		37	-471	839	
38	1391	917		38	-561	797	
39	1190	915		39	-668	683	
40	998	914		40	-719	575	
41	851	919		41	-758	416	
42	737	927		42	-784	254	
43	661	930		43	-798	111	
44	-180	927		44	-801	3	
45	-297	906		45	-798	-96	
46	-428	854		46	-789	-207	
47	-555	799		47	-773	-325	
48	-603	766		48	-759	-403	
49	-683	660		49	-733	-519	
50	-716	586		50	-697	-634	
51	-743	491		51	-654	-702	
52	-774	326		52	-587	-778	
53	-796	141		53	-490	-831	
54	-802	0		54	-376	-877	
55	-795	-147		55	-278	-918	
56	-777	-304		56	-180	-931	
57	-754	-435		57	-148	-945	
58	-726	-549		58	782	-919	
59	-633	-734		59	935	-910	
60	-548	-805		60	1082	-909	
61	-397	-869		61	1279	-910	
62	-295	-910		62	1369	-911	
63	-181	-929		63	1418	-920	
64	660	-930		64	1527	-922	
65	717	-927		65	1616	-923	
66	751	-926		66	1729	-924	

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

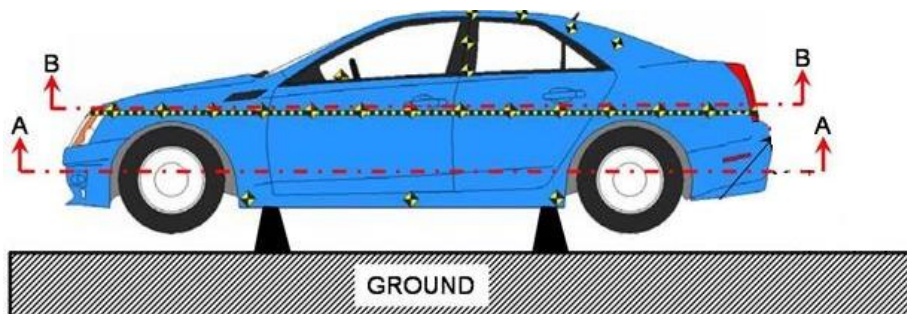
**VEHICLE EXTERIOR CRUSH PROFILE  
SECTION A-A (Continued)**

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
67	882	-917		67	1870	-925	
68	1030	-914		68	2024	-924	
69	1185	-915		69	2240	-924	
70	1328	-916		70	2368	-926	
71	1439	-918		71	2383	-986	
72	1610	-921		72	2429	-1002	
73	1787	-922		73	2463	-992	
74	2000	-921		74	2491	-1010	
75	2193	-920		75	2558	-995	
76	2333	-919		76	2613	-921	
77	2424	-930		77	2730	-853	
78	2473	-934		78	2791	-834	
79	2527	-936		79	2863	-791	
80	3358	-924		80	2945	-763	

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



**VEHICLE EXTERIOR CRUSH PROFILE  
SECTION B-B**

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
1	3055	-927		1	2987	-469	
2	3118	-918		2	3087	-341	
3	3205	-905		3	3196	-305	
4	3306	-883		4	3320	-166	
5	3411	-858		5	3508	-53	
6	3478	-824		6	3628	78	
7	3542	-754		7	3631	434	
8	3612	-656		8	3685	560	
9	3674	-545		9	3697	617	
10	3691	-494		10	3591	750	
11	3697	-490		11	3455	859	
12	3734	-386		12	3290	904	
13	3760	-269		13	3108	941	
14	3781	-120		14	2902	952	
15	3787	-18		15	2673	939	
16	3784	61		16	2562	934	
17	3773	175		17	2372	925	
18	3753	302		18	2172	922	
19	3717	433		19	2004	923	
20	3698	482		20	1799	925	
21	3680	529		21	1656	925	
22	3644	602		22	1454	925	
23	3594	683		23	1283	924	
24	3517	783		24	1130	922	
25	3450	841		25	918	920	

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

**VEHICLE EXTERIOR CRUSH PROFILE  
SECTION B-B (Continued)**

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
26	3333	877		26	686	919	
27	3169	911		27	510	927	
28	2963	932		28	348	939	
29	2759	926		29	309	934	
30	2571	921		30	243	935	
31	2455	920		31	136	930	
32	2312	917		32	37	920	
33	2084	916		33	-125	892	
34	1885	918		34	-252	867	
35	1690	920		35	-365	842	
36	1499	920		36	-497	790	
37	1391	920		37	-588	671	
38	1199	918		38	-649	527	
39	1029	916		39	-685	396	
40	874	914		40	-702	309	
41	715	912		41	-703	199	
42	591	916		42	-706	83	
43	462	925		43	-705	-36	
44	346	933		44	-704	-104	
45	199	933		45	-701	-195	
46	6	914		46	-697	-279	
47	-217	873		47	-685	-380	
48	-408	828		48	-655	-494	
49	-531	759		49	-601	-636	
50	-593	660		50	-556	-726	
51	-615	621		51	-466	-805	
52	-651	524		52	-300	-856	
53	-688	389		53	-80	-898	
54	-703	238		54	79	-922	
55	-708	77		55	218	-932	
56	-708	-46		56	273	-933	
57	-704	-197		57	796	-911	
58	-702	-296		58	957	-913	
59	-680	-413		59	1098	-914	
60	-645	-534		60	1243	-916	
61	-603	-642		61	1376	-917	
62	-578	-691		62	1378	-934	
63	-525	-768		63	1484	-936	
64	-433	-820		64	1574	-937	
65	-285	-860		65	1671	-939	
66	-106	-895		66	1831	-940	

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**VEHICLE EXTERIOR CRUSH PROFILE  
SECTION B-B (Continued)**

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
67	114	-927		67	1989	-940	
68	306	-934		68	2104	-940	
69	476	-924		69	2222	-942	
70	693	-913		70	2347	-944	
71	761	-913		71	2431	-945	
72	915	-915		72	2435	-1058	
73	1058	-916		73	2473	-1095	
74	1206	-918		74	2528	-1082	
75	1350	-919		75	2577	-1051	
76	1484	-921		76	2617	-1083	
77	1601	-920		77	2667	-1030	
78	1784	-920		78	2692	-962	
79	1936	-919		79	2743	-859	
80	2107	-917		80	2791	-761	
81	2330	-918		81	2856	-679	
82	2476	-921					
83	2666	-922					
84	2843	-932					
85	2999	-932					
86	3055	-927					

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**STRUCTURAL BUMPER BEAM POINTS**

	Point	Pre-Test (mm)			Post-Test (mm)			Difference (mm)		
		X	Y	Z	X	Y	Z	X	Y	Z
Redundant Structural Bumper Beam	B10							-371	118	-261
	B11							-340	91	-244
	B12							-282	59	-222
	B13							-217	35	-194
	B14							-150	18	-160
	B15							-84	1	-126
	B16							-17	-9	-91
	B17							45	-9	-50
	B18							104	9	-1
Center Structural Bumper Beam	B1							-368	111	-263
	B2							-338	86	-246
	B3							-278	57	-222
	B4							-213	33	-191
	B5							-147	17	-159
	B6							-82	-1	-126
	B7							-15	-11	-89
	B8							48	-14	-50
	B9							110	3	-2
Upper Radiator Support	1							-465	178	-100
	2							-442	173	-93
	3							-411	159	-106
	4							-342	134	-128
	5							-278	113	-124
	6							-202	91	-126
	7							-132	69	-127
	8							-60	47	-128
	9							13	28	-128

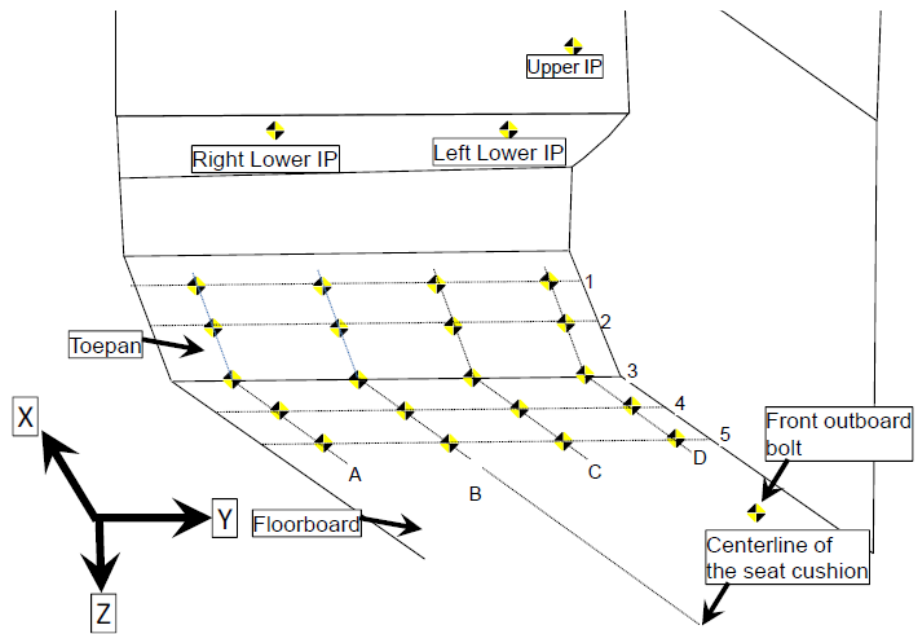
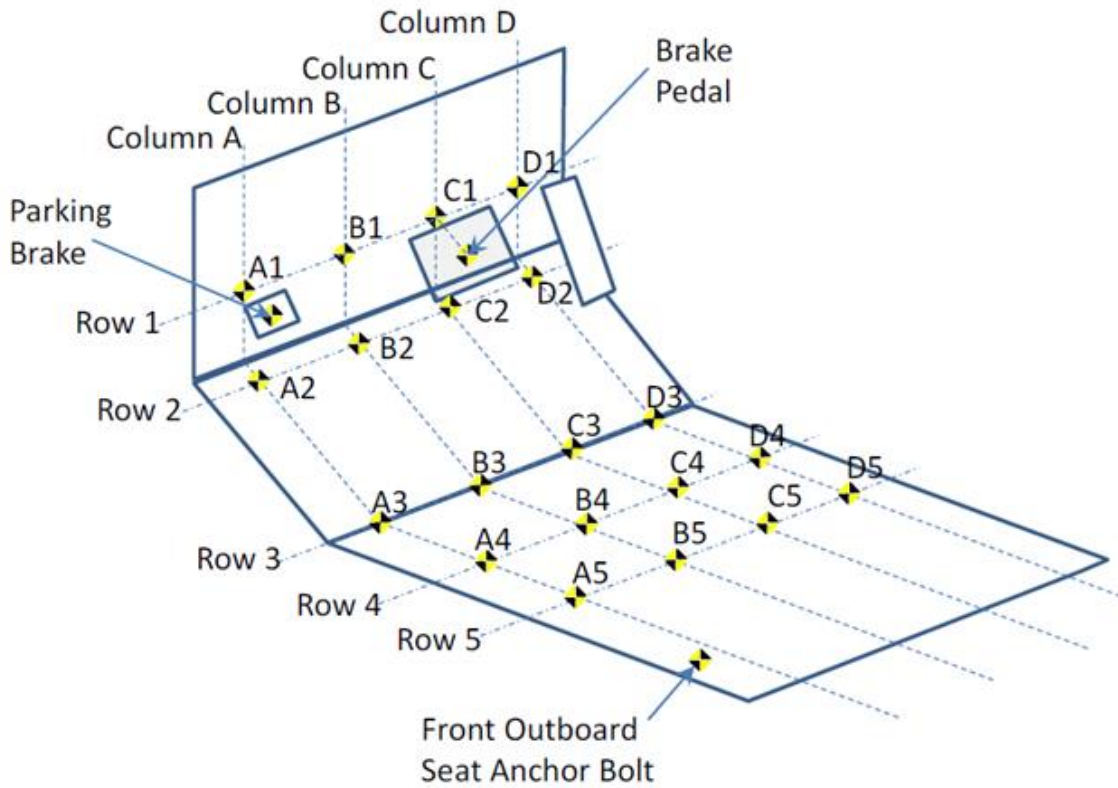
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



**Note: See Appendix D for toe pan measuring procedure**

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

**DRIVER FLOOR PAN MEASUREMENTS**

Intrusion Location	Pre-Test (mm)			Post-Test (mm)			Difference (mm)		
	X	Y	Z	X	Y	Z	X	Y	Z
A1							-110	31	-11
B1							-169	53	-19
C1							-149	53	-17
D1							-81	28	-15
A2							-78	24	-3
B2							-141	43	-17
C2							-150	51	-17
D2							-90	31	-15
A3							-41	23	-12
B3							-98	37	-4
C3							-89	27	-8
D3							-16	9	1
A4							-52	13	22
B4							-4	15	18
C4							-8	13	25
D4							-5	12	11
A5							-2	14	8
B5							-4	14	15
C5							-6	12	19
D5							-3	11	8
Brake Pedal							-128	87	-25
Driver IP Left							-53	-3	-8
Driver IP Right							-54	-2	-13
DOLP							UR*	UR*	UR*
Steering Column							-58	-16	33
Front Outboard Bolt							0	8	1
Emergency Brake							65	64	-16

\*UR = Unrecoverable data point

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

**DATA SHEET NO.13 (CONTINUED)  
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

**PASSENGER FLOOR PAN MEASUREMENTS**

Intrusion Location	Pre-Test (mm)			Post-Test (mm)			Difference (mm)		
	X	Y	Z	X	Y	Z	X	Y	Z
A1							-3	12	-8
B1							-1	11	-6
C1							0	9	-5
D1							1	10	-4
A2							-1	9	-6
B2							1	10	-6
C2							-1	9	-5
D2							0	10	-5
A3							1	8	-2
B3							1	9	-5
C3							1	11	-4
D3							0	10	-3
A4							2	8	-2
B4							1	9	-4
C4							11	7	-2
D4							-1	9	-3
A5							2	9	-1
B5							0	9	-5
C5							-1	9	-4
D5							1	9	-3
Pass IP Left							-1	5	3
Pass IP Right							-3	5	12
PORP							-6	6	17
Front Outboard Bolt							-2	4	0

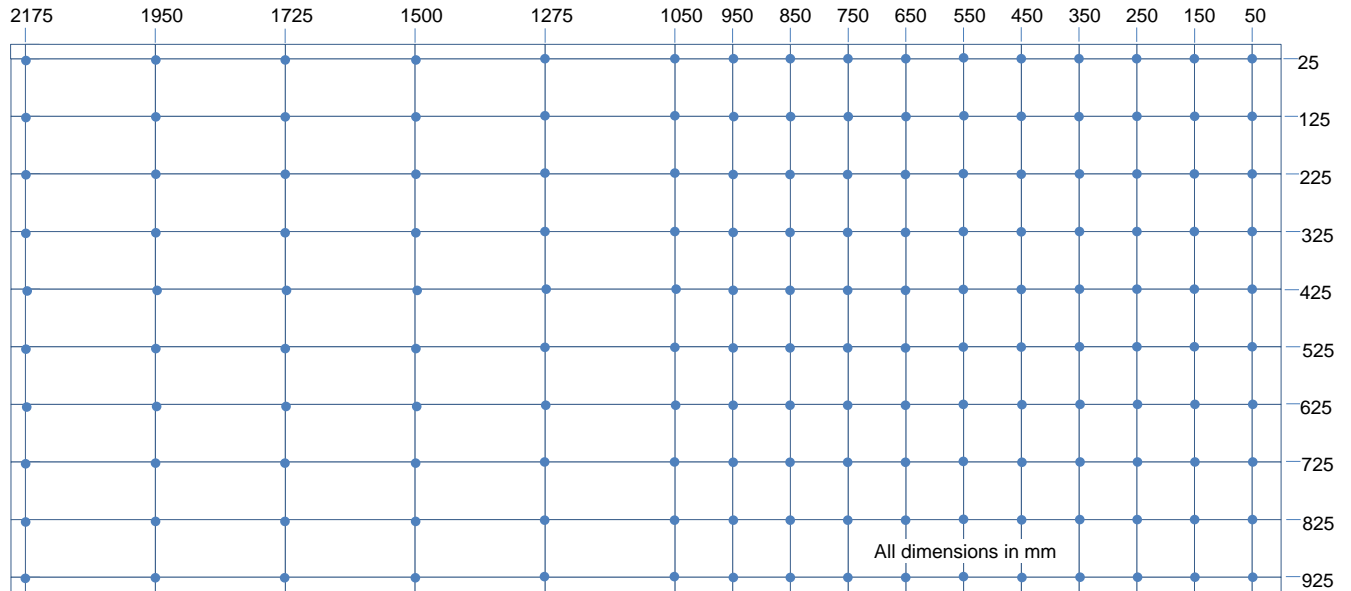
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

## DATA SHEET NO.14 RMDB CRUSH MEASUREMENTS

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013



	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
R10	-0.4	-0.9	-0.9	-0.9	-0.7	-0.8	-0.7	-0.7	2.3	-0.8	-0.9	5.6	5.4	0.3	-1.4	-0.1
R9	-0.6	-0.7	-0.6	-0.6	-0.6	-0.4	0.9	1.7	21.5	16.0	4.6	1.7	6.2	8.2	3.3	11.1
R8	-0.4	-0.3	-0.4	-0.3	-0.3	-0.2	-0.2	0.4	26.0	57.3	57.9	48.0	22.2	21.2	12.4	29.0
R7	0.0	-0.2	-0.2	-0.1	-0.1	0.1	0.1	0.3	8.9	66.9	84.3	95.7	78.9	43.5	30.4	56.9
R6	0.4	0.1	-0.1	0.0	0.2	0.3	0.4	3.8	11.3	40.7	118.1	148.4	127.6	28.8	56.8	101.3
R5	0.6	0.3	0.6	0.5	0.5	0.5	0.6	37.0	62.2	8.1	41.6	118.0	190.4	259.2	293.5	235.5
R4	1.0	1.2	1.0	0.9	0.9	1.0	2.1	50.8	110.9	48.1	-0.3	64.7	149.8	244.0	241.2	201.3
R3	1.2	1.1	1.2	1.1	1.1	1.2	13.0	81.0	146.2	85.0	9.8	26.1	114.2	194.8	212.1	174.9
R2	1.7	1.6	1.5	1.4	1.4	1.5	35.6	107.2	175.1	108.8	22.9	23.3	62.6	119.6	145.8	163.4
R1	1.4	1.9	1.7	1.9	*	*	*	*	*	125.8	39.9	21.7	34.7	64.1	77.8	95.7

\*Barrier was cut to accommodate the rail, therefore these points were un-measurable.

**DATA SHEET NO. 15  
SUMMARY OF FMVSS 212, 219 (PARTIAL), AND 301 DATA**

Test Vehicle: Research Vehicle 6395  
 Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
 Test Date: 09/24/2013

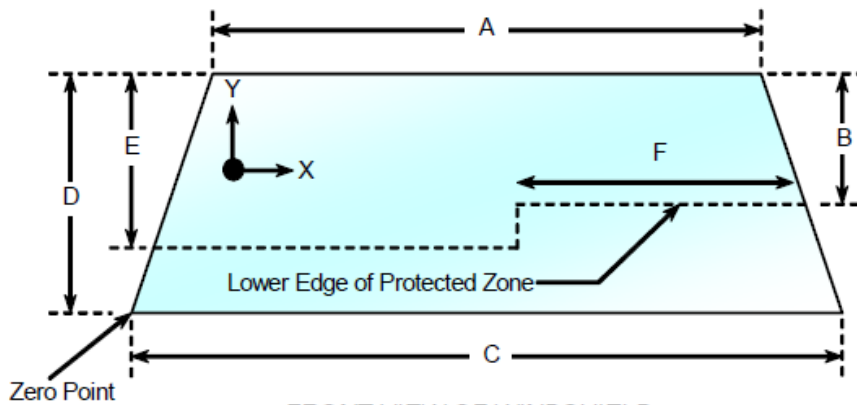
*Please provide windshield mounting details. A 0.8 mm trim surrounds the top and side of windshield while a plastic shroud is on the bottom.*

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°C

**WINDSHIELD PERIPHERY MEASUREMENTS**

Measurement	Pre-Test (mm)	Post-Test (mm)	% Retention
Left Side	2237	1862	83.3%
Right Side	2237	2237	100%
Total	4473	4099	91.6%



Item	Units	Value
A	mm	1243
B	mm	515
C	mm	1460
D	mm	885
E	mm	531
F	mm	297

FRONT VIEW OF WINDSHIELD

**AREAS OF PROTECTED ZONE FAILURES**

2. Provide coordinates of the area that the protected zone was penetrated more than .25 inches by a vehicle component other than one that is normally in contact with the windshield.

- No Penetration

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.

- No Penetration

X	Y

**DATA SHEET NO. 15 (CONTINUED)  
SUMMARY OF FMVSS 212, 219 (PARTIAL), AND 301 DATA**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013

**FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA**

Ambient Temperature of Test Vehicle at Time of Impact: 21° C

Test Time: 1:20 PM

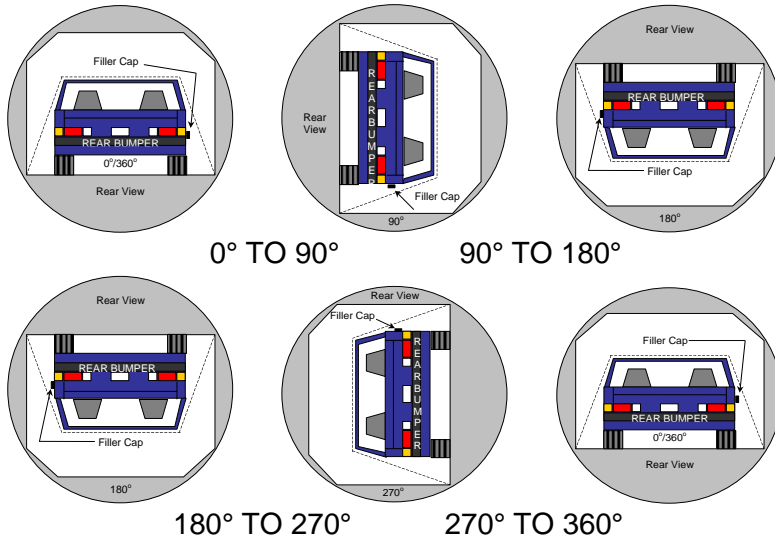
**Stoddard Solvent Spillage Measurements**

A.	From impact until vehicle motion ceases: (Maximum allowable = 1 oz.)	<u>0</u>	oz
B.	For the 5-minute period after motion ceases: (Maximum allowable = 5 oz.)	<u>0</u>	oz
C.	For the following 25 minutes: (Maximum allowable = 1 oz./minute)	<u>0</u>	oz
D.	Spillage	<u>0</u>	oz

**DATA SHEET NO. 16**  
**FMVSS 301 STATIC ROLLOVER RESULTS**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013



2. 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: None

**SOLVENT COLLECTION TIME TABLE IN SECONDS**

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	71	300	371
90° to 180°	61	300	631
180° to 270°	62	300	362
270° to 360°	65	300	365

**FMVSS 301 SPILLAGE TABLE**

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

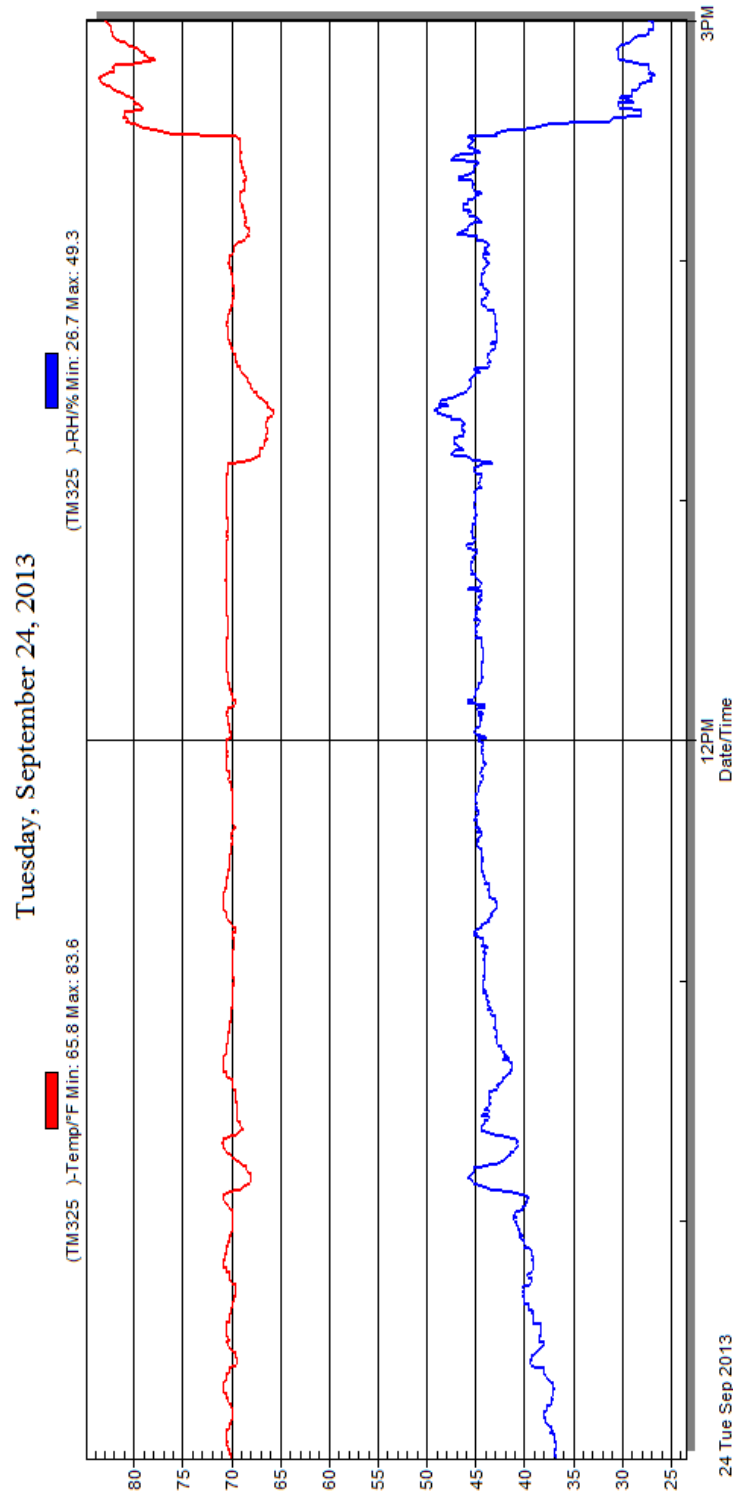
**SOLVENT SPILLAGE LOCATION TABLE**

Test Phase	Spillage Location
0° to 90°	None
90° to 180°	None
180° to 270°	None
270° to 360°	None

**DATA SHEET NO. 17**  
**DUMMY/VEHICLE TEMPERATURE STABILIZATION**

Test Vehicle: Research Vehicle 6395  
Test Program: R&D 90.1kph, 15° angle, 35% offset

Test No.: CAL2650  
Test Date: 09/24/2013



**Temperature Stabilization Chart/Data**

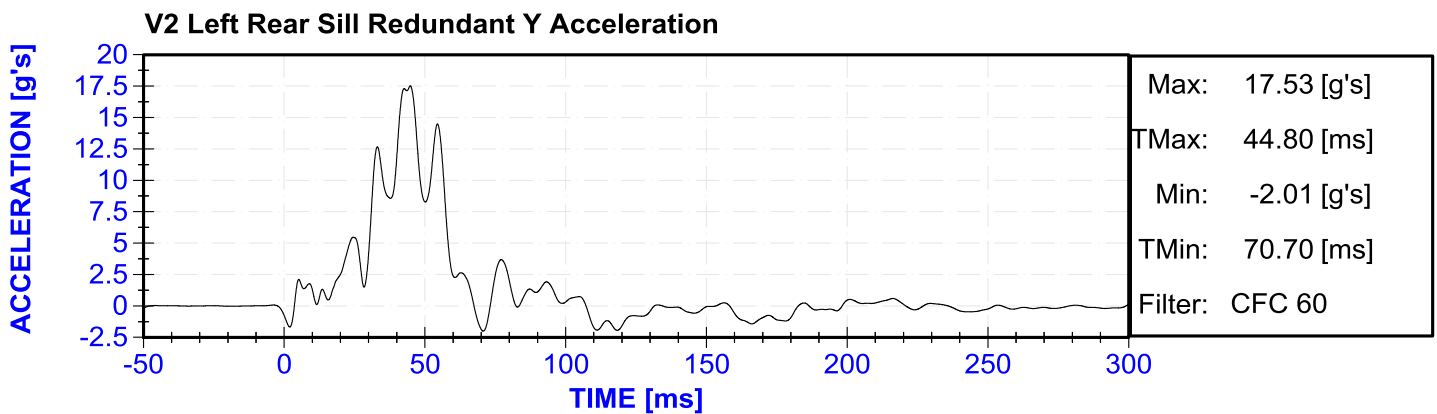
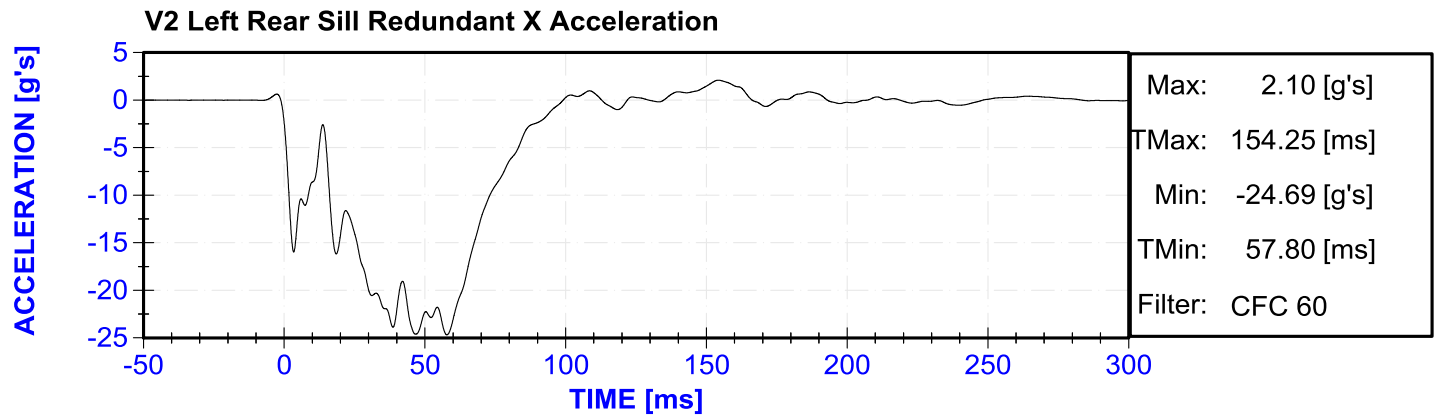
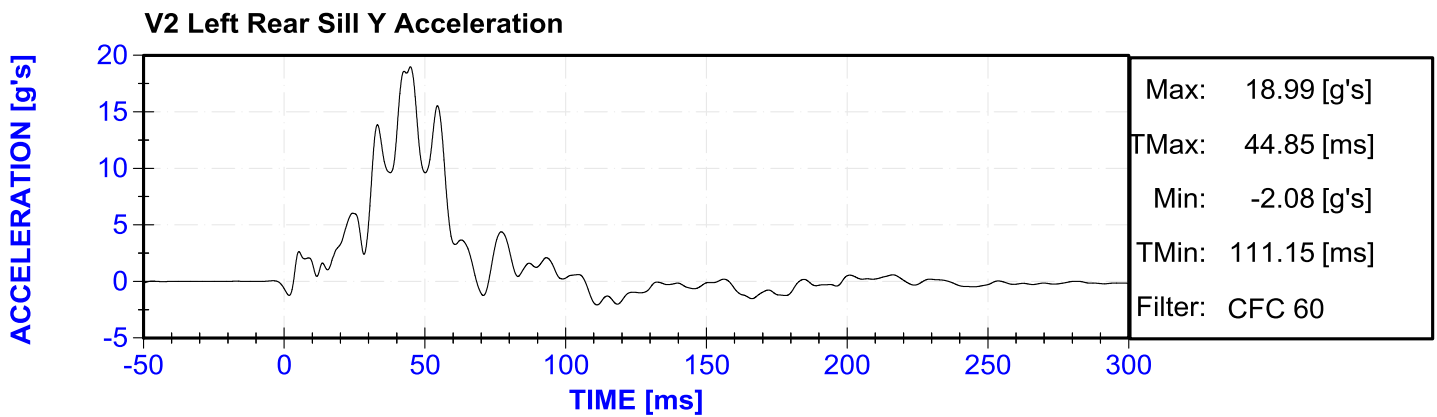
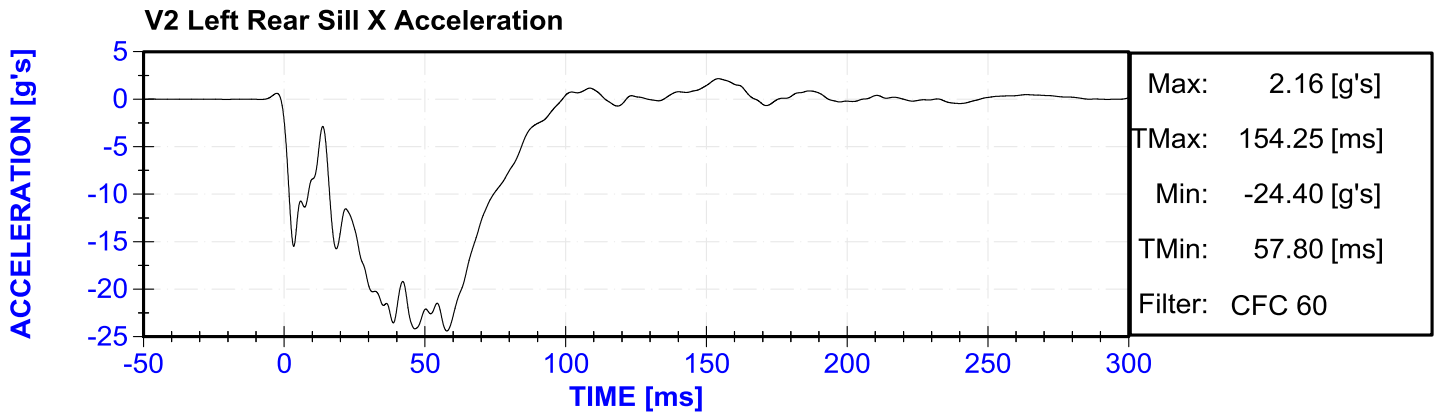
**APPENDIX A**  
**PHOTOGRAPHS**

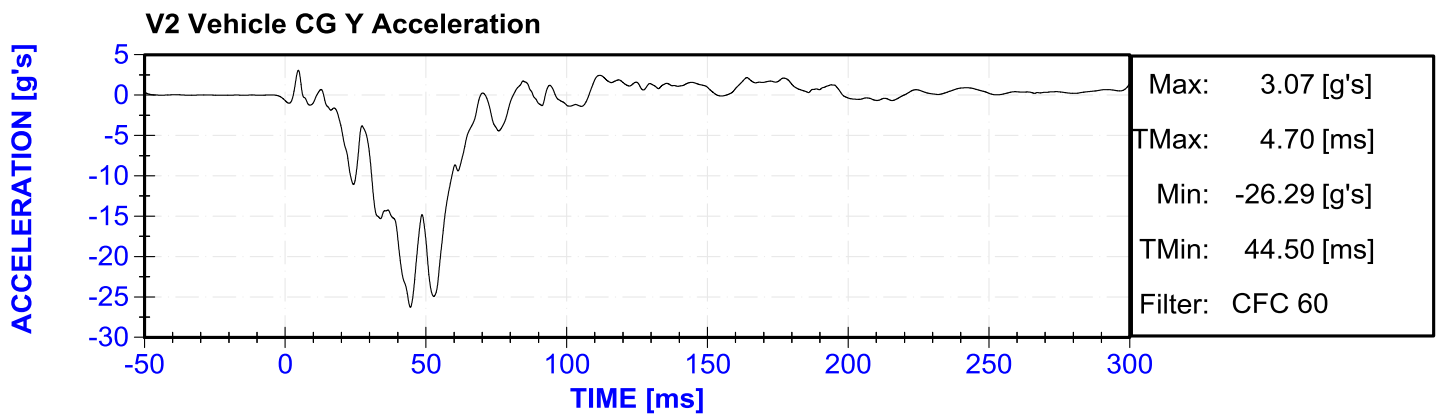
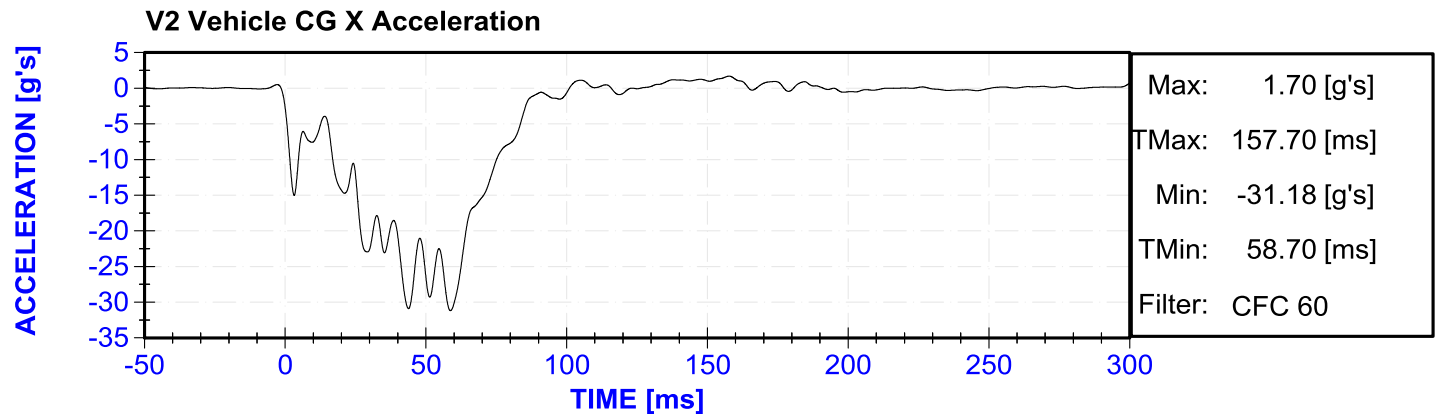
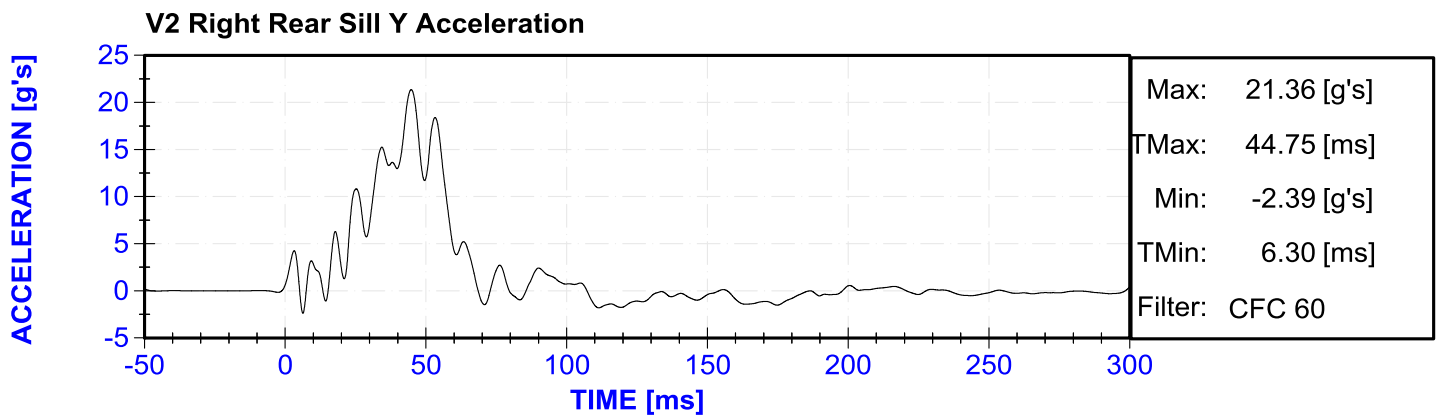
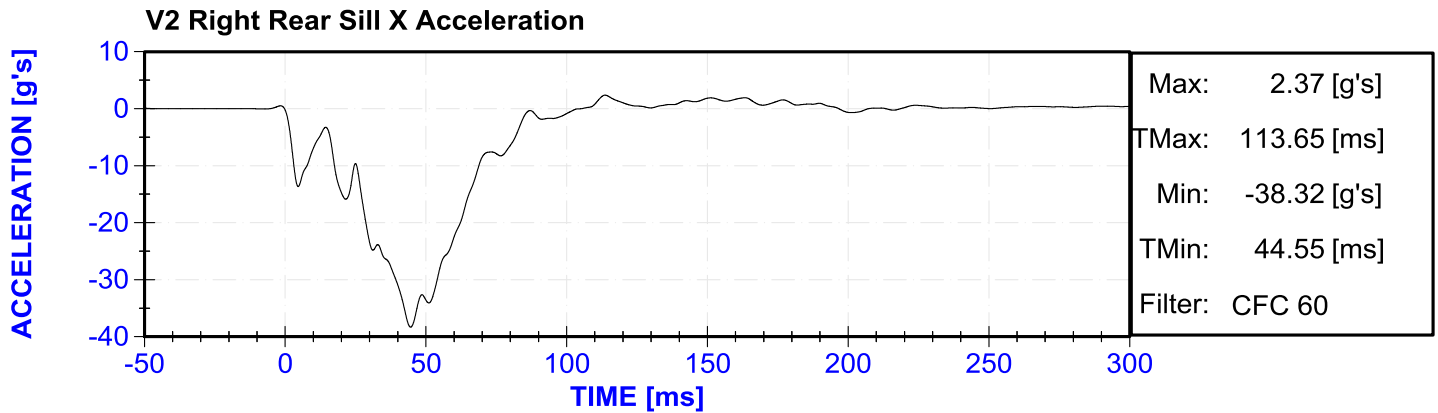
\*No Photographs Provided Per Loan Agreement\*

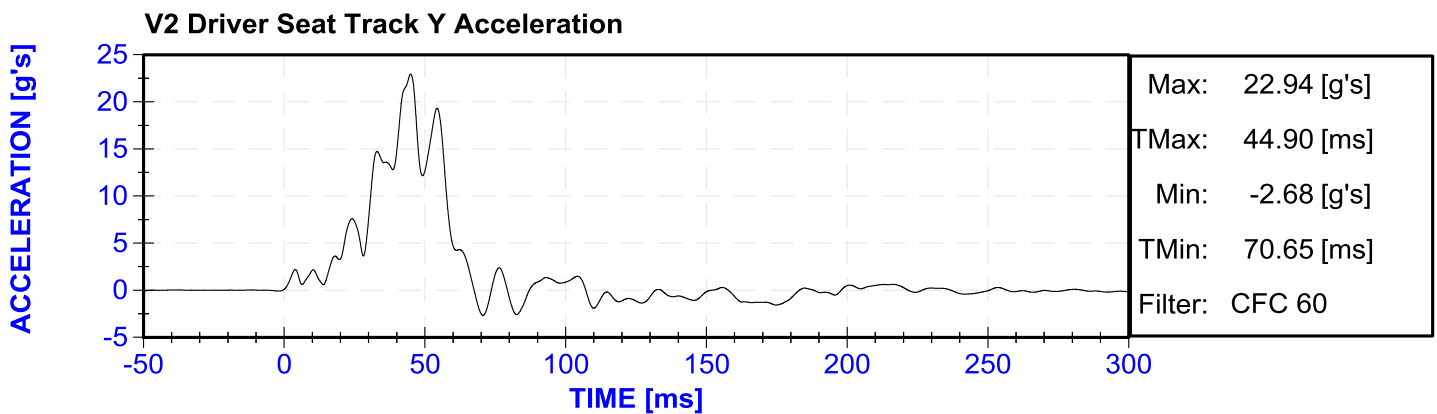
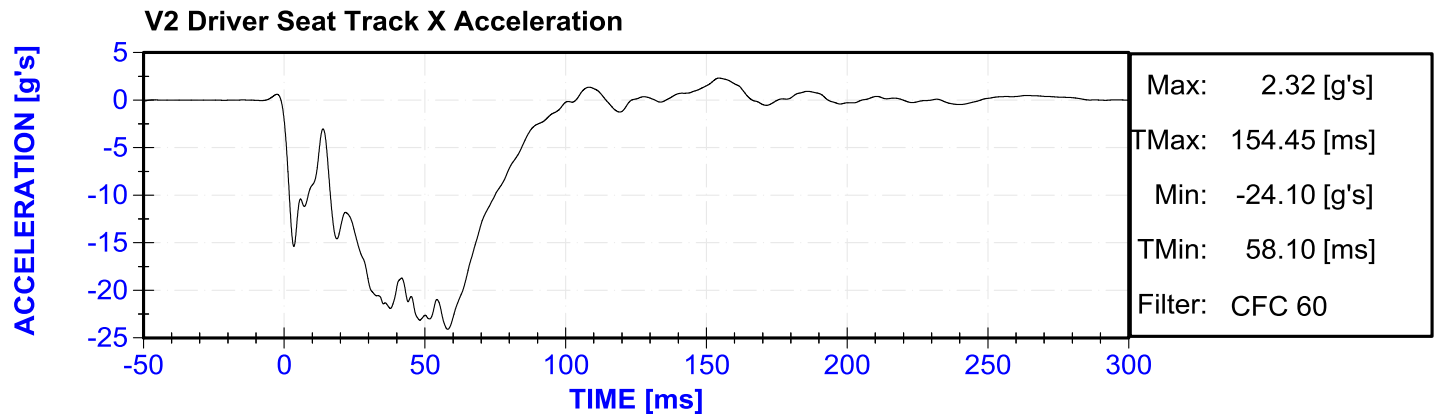
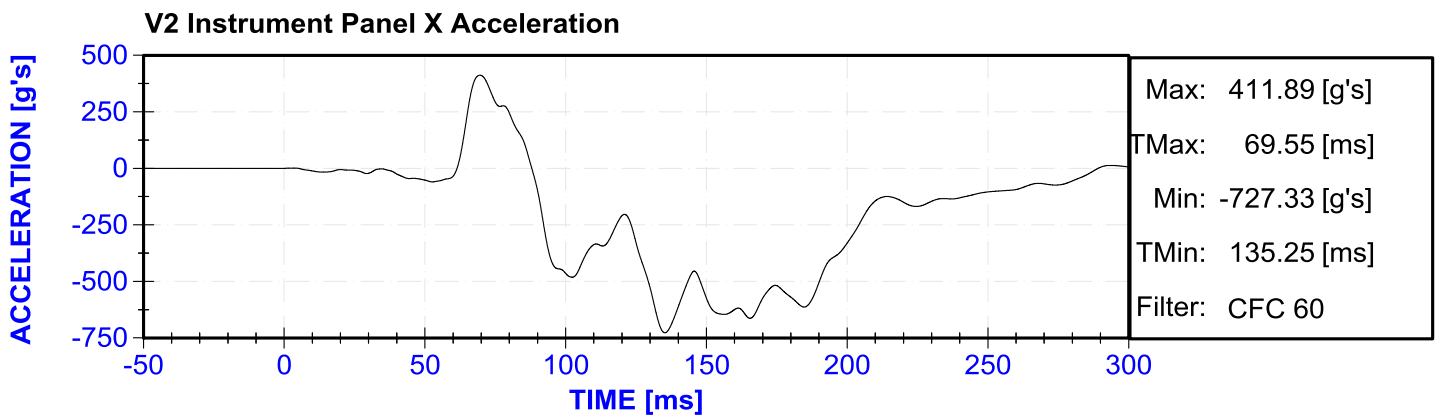
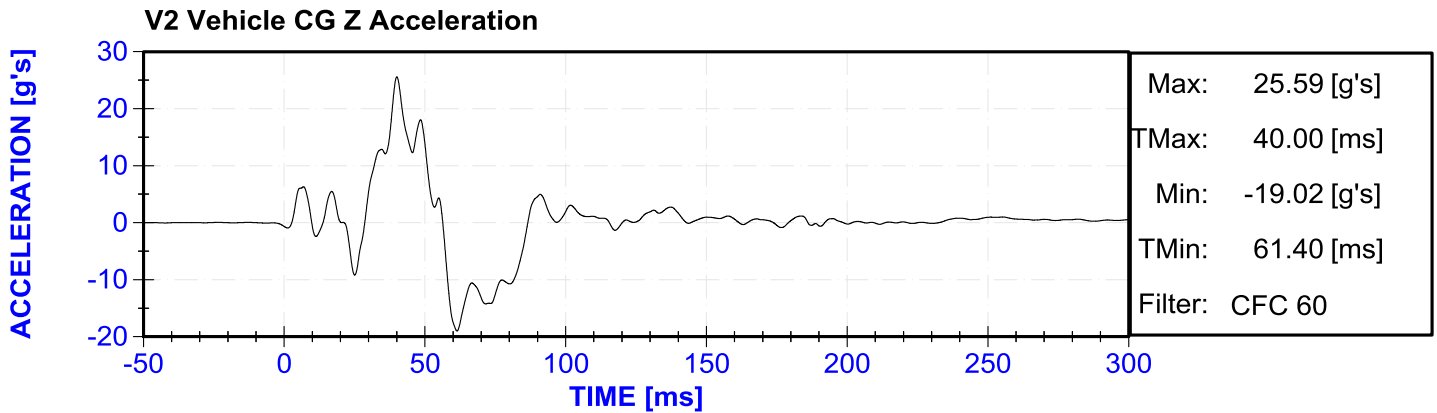
**APPENDIX B**  
**VEHICLE & DUMMY RESPONSE DATA TRACES**

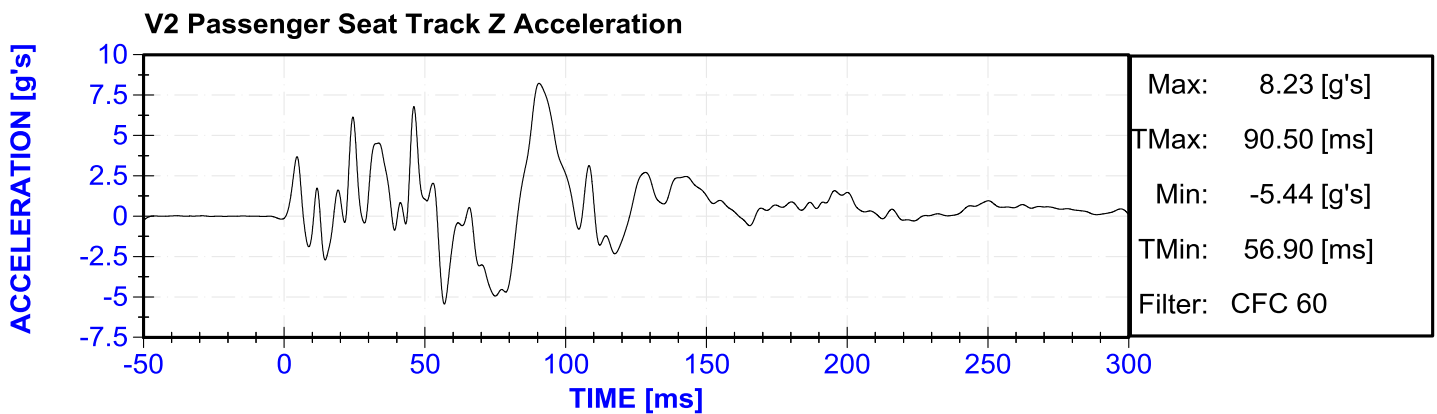
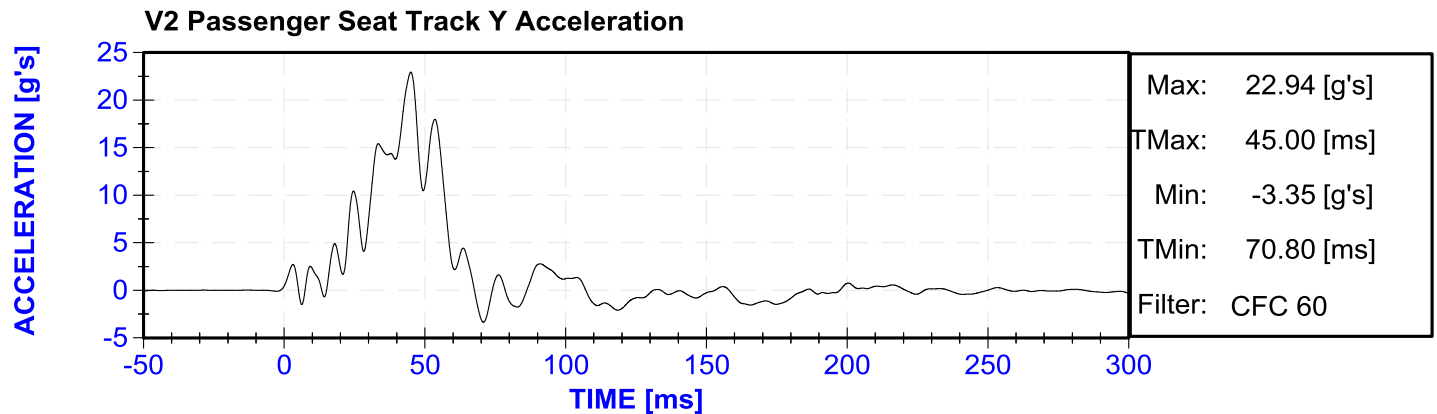
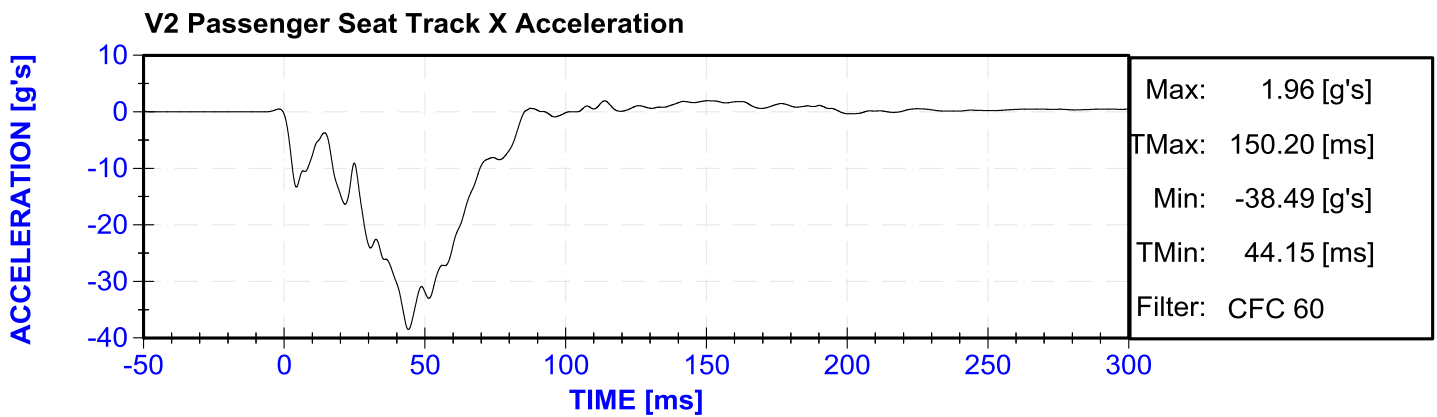
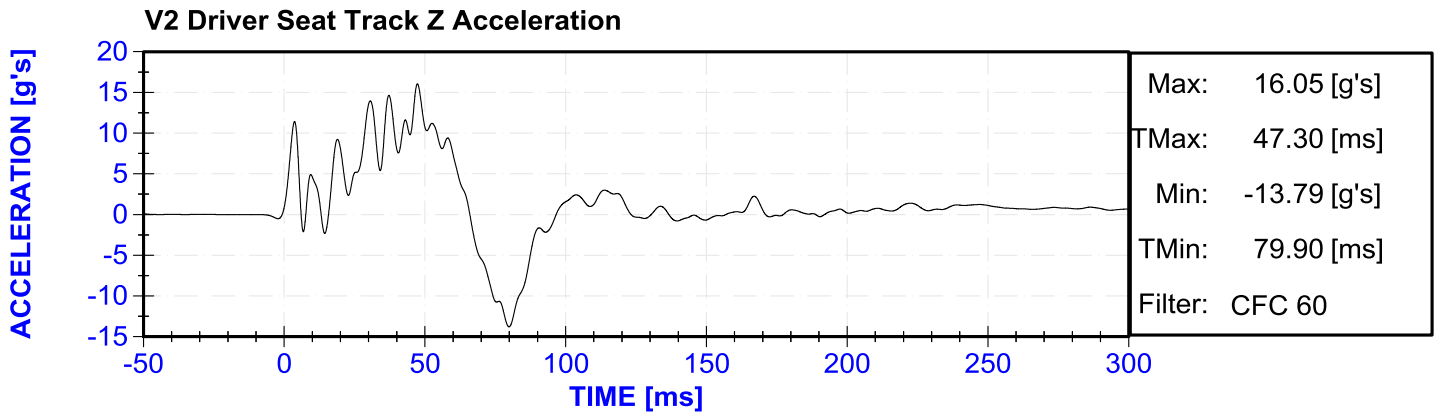
**Table of Data Plots**

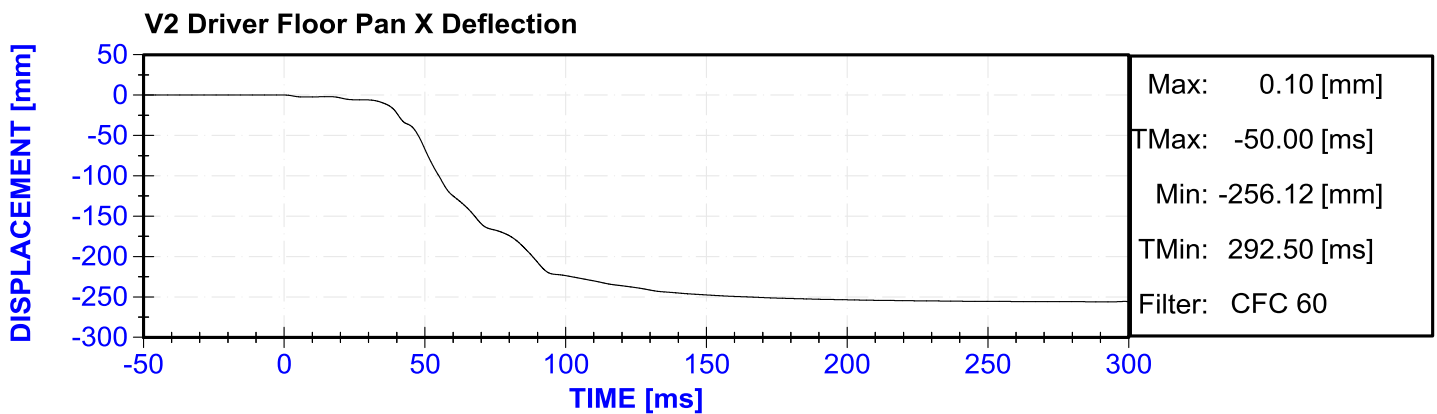
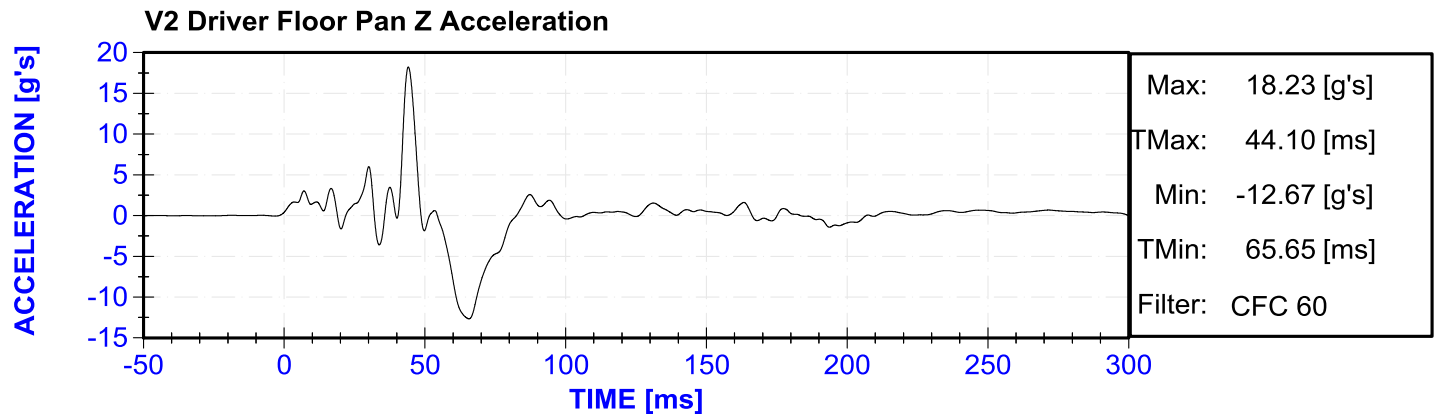
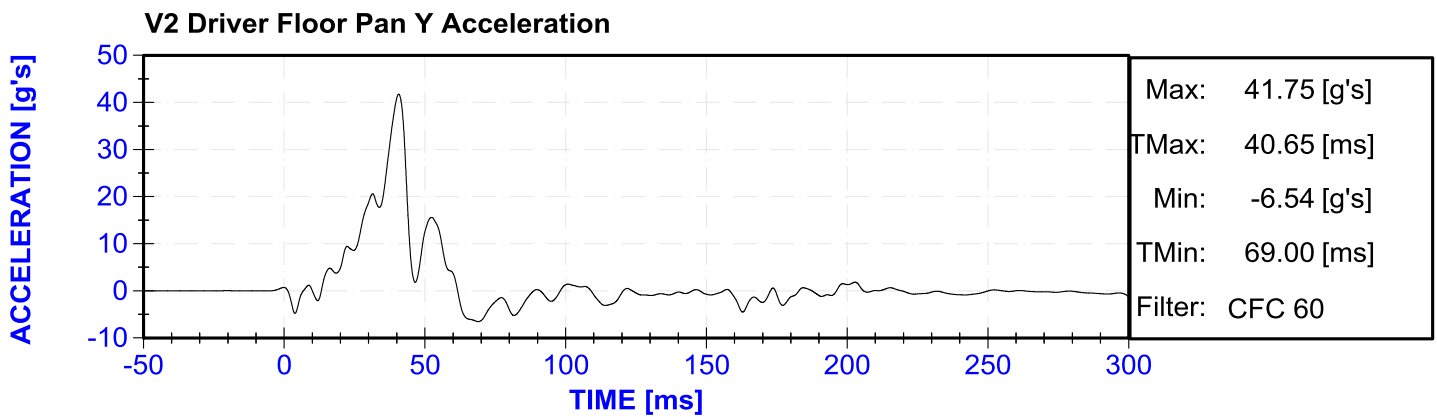
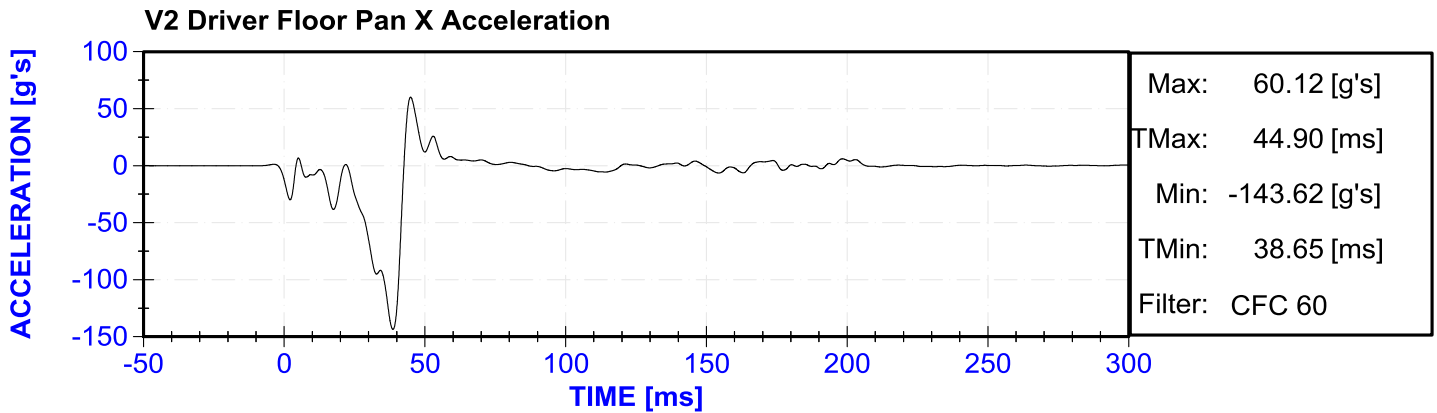
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Plot 1	V2 Left Rear Sill X Acceleration	B-3
Plot 2	V2 Left Rear Sill Y Acceleration	B-3
Plot 3	V2 Left Rear Sill Redundant X Acceleration	B-3
Plot 4	V2 Left Rear Sill Redundant Y Acceleration	B-3
Plot 5	V2 Right Rear Sill X Acceleration	B-4
Plot 6	V2 Right Rear Sill Y Acceleration	B-4
Plot 7	V2 Vehicle CG X Acceleration	B-4
Plot 8	V2 Vehicle CG Y Acceleration	B-4
Plot 9	V2 Vehicle CG Z Acceleration	B-5
Plot 10	V2 Instrument Panel X Acceleration	B-5
Plot 11	V2 Driver Seat Track X Acceleration	B-5
Plot 12	V2 Driver Seat Track Y Acceleration	B-5
Plot 13	V2 Driver Seat Track Z Acceleration	B-6
Plot 14	V2 Passenger Seat Track X Acceleration	B-6
Plot 15	V2 Passenger Seat Track Y Acceleration	B-6
Plot 16	V2 Passenger Seat Track Z Acceleration	B-6
Plot 17	V2 Driver Floor Pan X Acceleration	B-7
Plot 18	V2 Driver Floor Pan Y Acceleration	B-7
Plot 19	V2 Driver Floor Pan Z Acceleration	B-7
Plot 20	V2 Driver Floor Pan X Deflection	B-7
Plot 21	V1 Cart CG X Acceleration	B-8
Plot 22	V1 Cart CG Y Acceleration	B-8
Plot 23	V1 Cart CG Z Acceleration	B-8
Plot 24	V1 Cart Rear C/L X Acceleration	B-8
Plot 25	V1 Cart Rear C/L Y Acceleration	B-9
Plot 26	V1 Cart Rear C/L Z Acceleration	B-9

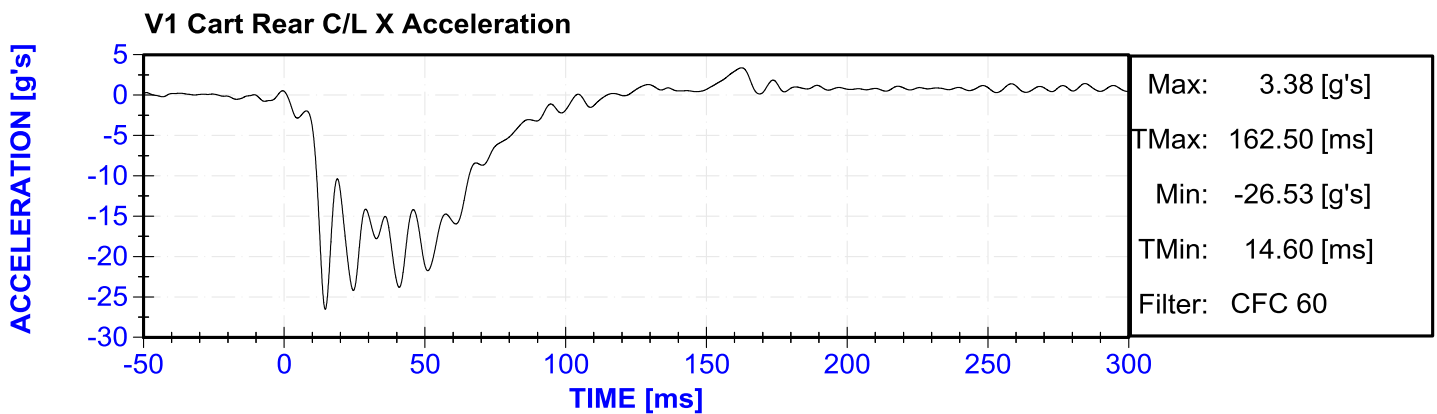
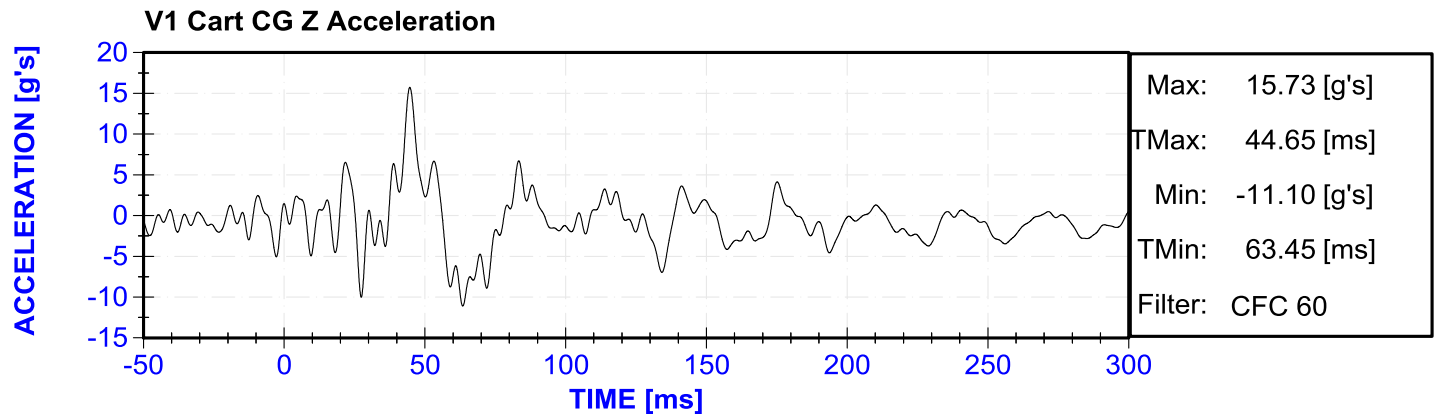
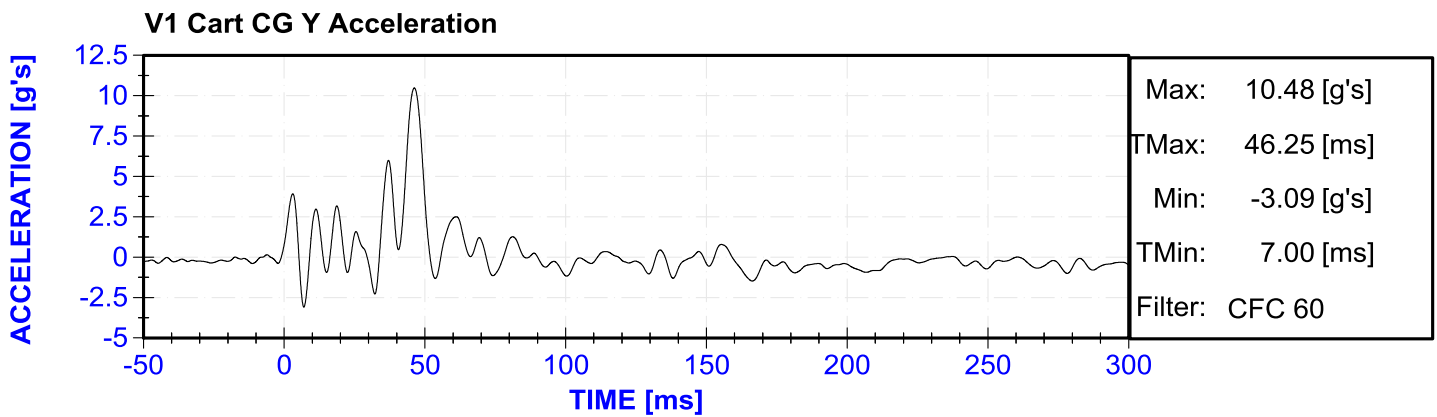
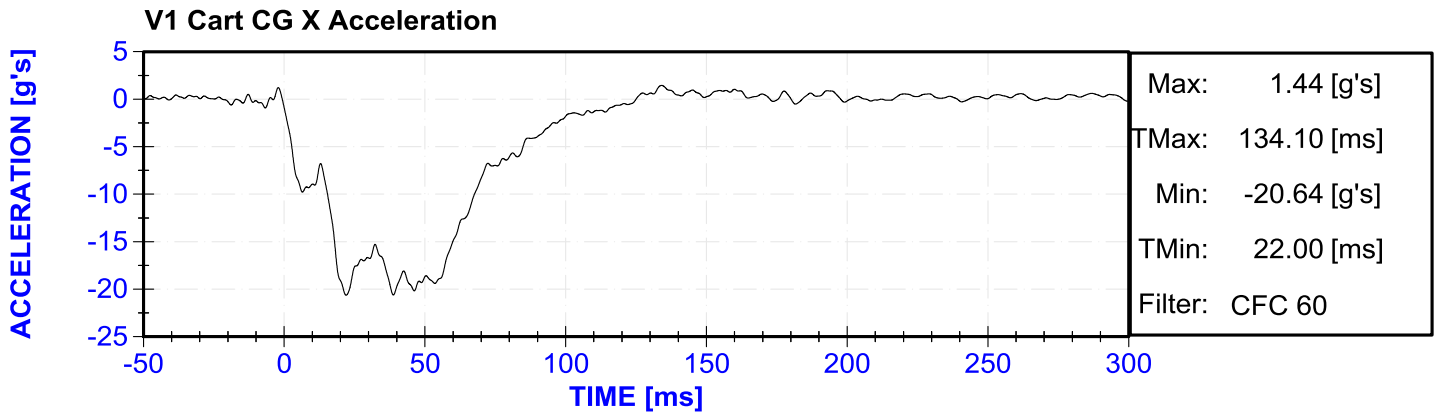


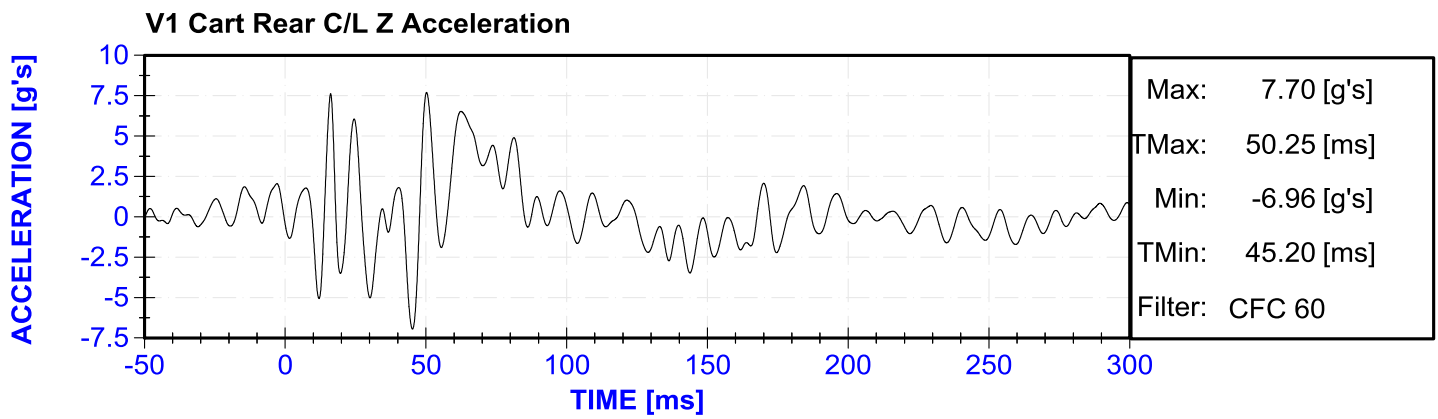
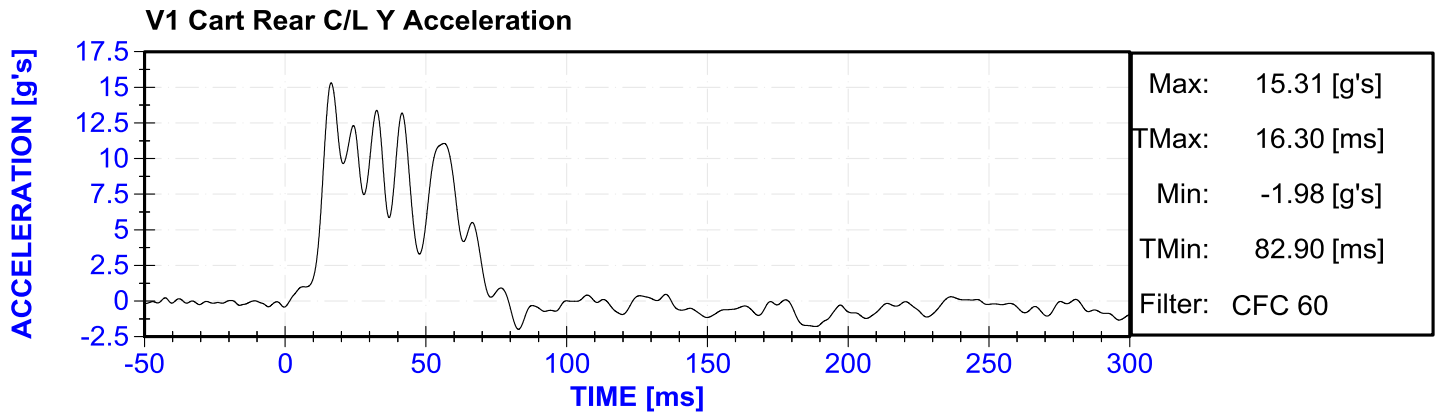












## APPENDIX C

### PART 572 E/O ATD CALIBRATION AND PERFORMANCE VERIFICATION DATA SHEETS

\*Not Required per Loan Agreement – THOR ATD's were NOT used\*

**APPENDIX D:**  
**CMM MEASUREMENT PROCEDURES**

### **Vehicle Coordinate System**

The origin point of the VCS is a point 50 mm forward of the rear window glass or hatchback door onto the roof of the vehicle along the vehicle's lateral centerline. The ground is not used as a reference.

The following procedure was used to create the Vehicle Coordinate System (VCS):

- 1) Place the As Delivered vehicle on a flat surface.
- 2) Measure the width of the vehicle at the rear of the vehicle to establish a first center point.
- 3) Measure the width of the vehicle at the front of the vehicle to establish a second center point.
- 4) Using a vertical laser beam, connect the two points to establish the lateral centerline of the vehicle.
- 5) Establish a point 50 mm from the edge of the rear window glass or rear hatchback door frame at the intersection of the roof onto the roof to establish the VCS origin point.
- 6) Construct a line perpendicular to the lateral centerline of the vehicle from VCS origin point towards the C-pillar. Mark a point along this line that is on the C-pillar at the body crease line between the roof and pillar geometry. This will be reference point #2.
- 7) Construct another perpendicular line in the opposite direction from the lateral centerline of the vehicle that is the same distance from the centerline as reference point #2. This will be reference point #3.
- 8) The VCS origin point is defined as the following:
  - Positive X is from the VCS origin point to the front of the vehicle
  - Positive Y is from the driver side of the vehicle to the passenger side of the vehicle
  - Positive Z is from the VCS origin point of the vehicle to the bottom of the vehicle

### **Steering Column Reference Point**

The Steering Column Reference point is the x, y, and z location of the geometric center of the steering wheel in the VCS.

### **Brake Pedal Reference Point**

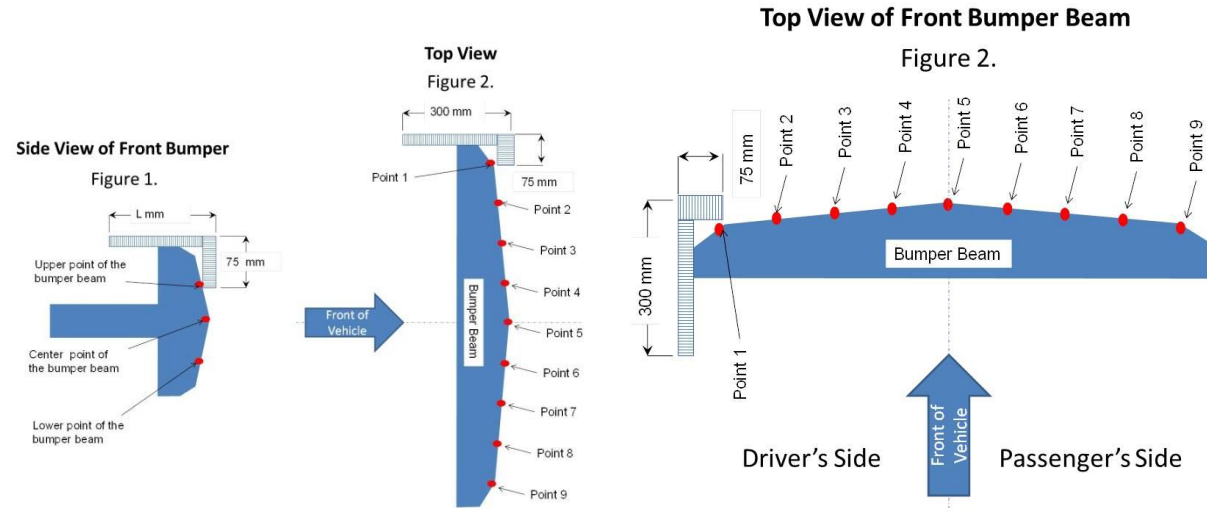
The Brake Pedal Reference Point is the x, y, and z location of the geometric center of the brake pedal pad (top surface) in the VCS.

### **Floor Reference Point**

The Floor Reference Point is the x, y, and z location of the floor in the VCS. Use the following procedure to determine the Floor Reference Point:

1. If the vehicle has an accelerator pedal with fore-aft adjustment, adjust the pedal to its forward most position
2. Locate the centerline of the top surface of the bottom of the accelerator pedal (CLAP)
3. Remove floor mats
4. Project a vertical line down from the CLAP point until contact is made to the floor. This point is the Floor Reference Point

## **Pre and Post Bumper Beam and Radiator Support Measurement**



Find the vertical center of the bumper beam using the following procedure (Reference Figure 1).

- 1) Position a square above the bumper beam at the centerline of the vehicle such that the plane of the square is aligned with the longitudinal axis of the vehicle and the “L mm” part of the square is parallel to the ground.
- 2) Move the square toward the ground until it contacts the bumper beam.
- 3) Move the square toward the rear of the vehicle until it contacts the bumper beam. The point where the 75 mm part of the square contacts the bumper beam is the Upper point of the bumper beam.
- 4) Perform the same procedure for the lower part of the bumper beam. The point where the 75 mm part of the square contacts the bumper beam is the Lower point of the bumper beam.
- 5) The center point of the bumper beam is half the distance between the Upper and Lower points of the bumper beam.
- 6) Transpose the lateral center of the bumper beam up onto the top of the upper radiator support.
- 7) Mark the center of the upper radiator support along its forward leading edge. If the radiator support is not flat this mark is made along the top edge.
- 8) Mark enough points along this edge to define its profile.

### **Pre and Post Driver Left Lower Instrument Panel**

The left lower instrument panel (knee bolster) lateral coordinates are defined by adding 15 cm from the steering column reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor reference point. If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure. Create a floor vehicle coordinate system on the floor at the location of this measurement.

### **Pre and Post Driver Right Lower Instrument Panel**

The left lower instrument panel (knee bolster) lateral coordinates are defined by subtracting 15 cm from the steering column reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor reference point. If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

**Pre and Post Brake Pedal (Figure 22)**

If the brake pedal is constructed so that it dangles loosely after the crash, the brake pedal is pushed straight forward against the toe pan/floor pan and held there to take the post-crash measurement. If the pedal drops away entirely, no post-crash measurement is taken.

**Pre and Post Driver Toe pan and Floor Board (Figure 22)**

*DRIVER POINT A1*

The vertical coordinate for the A1 measurement location is the vertical of the brake pedal reference. The lateral coordinate of the A1 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT B1*

The vertical coordinate for the B1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the B1 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT C1*

The vertical coordinate for the C1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the C1 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT D1*

The vertical coordinate for the D1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the D1 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT A2*

The vertical coordinate of the A2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the A2 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT B2*

The vertical coordinate of the B2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference the vertical coordinate of the floor reference. The lateral coordinate of the B2 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT C2*

The vertical coordinate of the C2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the C2 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT D2*

The vertical coordinate of the D2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the D2 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT A3*

The vertical coordinate of the A3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the A3 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT B3*

The vertical coordinate of the B3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the B3 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT C3*

The vertical coordinate of the C3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the C3 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT D3*

The vertical coordinate of the D3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the D3 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT A4*

The longitudinal coordinate of the A4 measurement location is obtained by subtracting 10 cm from the D3 reference. The lateral coordinate of the A4 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT B4*

The longitudinal coordinate of the B4 measurement location is obtained by subtracting 10 cm from the D3 reference. The lateral coordinate of the B4 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT C4*

The longitudinal coordinate of the C4 measurement location is obtained by subtracting 10 cm from the D3 reference. The lateral coordinate of the C4 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT D4*

The longitudinal coordinate of the D4 measurement location is obtained by subtracting 10 cm from the D3 reference. The lateral coordinate of the D4 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT A5*

The longitudinal coordinate of the A5 measurement location is obtained by subtracting 10 cm from the A4 reference. The lateral coordinate of the A5 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT B5*

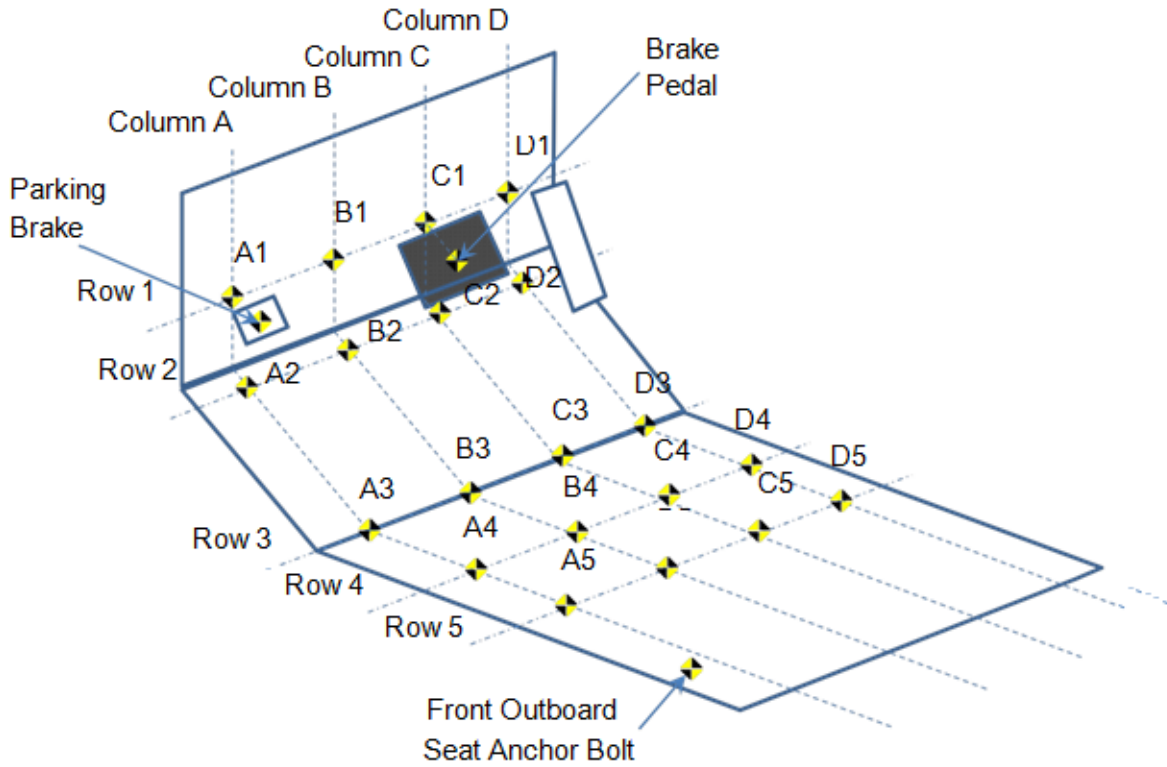
The longitudinal coordinate of the B5 measurement location is obtained by subtracting 10 cm from the B4 reference. The lateral coordinate of the B5 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

#### *DRIVER POINT C5*

The longitudinal coordinate of the C5 measurement location is obtained by subtracting 10 cm from the C4 reference. The lateral coordinate of the C5 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

*DRIVER POINT D5*

The longitudinal coordinate of the D5 measurement location is obtained by subtracting 10 cm from the D4 reference. The lateral coordinate of the D5 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

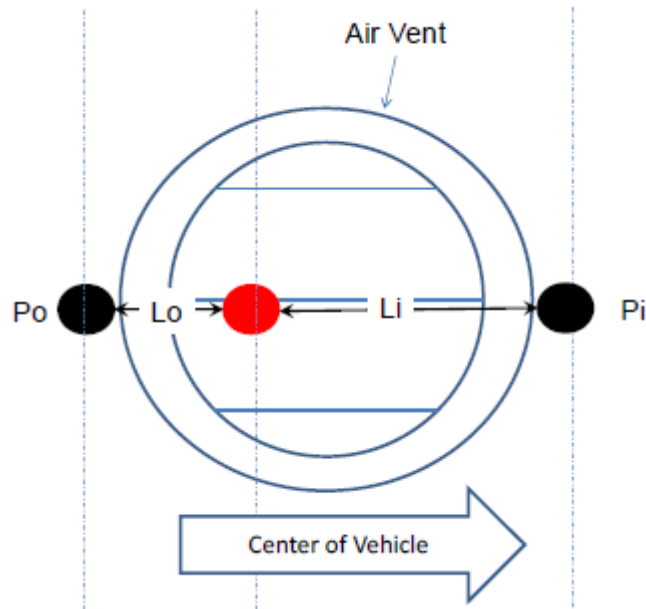


**Figure 22: Lower interior intrusion measurements**

### **Driver Upper Dash**

The upper dash point is obtained by subtracting 25 cm from the lateral coordinate of the steering column reference lateral coordinate. This defines a line of points on the edge of the upper dash. The upper dash point is located on the rearward most (toward the rear of the vehicle) point on this line. This point must be located at least 30 cm above the brake pedal reference point to ensure a vertical location high enough to represent a location that could be contacted by the driver's upper body or head. If the rearward most point is less than 30 cm above the brake pedal reference point, the upper dash point is located at this 30 cm reference location.

There may be instances when the upper dash point is located on a "soft component" such as an air vent or control knob (Figure 23). To measure a more robust structure, the upper dash point is replaced with two additional points, and the weighted average of their coordinates is used to represent the deformation of a point at the original location (Equation 1). Each new point is determined by moving inboard/outboard to a location that is just off of the soft component.



$$dp = \frac{Li}{Lo + Li} [X_o, Y_o, Z_o] + \frac{Lo}{Lo + Li} [X_o, Y_o, Z_o]$$

**Figure 23: Equation for Measuring Soft Component Driver Upper Dash Point**

### **Passenger Left Lower Instrument Panel**

The left lower instrument panel (knee bolster) lateral coordinates are defined by adding 15 cm from the center passenger seat reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor (without floor mats). If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

Create a floor vehicle coordinate system on the floor at the location of this measurement.

### **Passenger Right Lower Instrument Panel**

The left lower instrument panel (knee bolster) lateral coordinates are defined by subtracting 15 cm from the center passenger seat reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor (without floor mats). If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

### **Passenger Toe pan and Floor Board (Figure 24)**

#### *PASSENGER POINT A1*

The vertical coordinate for the A1 measurement location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the A1 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT B1*

The vertical coordinate for the B1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the B1 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT C1*

The vertical coordinate for the C1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the C1 is obtained by adding 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT D1*

The vertical coordinate for the D1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the D1 is obtained by adding 25 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT A2*

The vertical coordinate of the A2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the A2 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT B2*

The vertical coordinate of the B2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference the vertical coordinate of the floor reference. The lateral coordinate of the B2 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT C2*

The vertical coordinate of the C2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the C2 is obtained by adding 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT D2*

The vertical coordinate of the C2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the D2 is obtained by adding 25 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT A3*

The vertical coordinate of the A3 measurement location is obtained by subtracting 1 cm from the driver's floor reference. The lateral coordinate of the A3 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT B3*

The vertical coordinate of the B3 measurement location is obtained by subtracting 1 cm from the driver's floor reference. The lateral coordinate of the B3 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT C3*

The vertical coordinate of the C3 measurement location is obtained by subtracting 1 cm from the driver's floor reference. The lateral coordinate of the C3 is obtained by adding 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT D3*

The vertical coordinate of the D3 measurement location is obtained by subtracting 1 cm from the driver's floor reference. The lateral coordinate of the D3 is obtained by adding 25 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT A4*

The longitudinal coordinate of the A4 measurement location is obtained by subtracting 10 cm from the A3 reference. The lateral coordinate of the A4 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT B4*

The longitudinal coordinate of the B4 measurement location is obtained by subtracting 10 cm from the A3 reference. The lateral coordinate of the B4 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT C4*

The longitudinal coordinate of the C4 measurement location is obtained by subtracting 10 cm from the A3 reference. The lateral coordinate of the C4 is obtained by adding 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT D4*

The longitudinal coordinate of the D4 measurement location is obtained by subtracting 10 cm from the A3 reference. The lateral coordinate of the D4 is obtained by adding 25 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT A5*

The longitudinal coordinate of the A5 measurement location is obtained by subtracting 10 cm from the A4 reference. The lateral coordinate of the A5 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

#### *PASSENGER POINT B5*

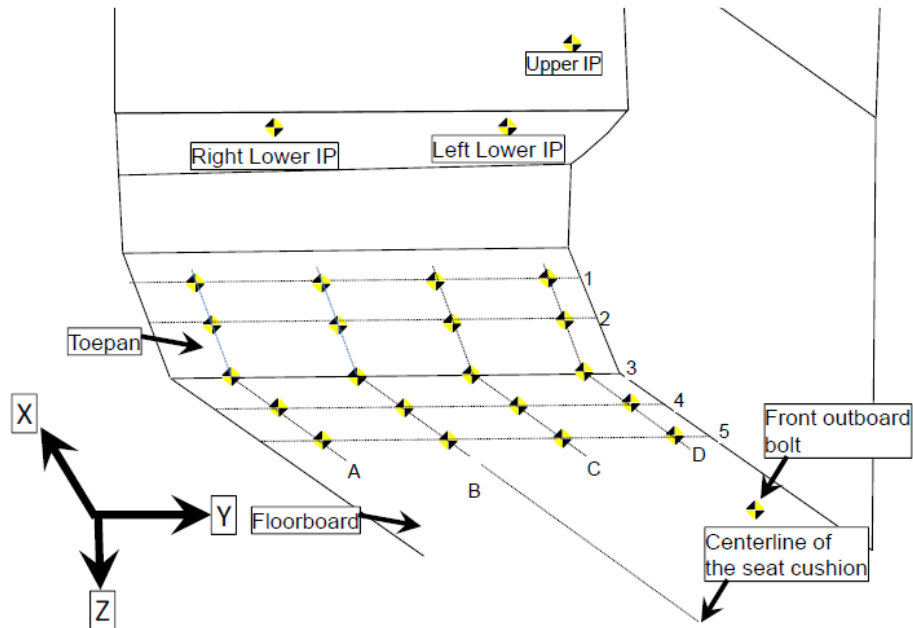
The longitudinal coordinate of the B5 measurement location is obtained by subtracting 10 cm from the B4 reference. The lateral coordinate of the B5 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

### **PASSENGER POINT C5**

The longitudinal coordinate of the C5 measurement location is obtained by subtracting 10 cm from the C4 reference. The lateral coordinate of the C5 is obtained by adding 15 cm from the center passenger seat reference lateral coordinate.

### **PASSENGER POINT D5**

The longitudinal coordinate of the D5 measurement location is obtained by subtracting 10 cm from the D4 reference. The lateral coordinate of the D5 is obtained by adding 25 cm from the center passenger seat reference lateral coordinate.



**Figure 24: Passenger side lower interior measurements**

### **Passenger Upper Dash**

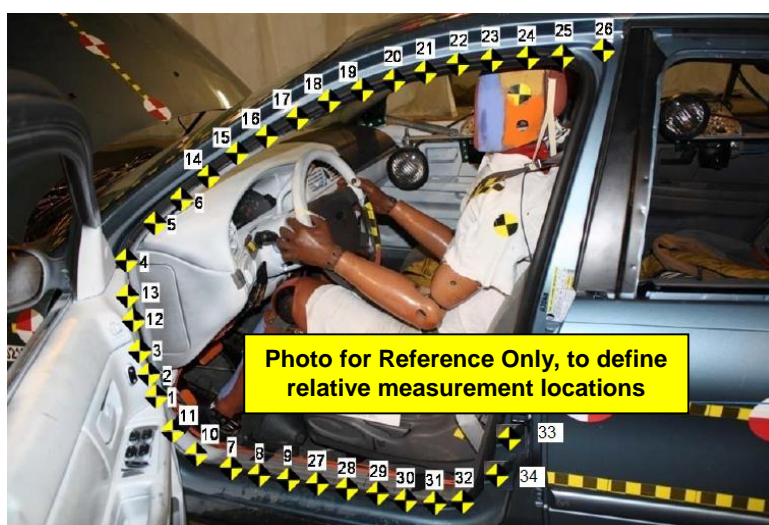
The upper dash point is obtained by adding 25 cm from the lateral coordinate of the center passenger seat reference lateral coordinate. This defines a line of points on the edge of the upper dash. The upper dash point is located on the rearward most (toward the rear of the vehicle) point on this line. This point must be located at least 30 cm above the brake pedal reference point to ensure a vertical location high enough to represent a location that could be contacted by the driver's upper body or head. If the rearward most point is less than 30 cm above the brake pedal reference point, the upper dash point is located at this 30 cm reference location.

There may be instances when the upper dash point is located on a "soft component" such as an air vent or control knob (Figure 23). To measure a more robust structure, the upper dash point is replaced with two additional points, and the weighted average of their coordinates is used to represent the deformation of a point at the original location (Equation 1). Each new point is determined by moving inboard/outboard to a location that is just off of the soft component.

### **Driver Door Measurements (Figure 25)**

Mark the following points on the inner most surface of the door opening, typically on the pinch weld.

- 1) **Point 1:** The vertical coordinates of this point is obtained by subtracting 0 cm from the brake pedal reference point.
- 2) **Point 2:** The vertical coordinates of this point is obtained by subtracting 7.5 cm from the brake pedal reference point.
- 3) **Point 3:** The vertical coordinates of this point is obtained by subtracting 15 cm from the brake pedal reference point
- 4) **Point 4:** The vertical coordinates of this point is obtained by subtracting 45 cm from the brake pedal reference point.
- 5) **Point 5:** The vertical coordinates of this point is obtained by subtracting 52.5 cm from the brake pedal reference point).
- 6) **Point 6:** The vertical coordinates of this point is obtained by subtracting 60 cm from the brake pedal reference point
- 7) **Point 7:** The longitudinal coordinates of this point is obtained by subtracting 20 cm from the brake pedal reference point. If the 20 cm point is forward of the actual door frame, this point is located 5 cm rearward of lower hinge pillar point.
- 8) **Point 8:** The longitudinal coordinates of this point is obtained by subtracting 35 cm from the brake pedal reference point.
- 9) **Point 9:** The longitudinal coordinates of this point is obtained by subtracting 50 cm from the brake pedal reference point.
- 10) **Point 10 and 11:** Mark 2 evenly spaced points between points 1 and 7
- 11) **Point 12 and 13:** Mark 2 evenly spaced points between points 3 and 4
- 12) **Point 26:** Mark a point at the intersection of the roof rail and the start of the B-pillar
- 13) **Points 14-25:** Mark 12 evenly spaced points between points 6 and 26
- 14) **Point 32:** Mark a point at the intersection of the lower sill and the start of the B-pillar
- 15) **Points 27-31:** Mark 5 evenly spaced points between points 9 and 32
- 16) **Point 33:** Subtract 150mm from the vertical coordinate of the brake pedal reference point
- 17) **Point 34:** Subtract 0mm from the vertical coordinate of the brake pedal reference point



**Figure 25: Driver Door Measurements**

### **Passenger Door Measurements**

Perform the same procedure as the driver door on the passenger side.

**Pre-Test Exterior Profile**

- 1) Expose the front bumper beam.
- 2) At the lateral center of the bumper beam, measure and mark the center of the front bumper beam (along front face of beam).
- 3) Using this Z coordinate, mark and measure enough points around the complete circumference of the vehicle to establish cross section A-A.
- 4) Transpose the lateral center of the bumper beam up onto the top of the upper radiator support.
- 5) Mark the center of the upper radiator support along its forward leading edge.
- 6) Using this Z coordinate, mark and measure enough points around the complete circumference of the vehicle to establish cross section B-B.

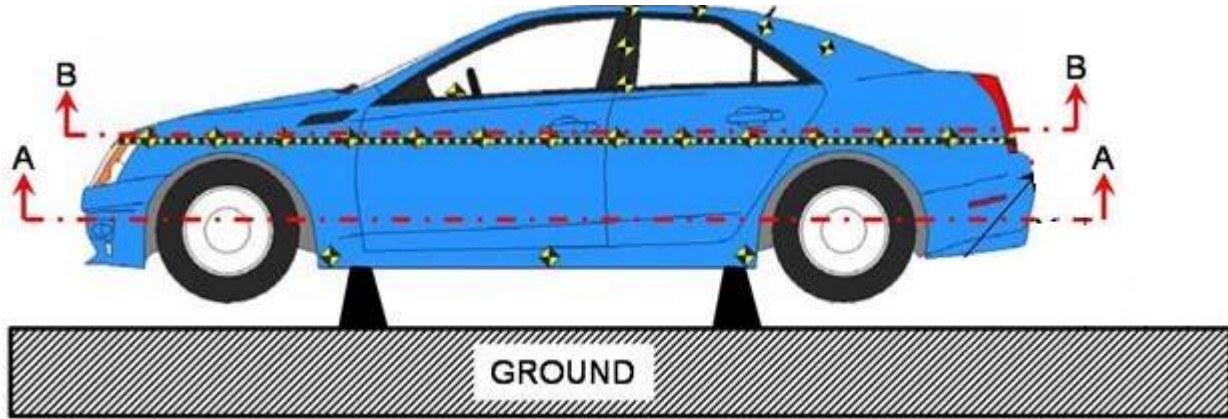
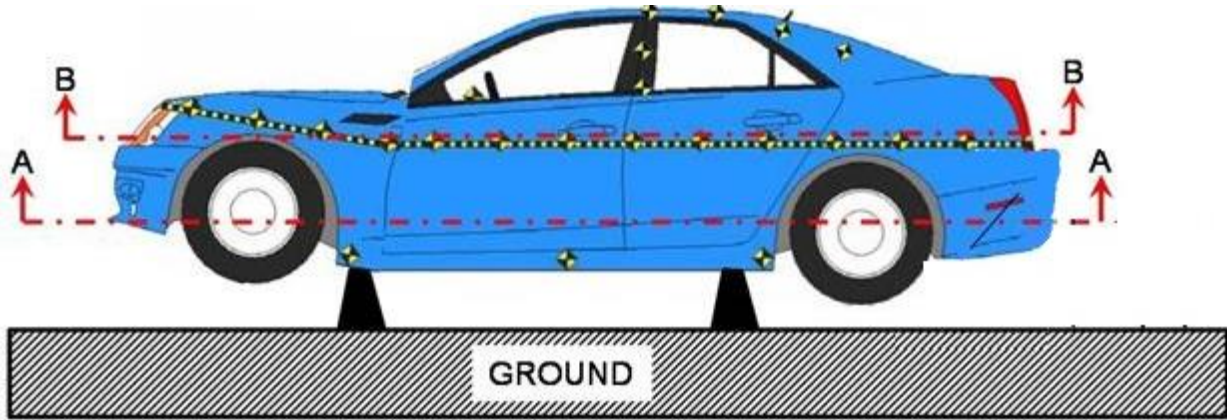


Figure 26: Pre-Test Vehicle Profile

### **Post-Test Exterior Profile**

- 1) Remove bumper cover
- 2) Using the vehicle's origin reference point leap into vehicle's coordinate system.
- 3) Using the pre-Test z-value at section A-A which was recorded from VCS origin, take measurements at this z-distance around the circumference of the vehicle.
- 4) Using the pre-Test z-value at section B-B that was recorded from VCS origin, take measurements at this z-distance around the circumference of the vehicle.



**Figure 27: Post-Test Vehicle Profile**

### **Pre and Post Honeycomb Requirements**

The contractor shall take pre-and post-crush measurements of the honeycomb while attached to the barrier. These measurements shall be documented in the appropriate datasheet. Also, the contractor shall take pre-and post-Test pictures of the left and right side, top, and front view of the honeycomb while attached to the barrier.