CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

CASE NO: CA04-020

VEHICLE: 2004 DODGE DURANGO

LOCATION: MARYLAND

CRASH DATE: MARCH 2004

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA04-020	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Certified Advanced 208-Compliant Vehicle Crash Investigation Vehicle: 2004 Dodge Durango Location: State of Maryland		*5. Report Date*: June 2006 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0204 *11. Contract or Grant No.* DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: March 2004 *14. Sponsoring Agency Code*	
15. Supplementary Note This on-site investigation focused on the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2004 Dodge Durango.			
16. Abstract This on-site investigation focused on the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2004 Dodge Durango. The frontal air bag system in the Dodge Durango was certified by the manufacturer to have met the requirements of the advanced Federal Motor Vehicle Safety Standard 208. This CAC safety system consisted of dual stage air bags for the driver and front right positions, seat track positioning sensors, a front right occupant presence sensor, and safety belt buckle switches. The Durango was involved in a run-off-road crash with a wooden utility pole that resulted in the deployment of the driver and front right passenger air bags and the firing of the retractor pretensioners. The vehicle was occupied by a restrained 52-year old male driver, an unrestrained 47-year old female front right passenger and five child passengers; two who were restrained in forward facing child safety seats. The front right passenger and the rear left (third row) child passenger sustained soft tissue injuries. The driver and the remaining child passengers were not injured. All occupants of the Durango were transported by ambulance to local hospital where they were examined, treated and released. The Durango was towed from the scene of the crash.			
17. Key Words Certified Advanced 208-Compliant occupant protection Driver air bag deployment		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 16	*22. Price*

TABLE OF CONTENTS

CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLAINT VEHICLE CRASH INVESTIGATION
SCI CASE NO.: CA04-020
VEHICLE: 2004 DODGE DURANGO
LOCATION: MARYLAND
CRASH DATE: MARCH 2004

BACKGROUND

This on-site investigation focused on the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2004 Dodge Durango **(Figure 1)**. The frontal air bag system in the Dodge Durango was certified by the manufacturer to have met the requirements of the advanced Federal Motor Vehicle Safety Standard No. 208. This CAC safety system consisted of dual stage air bags for the driver and front right positions, seat track positioning sensors, a front right occupant presence sensor, and safety belt buckle switches. The Durango was involved in a run-off-road crash with a wooden utility pole that resulted in the deployment of the driver and front right passenger air bags and the firing of the retractor pretensioners. The vehicle was occupied by a restrained 52-year old male driver, an unrestrained 47-year old female front right passenger and five child passengers; two who were restrained in forward facing child safety seats. The front right passenger and the rear left (third row) child passenger sustained soft tissue injuries. The driver and the remaining child passengers were not injured. All occupants of the Durango were transported by ambulance to local hospital where they were examined, treated and released. The Durango was towed from the scene of the crash.

Figure 1. Exemplar 2004 Dodge Durango.

This March 2004 crash was identified from a list of claims from a major insurance company that was provided to the NHTSA's Crash Investigations Division. The list consisted of total loss vehicles that were equipped with Certified Advanced 208-Complaint safety systems. This Durango was located at the tow facility and cooperation was established with the manager to inspect the vehicle on April 22, 2004. In addition, the crash site was inspected and interviews were conducted with the driver and front right passenger of the vehicle. The Child Safety Seats (CSS) were removed from the vehicle at the time of the inspection. A family member provided the Make, Model Numbers and the Dates of Manufacturer of the safety seats to the SCI investigator. These safety seats were not inspected during this investigation.

SUMMARY

Crash Site

The crash occurred off-road of a five-lane divided arterial roadway during dark, but lighted conditions. The roadway consisted of three northbound lanes and two southbound lanes that were divided by a curbed median. All travel lanes were delineated

by broken white lane lines with solid edge lines. Both road edges were bordered by 15 cm (6") barrier curbs. The roadway curved to the left for northbound travel with a slight downgrade of less that two percent. A grassy area was located adjacent to the east road edge. A single wooden utility pole was located within the grassy area and was positioned 8.2 m (27') east of the curb line. This pole was struck and fractured by the crash. At the time of the SCI inspection, the utility pole was replaced. Located south of the crash site were an overpass for an Interstate roadway and an off-ramp for Interstate travel. The driver of the Durango exited the Interstate onto the ramp that transitioned into the northbound travel lanes. The posted speed limit was 48 km/h (30 mph). **Figure 2** is an overall view of the crash site. The Crash Schematic is included as **Figure 15** of this narrative report.

Figure 2. Overall view of the crash site.

Vehicle Data

The subject vehicle in this crash was a four-wheel drive 2004 Dodge Durango Sport Utility Vehicle (SUV). The Durango was manufactured on 11/03 and was identified by Vehicle Identification Number (VIN) 1D4HB48N04F (production number deleted). The Durango was a rental vehicle on a weekly rental rate to temporarily replace the driver's vehicle that was under repair. The Durango was a four-door SUV, powered by a conventionally mounted 4.7 liter V-8 linked to a five speed automatic transmission with a column mounted transmission selector lever. A tow/haul feature switch was incorporated into the end of the shift lever. Additional exterior features included a full-size spare that was mounted under to the rear aspect of the undercarriage and a roof rack with no crossbars. The service brakes were power-assisted four-wheel disc with anti-lock (ABS). The Durango was equipped with six-spoke OEM steel wheels with plastic hubcaps and P245/70R17 Goodyear Wrangler SR-A all-season tires. The vehicle manufacturer recommended cold tire pressure was 227 kPa (33 PSI). The specific tire data at the time if the SCI inspection is identified in the following table:

Position	Measured Pressure	Tread Depth	Damage
Left Front	0 kPa	9 mm (11/32")	1 cm deep dent to the outer bead of the wheel w/air out
Left Rear	231 kPa (34 PSI)	9 mm (11/32")	None
Right Front	217 kPa (32 PSI)	8 mm (10/32")	None
Right Rear	221 kPa (32 PSI)	9 mm (11/32")	None

The interior of the Durango was equipped with three rows of cloth covered seats which provided seating for seven occupants. The front row consisted of two bucket seats with adjustable head restraints and a fixed center console. Both head restraints were adjusted to the full down position at the time of the SCI inspection. The driver's seat was an 8-way power seat and the front right passenger seat was manually adjusted. The steering

wheel was adjustable (tilt) with a seven-position detent. At the time of the SCI inspection, the wheel was adjusted to the full up-position.

The second row seat was a double split bench with individual cushions and seatbacks for the three positions. The cushions folded forward against the front seat backs and the seat backs folded forward to a flat position. All three positions of the second row were equipped with adjustable head restraints. The rear left position was adjusted 6 cm (2.25") above the seat back while the center rear was set to the full down position. The rear right head restraint was removed from the seat back and found lying on the floor. The outboard positions of the second row seat were equipped with **L**ower **A**nchors and **T**ethers for **CH**ildren (LATCH).

The third row was equipped with a two-passenger bench seat with a forward folding seat back and adjustable head restraints. Both head restraints were adjusted to the full-down positions.

Crash Sequence

Pre-Crash

The driver of the 2004 Dodge Durango was traveling in a westerly direction on an interstate roadway and exited onto a divided five-lane road to travel in a northerly direction. He directed the vehicle onto the outboard travel lane and traveled under an overpass while negotiating a left curve. As he continued northbound, the driver experienced a medical episode (seizure) due to a previous health issue and became unconscious at the wheel. The driver slumped to his right which resulted in an inadvertent right steering input to the vehicle. The Durango departed the right road edge in a presumed tracking attitude (**Figure 3)**.

Figure 3. Point of road departure and location of struck pole.

Crash

The outer bead area of the left front wheel engaged the barrier curb as the vehicle departed the travel lane. The curb impact abraded the wheel and dented the steel wheel to a depth of 1 cm (0.5"). This impact resulted in an air out of the left front tire. Gouge marks were present of the top surface of the curb at the location of road departure.

The SUV traversed a grassy area that separated the travel lanes from a parking lot exit-ramp. Based on the pre-crash inadvertent steering input and the resultant damage, the vehicle was tracking, or in a near tracking mode as it traversed the off-road area. There was no avoidance action initiated by the driver at this point.

The center front area of the Dodge Durango impacted a wooded utility pole that was located 8.2 m (27') outboard of the curb line. The 12 o'clock direction of force impact fractured the pole. (The pole was replaced prior to notification of this SCI investigation).

The impact crushed the front bumper system to a measured depth of 49 cm (19.4”). The barrier routine algorithm of the WINSMASH program was utilized to compute a total velocity change of 30 km/h (18.6 mph) for the Durango. The vehicle’s single point sensing system detected a sufficient longitudinal deceleration to deploy the CAC frontal air bag system and the front retractor pretensioners. Due to the lack of a downloadable Event Data Recorder (EDR), the deployment stage of the frontal air bags was unknown. There was no evidence at the crash site to support final rest location of the vehicle.

Post-Crash

The Durango came to rest at or near the base of the fractured utility pole. The driver, front right passenger, and the children restrained in the child safety seats remained in the vehicle post-crash. They were removed from the vehicle by rescue personnel. The three child occupants who were restrained in the manual safety belt systems exited the vehicle unassisted. All of the vehicle’s occupants were transported to local hospitals where they were evaluated and treated for their injuries and released.

Vehicle Damage

Exterior

The center frontal area of the Dodge Durango impacted the utility pole deforming the front bumper system to a U-shape. The bumper system consisted of the fascia that was formed to fit over the bumper beam. The bumper beam was supported by mounts at the front frame rails and extended 12 cm (4.75”) outboard of the frame rails. The corners of the fascia extended beyond the beam; however, there was no structure at the corners of the fascia. The direct contact damage on the bumper fascia began 8 cm (3”) left of center and extended 20 cm (8”) to the right. The impact fractured and separated the fascia on both sides of the license plate assembly. The narrow impact was located between the frame rails and crushed the bumper beam to a maximum depth of 49 cm (19.4”), located 10 cm (4”) right of the vehicle’s centerline **(Figure 4)**. The lateral width of the deformed bumper beam was 53 cm (21”). This value represented the Field L, a combination of direct and induced damage. The frontal crush profile was documented at six equidistant points along the bumper beam **(Figure 5)**. These values were as follows: C1 = 0 cm , C2 = 9 cm (3.5”), C3 = 34 cm (13.25”), C4 = 49 cm (19.4”), C5 = 31 cm (12.4”), C6 = 2 cm (0.75”). The Collision Deformation Classification (CDC) for this impact was 12-FCEN-3.

The forward opening hood of the Durango remained closed and latched post-crash. All four doors, plus the rear lift gate remained closed during the crash and remained operational post-crash. The windshield was fractured by the deployment of the front right passenger air bag. All side and backlight glass remained intact. The left front steel wheel contacted the barrier curb as the Durango departed the roadway. The contact abraded the plastic wheel cover and dented the outer bead to a depth of 1 cm over a 15 cm (6”) area. This wheel impact aired out the left front tire. The CDC for this event was 12-FLWN-3.

Figure 4. Frontal damage to the Dodge Durango.

Figure 5. Overhead view documenting the extent of frontal crush.

Interior

The interior of the Dodge Durango sustained minor severity damage that was associated with frontal air bag deployment and occupant contact. The passenger compartment was not reduced in size by intrusion. Both frontal air bag modules deployed as designed. The front right module cover flap contacted and fractured the laminated windshield. The fracture site was primarily the width of the flap, however, the cracks radiated from the right A-pillar to 27 cm (10.75") left of the vehicle's centerline.

The belted driver contacted the knee bolster with his left knee. A scuff mark was located 34-42 cm (13.25-16.5") left of center and 37-38 cm (14.5-15") below the top instrument panel.

The second row, right side child passenger contacted and scuffed the right front seat back. A laterally oriented 7 cm (2.75") diameter scuff mark was located on the upper surface of the seat back. A longitudinally oriented crack was noted to the plastic cover of the lower right B-pillar. This crack was related to the tensioning of the stowed belt system by the firing of the retractor pretensioner.

The seat back of the second row, left position contained four horizontally oriented lines that were possibly related to the child safety seat. These lines were not permanent in the fabric. Similar lines were present on the cushion and seat back of the left third row seat.

Certified Advanced 208-Complaint Frontal Air Bag System

The 2004 Dodge Durango was equipped with Certified Advanced 208-Complaint frontal air bag system for the driver and front right passenger positions. This system consisted of dual stage frontal air bags, seat track positioning sensors, a front right occupant presence sensor, and retractor pretensioners. The system deployed **(Figure 6)** as a result of the frontal impact with utility pole. The manufacturer of this vehicle has certified that

Figure 6. Deployed CAC Frontal air bags.

this 2004 Dodge Durango meets the advanced air bag requirements for FMVSS 208. This system utilized a single point crash sensing and diagnostic module that was mounted on the center tunnel within the passenger compartment. This air bag control module was not supported by the Vetronix Crash Data Retrieval tool; therefore it was not downloaded for this investigation.

The driver's air bag was conventionally mounted within the four-spoke steering wheel rim. The spokes were positioned at the 3/9 and 5/7 o'clock positions. The module was concealed by semicircular symmetrical cover flaps with a vertical tear seam. The maximum width of the flaps was 7 cm (2.9") and the vertical height at the seam was 13 cm (5.25"). A horn pad was mounted within the module behind the vinyl cover flaps. A wire connector to this pad separated as a result of the deployment. There was no damage or occupant contact evidence of these flaps.

The driver air bag membrane measured 63 cm (25") in diameter in its deflated state. The air bag was tethered by two internal straps that were 6 cm (2.25") in width located at the 12 and 6 o'clock positions. The maximum excursion of the bag at the tether locations measured 23 cm (9"). The air bag was vented by two X-cut ports that formed four triangles **(Figure 7)**. The air bag was stamped with the following nomenclature at the 12 o'clock position of the forward panel:

Figure 7. X-cut vent port.

2403048 AB
900009012
900009012

31 10 03 G
S
Assembled in Mexico
of USA Components

There was no contact evidence or damage to the driver's air bag.

The front right passenger air bag was a top-mount design incorporated into the right upper instrument panel (IP). The air bag module was concealed by a single cove flap that was hinged at the forward aspect. The flap measured 26 cm (10.25") in width at the hinge point, 18 cm (7") in depth, and 29 cm (11.4") across the leading edge. This leading edge was 18 cm (7") forward of the apex of the upper IP and the mid panel. The cover flap was a single ply of thin vinyl. The flap was intact at the time of the SCI inspection; however, the leading edge was in a vertical position against the windshield. The flap contacted and fractured the laminated windshield with cracks radiating from the right upper A-pillar to a point located 27 cm (10.75") left of the centerline.

The face of the deployed and deflated passenger air bag measured 47 cm (18.5") horizontally and approximately 46 cm (18") vertically. The air bag was tethered by a 9 cm (3.5") wide internal band that was sewn to the face of the membrane 35 cm (14") below the top seam. This tether limited the rearward excursion of the bag to 20 cm (8") at the tether stitching from the apex of the top and mid IP. A second tether was noted to the bottom aspect of the bag. This was located 17 cm (6.5") forward of the bottom seam, on the forward panel of the bag. The air bag was vented by two X-cut ports similar to the driver's bag. These cut ports were larger in size and were located at the 3 and 9 o'clock positions on the side panels. There was no damage or occupant contact evidence on the deployed front right air bag. The following nomenclature was stamped on the top panel of the front right air bag:

HB
2400832 AF
Y0630
Y0630
Y0630
28 10 03
S
Assembled in Mexico
of USA Components

The PASSENGER AIR BAG ON/OFF indicator lamp was located within the center instrument panel below the vent louver, forward of the front right passenger position.

The Durango was not equipped with the optional head curtain air bags. Side impact air bags were not available for this vehicle.

Manual Safety Belt Systems

The 2004 Dodge Durango was equipped with 3-point lap and shoulder belts for the seven designated seated positions. The front seat belt systems consisted of continuous loop webbings with sliding latch plates, adjustable D-rings and retractor pretensioners. The driver's retractor was an Emergency Locking Retractor (ELR) while the front right position was a switchable ELR/Automatic Locking Retractor. The driver was restrained by the safety belt system at the time of the crash; however the front right passenger was not restrained. Both retractor pretensioners fired as a result of the crash and the deployment of the CAC frontal air bag deployment.

The driver's D-ring was adjusted to the full-up position. He loaded the belt system which resulted in frictional abrasions on the outboard aspect of the latch plate from the shoulder belt webbing. A D-ring transfer was present full width across the webbing and measured 9 cm (3.5") in length **(Figure 8)**. The transfer began 2 cm (0.75") below the D-ring and extended toward the retractor due to the firing of the pretensioner which locked the belt in its worn position **(Figure 9)**.

Figure 8. D-ring transfer.

Figure 9. Locked position of the driver's safety belt webbing.

The front right passenger was unrestrained. This belt system was retracted against the B-pillar and was spooled taut and locked against the pillar as a result of the firing of the pretensioner.

The second row safety belts consisted of three point continuous loop webbings. The second row outboard positions were equipped with light-weight locking latch plates, ELR retractors with the belt sensitive feature, and adjustable D-rings. The buckles were attached to the inboard aspects of the seat frames. The left D-ring was adjusted 3 cm (1") below full-up while the right D-ring was adjusted to the full-up position. The center position was integrated into the center rear seat back and was equipped with a sliding latch plate and an ELR/ALR retractor. The buckle was attached to the right side of the center rear seat cushion.

The second row left safety belt was utilized to restrain a forward facing CSS that was occupied by a 9-month old male. This belt system contained subtle wear marks on the latch plate; however, there was no loading evidence on the webbing or hardware. The second row, center rear position was occupied by a 7-year old female. She was restrained by the manual safety belt system and was not injured. There was no crash related loading evidence on this belt system. The right rear position of this seat was occupied by a 12-year old female. She was restrained by the 3-point safety belt system. Loading evidence was limited to a frictional abrasion on the plastic locking mechanism of the light-weight locking latch plate. **Figure 10** is an overall view of the second row seat and the safety belt systems.

The third row seat was a two-passenger seat that was equipped with continuous loop webbings, light-weight locking latch plates, fixed D-rings, and ELR retractors with the belt sensitive feature. The buckles were secured to the forward folding seat frame.

The third row, left side belt system was utilized to restrain a forward facing CSS that was occupied by a 3-year old female. An 11-year old female occupied the right position of the third row. There was no loading evidence to these safety belt systems. **Figure 11** is an overall view of the third row seat and the safety belt systems.

Figure 10. Second row seat and safety belt systems.

Figure 11. Third row seat and safety belt systems.

Child Safety Seats

The driver stated during the SCI interview that two of his grandchildren were restrained in forward facing CSSs. He further stated that he buckled both seats into the vehicle utilizing the 3-point lap and shoulder belt systems. The CSSs were not with the vehicle at the time of the SCI inspection, therefore they were not inspected. The driver did locate the CSSs following the initial interview and provided the following information.

The 9-month old male was positioned in a forward facing Evenflo convertible seat that was equipped with a tray shield. The driver reported the Model No. as 2297-01-02 with additional numbers of 25808677-6-02 and 25804567-L. Again, the driver stated that he installed this seat and secured it with the vehicle's 3-piont safety belt system routed through the rear belt path. He pulled on the webbing to secure the CSS tight in the left outboard position. It should be noted that children less than one year of age should be restrained in a rear facing child safety seat. Both seats remained in use by the family following the crash.

A 3-year old female was restrained in a Cosco convertible CSS that was used in the forward facing position in the third row, left position. The Model No. was 22-500WAL with a Date of Manufacturer of 07-11-02. The driver noted that this seat was equipped with a tray shield and a three-point harness system. He could not recall the adjustment of the harness system over the child. The driver further stated that he routed the vehicle's safety belt through the belt path at the rear aspect of the CSS and pulled the belt snug.

Occupant Demographics

Driver

Age/Sex:	52-year old/Male
Height:	170 cm (67")
Weight:	73 kg (160 lb)
Manual Restraint Usage:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Seat Track Position:	Mid track 12 cm (4.75") aft of full forward and 9 cm (3.5) forward of full rear

Eyewear:	None
Egress From Vehicle:	Removed by rescue personnel
Mode of Transport From Scene:	Transported by ambulance to a regional trauma center
Type of Medical Treatment:	Treated and released

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Not injured, complaint of mild headache	N/A	Impact force

Source – Emergency room records

Driver Kinematics

The 52-year old male driver of the Dodge Durango was seated in a mid track position with the seat back reclined to a 15 degree angle. In this position, the horizontal distance between the center of the driver air bag module and the seat back was 56 cm (22") measured 36 cm (14") above the seat bight. The driver was restrained by the manual safety belt system. Belt usage was supported by the locked and worn position of the belt webbing due to the firing of the retractor pretensioner and loading evidence on the latch plate and the shoulder belt webbing from D-ring interaction. Prior to the crash, the driver relinquished control of the vehicle as he experienced a medical episode (seizure) due to a known medical condition. He reportedly lost consciousness at the wheel and slumped to his right. This action resulted in the driver applying an inadvertent right steering input which caused the vehicle to depart the right roadside.

At impact with the utility pole, the frontal air bags deployed. The driver initiated a forward trajectory and loaded the manual safety belt system and the deployed driver's air bag. This combination of restraint provided the driver with a ride down of the crash forces and prevented him from injury. His right knee contacted the bolster; however, no injury occurred from the bolster contact.

The driver was removed from the vehicle and transported by ground ambulance to a local hospital where he was evaluated for possible injury and released.

Front Right Passenger

Age/Sex:	47-year old/Female
Height:	157 cm (62")
Weight:	73 kg (162 lb)
Manual Restraint Usage:	None
Usage Source:	Vehicle inspection
Seat Track Position:	Mid track 13 cm (5.25") aft of full forward and 8 cm (3.25") forward of full rear
Eyewear:	None
Egress From Vehicle:	Removed by rescue personnel
Mode of Transport	

From Scene: Transported by ambulance to a local hospital
Type of Medical Treatment: Treated and released

Front Right Passenger Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Abrasion and contusion of right forearm	Minor (790202.1,1; 790402.1,1)	Expanding front right air bag
2nd degree burn of the right anterior forearm	Minor (792006.1,1)	Exhausting air bag gases
Mild headache	N/A	Impact force

Source – Emergency room records

Front Right Passenger Kinematics

The 47-year old front right female passenger of the Dodge Durango was seated in a mid track position with the seat back reclined to a measured 10 degree angle. In this position, the horizontal distance between the apex of the upper and mid instrument panel and the front right seat back was 76 cm (29.75"). The distance between the leading edge of the front right air bag module cover flap and the seat back was 93 cm (36.75"). Both measurements were located 43 cm (17") above the seat bight. The front right passenger was not restrained by the manual safety belt system. The retractor pretensioner fired and locked the belt taut against the right B-pillar. She was dressed in a long coat.

Figure 12. Front right passenger's trajectory and deployed air bag.

Immediately prior to impact, the front right passenger extended her right arm in an attempt to brace against the upper right instrument panel. At impact, the CAC frontal air bag system deployed. The expanding front right air bag contacted the front right passenger's right forearm which abraded and contused the arm. The gases that exhausted from the lateral vent port of the front right air bag discharged onto her right wrist and sleeve area. She reported that the sleeve of her coat was singed. The hospital medical records listed the passenger as sustaining a 2nd degree burn of the right anterior forearm.

She initiated a forward trajectory and loaded the deployed front right air bag which prevented her from contact with frontal components **(Figure 12)** and protected the passenger from potential injury. She rebounded into the front right seat back where she came to rest.

The front right passenger was transported by ambulance to a local hospital emergency room where she was treated for her injuries and released.

Second Row Left Passenger

Age/Sex:	9-month old/Male
Height:	Unknown by driver
Weight:	Unknown by driver
Manual Restraint	
Usage:	Restrained in a forward facing convertible Evenflo CSS
Usage Source:	Police Accident Report, driver statements
Egress From Vehicle:	Removed from CSS by rescue personnel
Mode of Transport	
From Scene:	Ambulance
Type of Medical Treatment:	Transported to a local hospital (No record of treatment)

Second Row Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – Driver interview

Second Row Left Passenger Kinematics

The 9-month old male second row left infant passenger was positioned in a forward facing convertible Evenflo child safety seat and restrained by the tray shield harness system. The forward facing CSS was installed in the rental vehicle by the driver and secured with the 3-point lap and shoulder belt system.

At impact, the child and the CSS responded to the 12 o'clock impact force by initiating a forward trajectory. It should be noted that children less than one year of age should be restrained in a rear facing child safety seat. The child safety seat and the integrated harness system; however, provided a ride down of the frontal crash forces. The driver reported the child as not injured.

Second Row Center Passenger

Age/Sex:	7-year old/Female
Height:	107 cm (42")
Weight:	36 kg (80 lb)
Manual Restraint	
Usage:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, PAR, driver interview
Egress From Vehicle:	Exited vehicle unassisted
Mode of Transport	
From Scene:	Ambulance
Type of Medical Treatment:	Transported to a local hospital (No record of treatment)

Second Row Center Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – Driver interview

Second Row Center Passenger Kinematics

The second row center child passenger was reported by the driver as restrained by the manual 3-point lap and shoulder belt usage. Belt usage was confirmed by the lack of interior contact and injury by this passenger.

At impact, she initiated a forward trajectory and loaded the manual safety belt system which held her in position and prevented her from injury. She was transported by ambulance to a local hospital. There was no record of treatment for this passenger at the medical facility.

Second Row Right Passenger

Age/Sex:	12-year old/Female
Height:	147 cm (58")
Weight:	50 kg (110 lb)
Manual Restraint	
Usage:	3-point lap and shoulder belt system
Usage Source:	Police Accident Report, driver statements
Egress From Vehicle:	Exited vehicle unassisted
Mode of Transport	
From Scene:	Ambulance
Type of Medical Treatment:	Transported to a local hospital (No record of treatment)

Second Row Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not injured	N/A	N/A

Source – Driver interview

Second Row Right Passenger Kinematics

The second row right child passenger was restrained by the manual safety belt system. Prior to impact, she extended her right arm in an attempt to brace against the front right seat back. This was evidenced by a scuff mark of the seat back fabric. She initiated a forward trajectory and loaded the manual safety belt which prevented her from contact with interior components and possible injury. She was transported by ambulance to a local hospital. There was no record of treatment at the medical facility.

Third Row Left Passenger

Age/Sex:	3-year old/Female
Height:	Unknown by driver
Weight:	Unknown by driver
Manual Restraint	
Usage:	Restrained in a forward facing convertible Cosco CSS
Usage Source:	Police Accident Report, driver statements
Egress From Vehicle:	Removed from CSS by rescue personnel
Mode of Transport	
From Scene:	Ambulance

Type of Medical Treatment: Transported to a local hospital (No record of treatment)

Third Row Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Sutured laceration over left eye	Minor (290602.1,2)	CSS tray shield

Source – Driver interview

Third Row Left Passenger Kinematics

The 3-year old female, third seat left child passenger was seated in a forward facing convertible Cosco child safety seat. The CSS was secured to the vehicle by the 3-point lap and shoulder belt system. The driver stated that he pulled on the belt system as he installed the CSS to tighten the belt system. The child was secured to the CSS by the tray shield harness system.

At impact, the child initiated a forward trajectory and loaded the integral harness system. This harness system arrested the forward motion of the child torso. Her head jackknifed forward over the harness straps which allowed her face to impact the tray shield of the CSS. This contact resulted in a laceration over her left eye. She was transported to a local hospital where the laceration was sutured.

Third Row Right Passenger

Age/Sex:	11-year old/Female
Height:	160 cm (63”)
Weight:	52 kg (115 lb)
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	Police Accident Report, driver statements
Egress From Vehicle:	Exited vehicle unassisted
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Transported to a local hospital (No record of treatment)

Third Row Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Ruptured blood vessel under eye, NFS	N/A	Impact force

Source – Driver interview

Third Row Right Passenger Kinematics

The third row right child passenger was restrained by the manual 3-point lap and shoulder belt system. She responded to the frontal impact force by initiating a forward trajectory and loading the belt system. The safety belt prevented the child passenger from contact with the forward seat back and possibly injury. The driver reported that the child sustained a ruptured vessel under the eye. She was transported by ambulance to a local hospital where she was treated and released. There was no record of treatment for this child.

Figure 15 – Scene Schematic