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## ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN07036  
LOCATION - TEXAS  
VEHICLE - 2001 CHEVROLET MALIBU  
CRASH DATE - October 2007

Submitted:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be 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 Documentation Page**

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16. <i>Abstract</i> This report covers an on-site child safety seat (CSS) investigation that involved a 2001 Chevrolet Malibu, a 2007 Hyundai Tiburon, an unidentified tractor-semitrailer, a 1983 Ford F-100, and two pedestrians. This crash is of special interest because the Chevrolet's second row left passenger (18-month-old, female), second row center passenger (1½-month-old, male), and second row right passenger (4-year-old, male) were seated in child safety seats. All the vehicles were traveling south. The Ford ran out of gas and stopped in the center lane. The Chevrolet's driver stopped in the outside lane and the front right passengers of the Ford and Chevrolet began pushing the Ford into the outside lane as the Chevrolet followed slowly. The Hyundai approached in the outside lane, the driver steered left to avoid impacting the Chevrolet, and the left side of the Hyundai impacted the right rear corner of a tractor-semitrailer (event 1), which was traveling in the center lane. The Hyundai continued southbound and its front right impacted and underrode the back left of the Chevrolet (event 2). The front left of the Chevrolet impacted one of the two pedestrians pushing the Ford (event 3) and then impacted and underrode the back right of the Ford (event 4). The impact caused the Ford to rotate counterclockwise approximately 180 degrees, and its left front door impacted the left rear quarter panel of the Chevrolet (event 5). The Ford and Chevrolet came to final rest in the roadway. The final rest position of the Hyundai was not known. The tractor-semitrailer did not stop and was not identified. The Chevrolet's driver and all three second row passengers were transported to a hospital and treated and released. The driver was restrained and sustained moderate injuries. The second row left passenger was restrained in a forward facing CSS and was not injured. The second row center passenger was restrained in a rear facing infant CSS and sustained minor injuries. The second row right passenger was restrained in a high back booster CSS and was not injured.					
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This crash was brought to the National Highway Traffic Safety Administration's (NHTSA) attention on or before November 6, 2007 by an article in a Texas newspaper. The crash involved a 2001 Chevrolet Malibu, a 2007 Hyundai Tiburon GS, an unidentified tractor-semitrailer, a 1983 Ford F-100 XLT, and two pedestrians. The crash occurred in October, 2007, at 21:13 hours in Texas and was investigated by the applicable city police department. This crash is of special interest because the Chevrolet's second row left passenger (18-month-old, female), second row center passenger [1½ -month-old, male], and second row right passenger [4-year-old, male] were seated in child safety seats (CSS). This contractor inspected the Chevrolet (**Figure 1**) on November 14, 2007. The Hyundai, Ford, and scene were inspected on November 15, 2007, and the Chevrolet's driver was interviewed on November 20, 2007. This report is based on the police crash report, interviews with the case vehicle's driver and police officers, scene and vehicle inspections, occupant kinematic principles, occupant medical records and this contractor's evaluation of the evidence.



## SUMMARY

This crash occurred at night under clear weather conditions on a dry, six-lane divided city street, which was illuminated by street lights. All the vehicles were traveling south. The Ford ran out of gas and stopped in the center lane. The Chevrolet's driver stopped in the outside lane and the front right passengers of the Ford and Chevrolet began pushing the Ford into the outside lane as the Chevrolet followed slowly. The Hyundai approached in the outside lane, the driver steered left to avoid impacting the Chevrolet, and the left side of the Hyundai impacted the right rear corner of a tractor-semitrailer (event 1), which was traveling in the center lane. The Hyundai continued southbound and its front right impacted and underrode the back left of the Chevrolet (event 2). The front left of the Chevrolet impacted one of the two pedestrians (event 3), and then impacted and underrode the back right of the Ford (event 4). The impact caused the Ford to rotate counterclockwise approximately 180 degrees, and its left front door impacted the left rear quarter panel of the Chevrolet (event 5). The Ford and Chevrolet came to final rest in the roadway. The final rest position of the Hyundai was not known. The tractor-semitrailer did not stop and was not identified. The Chevrolet's driver and all three second row passengers were transported to a hospital and treated and released. The driver was restrained and sustained moderate injuries. The second row left passenger was restrained in a forward facing CSS and was not injured. The second row center passenger was restrained in a rear facing infant CSS and sustained minor injuries. The second row right passenger was restrained in a high back booster CSS and was not injured.

**Crash Environment:** The trafficway on which all the vehicles were traveling was a six-lane, divided, city street, traversing in a north-south direction (**Figure 2**). The roadway had three through lanes in each direction and was divided by a raised, concrete median. The roadway pavement markings consisted of broken white lane lines and a yellow median curb. The roadway was straight and level and the posted speed limit was 72 km/h (45 mph). At the time of the crash, the light condition was dark with street lights, the atmospheric condition was clear, and the roadway pavement was dry bituminous. The traffic density was moderate and the site of the crash was urban commercial. See the Crash Diagram at the end of this report.

**Pre-Crash:** The Chevrolet was traveling south in the outside lane and the Ford was traveling south in the center lane. The Ford ran out of gas and stopped. The Chevrolet's driver also stopped, the front right passenger exited, and he and the Ford's front right passenger began pushing the Ford into the outside lane as the Chevrolet followed slowly. Meanwhile, a tractor-semitrailer was traveling south in the center lane approaching the Ford and Chevrolet, and the Hyundai was traveling south in the outside lane behind the tractor-semitrailer approaching the Chevrolet. The Hyundai's driver steered left to avoid an impact with the Chevrolet and the initial impact occurred in the center lane.

**Crash:** The left side of the Hyundai (**Figure 3**) impacted the right rear corner of the semitrailer (event 1) and continued southbound toward the Chevrolet. The Chevrolet's driver was unaware of this event and did not make any avoidance maneuvers. The front right of the Hyundai (**Figure 4**) impacted and underrode the back left of the Chevrolet (event 2, **Figure 5**). The impact caused the Hyundai's driver and front right passenger air bags to deploy. The Hyundai and Chevrolet rotated clockwise an unknown number of degrees and continued southbound. The front of the Chevrolet impacted one of the pedestrians (event 3) and impacted and underrode the back right of the Ford (event 4, **Figures 6 and 7**). The other pedestrian (the Chevrolet's former front



**Figure 2:** View south to the area of the crash



**Figure 3:** Hyundai's left side damage from the impact with the semitrailer



**Figure 4:** Hyundai's front damage from the impact with the back of the Chevrolet



right passenger) was listed as injured on the police crash report, but it is not known if he was impacted by the Chevrolet. The impact caused the Ford to rotate counterclockwise approximately 180 degrees and its left front door (**Figure 8**) impacted the left rear quarter panel of the Chevrolet (event 5). The Chevrolet came to final rest in the outside southbound lane heading in an unknown direction. The Chevrolet's Delta V was 52 km/h (32.3 mph) for the back impact and 26 km/h (16.1 mph) for the front impact. The Ford came to final rest in the center lane heading north. The final rest position of the Hyundai and the two pedestrians was not known. The tractor-semitrailer did not stop and was not identified.



**Figure 5:** Damage to back of Chevrolet from impact with the front of the Hyundai



**Figure 6:** Damage to the front of the Chevrolet from impact with the back of the Ford



**Figure 7:** Damage to back of the Ford from the impact with the front of the Chevrolet



**Figure 8** Damage to the Ford's left front door from impact with the Chevrolet's left quarter panel

**Post-Crash:** The Chevrolet's driver was reportedly unconscious following the crash. One of the pedestrians (the Chevrolet's former front right passenger) removed her and the three second row passengers from the vehicle. Police and emergency medical personnel responded to the scene and the driver and three passengers were transported by ambulance to a hospital. The Hyundai's driver, front right passenger, and the two pedestrians were also transported by ambulance to a hospital.

The 2001 Chevrolet Malibu was a front wheel drive, 4-door sedan (VIN: 1G1ND52J31M-----) equipped with a 3.1L, V6 engine, 4-speed automatic transmission, anti-lock brakes and traction control. The front row was equipped with redesigned frontal air bags, bucket seats with adjustable head restraints, and lap-and-shoulder seat belts with adjustable upper anchors. The second row was equipped with a bench seat, a lap belt in the center position, integral head restraints and lap-and-shoulder seat belts at the outboard positions. The vehicle was not equipped with Lower Anchors and Tethers for Children (LATCH). The vehicle’s specified wheelbase was 272 centimeters (107.1 inches). The vehicle’s mileage at the time of the inspection could not be determined because it was equipped with an electronic odometer.

CASE VEHICLE DAMAGE

**Exterior Damage:** The Chevrolet’s impact with the Hyundai involved the left portion of the back end. The back bumper, trunk lid, left quarter panel, left rear door, and left rear wheel were directly damaged. The direct damage began at the back left bumper corner and extended 54 centimeters (21.3 inches) along the back bumper. The crush measurements were taken at the back bumper bar, and the residual maximum crush was 148 centimeters (58.3 inches) occurring at C<sub>1</sub> (Figure 9). The table below shows the Chevrolet’s back crush profile.

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	2	54	148	63	148	109	94	66	44	5	-50	0
in		21.3	58.3	24.8	58.3	42.9	37.0	26.0	17.3	2.0	-19.7	0.0



Figure 9: Left side view of the crush to the back of the Chevrolet



Figure 10: Left side view of the Chevrolet’s above bumper crush



The left side wheelbase was shortened 82 centimeters (32.3 inches) while the right side wheelbase was extended 1 centimeter (0.4 inch). The induced damage involved the right quarter panel, left C-pillar, trunk lid, left front door, roof, and backlight glazing, which disintegrated as a result of the impact.

The Chevrolet's front impact with the back of the Ford involved the left portion of the front end. The front bumper, left headlamp/turn signal assembly, hood, left fender, and left front wheel were directly damaged. The direct damage began at the front left bumper corner and extended 31 centimeters (12.2 inches) along the bumper. Due to the Chevrolet's underride of the Ford, the crush measurements were taken at both the bumper level and the upper radiator support (**Figure 10**) and the results were averaged. The residual maximum above the bumper crush was measured as 46 centimeters (18.1 inches) and occurred at C<sub>2</sub>. The residual maximum crush at the bumper was 14 centimeters (5.5 inches) and occurred at C<sub>1</sub>. The induced damage from this impact involved the front bumper, right and left fenders, hood, and the windshield. The table below shows the final crush profile based on the crush averaging protocol; however, the maximum crush value reflects the crush above the bumper.

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	4	31	46	141	29	29	19	9	6	6	-55	0
in		12.2	18.1	55.5	11.4	11.4	7.5	3.5	2.4	2.4	-21.7	0.0

The Chevrolet's second impact with the F-100 probably involved the back left corner. However, due to the overlapping damage to this portion of the vehicle from the impact with the Hyundai, the direct damage could not be distinguished.

**Damage Classification:** The Collision Deformation Classifications (CDCs) for the Chevrolet were **06-BYEW-8 (180 degrees)** for the back impact with the Hyundai and **12-FLEE-2 (0 degrees)** for the front impact with the Ford. The CDCs for the Chevrolet's impact with the pedestrian and the Ford's left front door were **12-F9999-9 (0 degrees)** and **99-LB999-9**, respectively. They were partially unknown due to the overlapping damage. The WinSMASH reconstruction program, Damage Only Algorithm was used to reconstruct the Chevrolet's Delta V for the back and front impacts. The total Delta V for the back impact was, 52 km/h (32.3 mph), and the Longitudinal and Lateral components were 52 kmph (32.3 mph) and 0 kmph. The Total Delta V for the front impact was 26 km/h (16.2 mph), and the Longitudinal and Lateral components were -26.0 km/h (-16.2 mph) and 0 km/h. The Chevrolet was towed due to damage.

The manufacturer's recommended tire size was P215/60R15. The Chevrolet was equipped with tires of this size. The vehicle's tire data are shown in the table below.

Tire	Measured Pressure		Vehicle Manufacturer's Recommended Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	Flat	Flat	200	29	6	8	None	No	Yes
LR	Flat	Flat	200	29	7	9	None	Yes	Yes
RR	Flat	Flat	200	29	7	9	None	No	Yes
RF	207	30	200	29	6	8	None	No	No

**Vehicle Interior:** The driver's seat back was slightly rotated counterclockwise indicating the driver loaded the seat back during the back impact. There was no other evidence of occupant contact to any of the interior surfaces or components. The driver's seat belt retractor was jammed and the seat belt was in the retracted position. The second row seat had intruded longitudinally and vertically into the second row (Figure 11), and the dominate intrusion direction was longitudinal. The seat back and seat cushion intruded 52 centimeters (20.4 inches) and 41 centimeters (16.1 inches) respectively into the left occupant space, 46 centimeters (18.1 inches) and 35 centimeters (13.8 inches) into the center occupant space, and 20 centimeters (7.9 inches) and 18 centimeters (7.1 inches) into the right occupant space. There was no evidence of deformation to the steering wheel or compression of the energy absorbing steering column.



**Figure 11:** Displacement and intrusion of Chevrolet's second row seat

#### AUTOMATIC RESTRAINT SYSTEM

The Chevrolet's driver air bag was located in the steering wheel hub and the front right passenger's air bag was located on the top of the instrument panel. These air bags did not deploy during the crash.

**Second Row Left Child Safety Seat:** The Chevrolet's second row left passenger [18-month-old, female; 76 centimeters and 10 kilograms (30 inches, 22 pounds)] was seated in a forward-facing, convertible CSS (Figure 11). The CSS was designed for children over 1-year-old who weighed 9-18 kilograms (20-40 pounds) and were 74-102 centimeters (29-40 inches) tall. The CSS was manufactured by the Dorel Juvenile Group. There were no labels indicating model number or date of manufacture remaining on the CSS. A partial label on the front indicated the CSS was a Touriva model. The CSS was designed with a five-point harness and there were three sets of slots on the back of the CSS to thread the harness straps through. The harness straps were threaded through the top set of slots and a harness retainer clip was attached to the harness straps. The driver stated during the interview that the child was restrained by the harness and the harness clip was positioned at the child's armpit level. The vehicle's lap-and-shoulder belt was routed through the forward facing belt path at the time of the crash. The driver did not realize the retractor was switchable and didn't extend the belt webbing fully to activate the locking feature. She pulled the lap-and-shoulder belt tight to secure the CSS.

The CSS was constructed of a one piece plastic shell. A 2 centimeters (0.8 inch) thick foam pad was attached to the CSS seat back and a lightly padded cloth cover was fitted over the shell.

Inspection of the CSS revealed a dent and load marks in the shell at the front left corner (Figure 12). The damage was caused by the CSS loading into the left front seat back during the crash. There were also three small load marks on the inboard right side. There was no evidence of loading or damage to the remainder of the CSS and no evidence of loading to the harness.

**Second Row Center Child Safety Seat:** The Chevrolet's second row center passenger [1½-month old, male; 53 centimeters and 5 kilograms (21 inches and 10 pounds)] was seated in a rear-facing, infant seat (Figure 13). The CSS was designed for infants who weighed 2-10 kilograms (5-22 pounds) and were 74 centimeters (29 inches) tall or less. The CSS was an Evenflo Discovery and



Figure 11: Chevrolet's second row left CSS



Figure 12: Deformation of second row left CSS (arrow)

was manufactured on January 13, 2006, and its model number was 3911594-P1. This CSS was subject to a NHTSA recall, which involved Discovery CSSs manufactured between April 2005 and January 29, 2008. The affected model numbers were: 390, 391, 534, and 522. The CSSs were recalled by the manufacturer beginning February 1, 2008. The recall was initiated because side impact tests conducted at 62 km/h (38.5 mph) caused the CSS to separate from the base. The conditions of the test did not apply in this case because the CSS was not used with the base, and the vehicle did not sustain a severe side impact.

The CSS was designed with a three-point harness and a carrying handle. The harness strap was one-piece and was threaded through a sliding latch plate. There were two sets of slots in the seat back to thread the harness strap through, and the harness was threaded through the bottom set of slots. The child was restrained by the harness and the harness retainer clip was positioned at the child's armpit level. The CSS had a belt guide on each side and the second row center lap belt was routed through these guides. The driver pulled the lap belt tight to secure the CSS. The lap belt was equipped with a locking latch plate.

The CSS was constructed of a one piece plastic shell. The seat back was fitted with a 2 centimeters (0.8 inch) thick foam pad, and the shell was covered with a lightly padded cloth cover.

Inspection of the CSS revealed multiple load marks in the plastic on the inside of the shell (**Figure 14**). The most significant load marks were near the hubs of the carrier attachments. The load marks were probably caused by the flexing of the CSS as a result of the seat intrusion. There were also minor load marks at the right and left seat belt guides, as well as in random locations throughout the shell. There was no evidence of damage or loading on the harness webbing, buckles, and latch plate.

**Second Row Right Child Safety Seat:** The Chevrolet's second row right passenger [4-year-old, male; 106 centimeters and 16 kilograms (42 inches and 36 pounds)] was seated in a Dorel High



**Figure 13:** Chevrolet's second row center infant seat



**Figure 14:** Orange dots show load marks in plastic shell of second row center CSS



Back Booster CSS (**Figure 15**). The CSS was designed for children over 1-year-old who weighed 13-36 kilograms (28-80 pounds) and were 74-132 centimeters (29-52 inches) tall. The CSS was manufactured on February 16, 2005, and its model number was 22-208-WAL. The CSS was designed with a five-point harness and a tether. There were 2 sets of slots on the seat back to route the harness straps through, and they were routed through the top set of slots. The harness straps were also routed through a set of slots in the bottom of the CSS. A harness retainer clip was attached to the harness straps, which was positioned at the child's armpit level. The driver routed the vehicle's lap-and-shoulder belt through the forward facing belt path and pulled tightly to secure the CSS; however, she did not activate the retractor's locking feature before to securing the CSS.

The CSS was constructed of a one-piece, plastic shell with a lightly padded cloth cover. Inspection of the CSS revealed evidence of probable loading on the bottom of the seat (**Figure 16**). The remainder of the child seat was unremarkable.

#### EVENT DATA RECORDER

A copy of the Chevrolet's Event Data Recorder (EDR) file was obtained from the police. The EDR report indicated that a non-deployment event was recorded. The report also indicated that the driver's seat belt switch circuit status was recorded as buckled, multiple events were associated with the record, one or more of the events were not recorded, and the event recording was complete. The maximum recorded velocity change was -2.34 km/h (-1.46 mph). The EDR report is attached at the end of this report.

#### CASE VEHICLE DRIVER KINEMATICS

The Chevrolet's driver [22-year-old, female; 165 centimeters and 68 kilograms (65 inches, 150 pounds)] stated during the interview that she was seated in an upright posture leaning to the left with her back against the seat back. Her left foot was on the floor, right foot on the brake,



**Figure 15:** Chevrolet's second row right CSS as found by the SCI investigator



**Figure 16:** Orange dots show probable load marks in the plastic shell



right hand on the steering wheel, and her left arm was on the door armrest. Her seat track was located in the middle position and the seat back was slightly reclined.

Based on the driver interview and supported by the EDR data, the Chevrolet's driver was restrained by the lap-and-shoulder seat belt. The driver sustained an abrasion on her left shoulder and a contusion on her left chest consistent with usage of the seat belt.

The Hyundai's impact with the back of the Chevrolet displaced the driver rearward opposite the 180 degree direction of principal force and she loaded the seat back as the second row seat intruded into the seat back. She sustained fractures of three lumbar vertebrae from loading the seat back. The vehicle's impact with the back of the Ford displaced the driver forward opposite the 0 degree direction of principal force and she loaded the seat belt. She remained restrained in the seat throughout the crash.

### CASE VEHICLE DRIVER INJURIES

The driver sustained moderate injuries and was treated and released from a hospital. She was later treated by a chiropractor for neck and lower back pain. The table below shows the her injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
	Neck with muscle pain (i.e., can't raise right arm without help)	not coded	Noncontact injury: impact forces	Probable	Interviewee (same person)
1	Contusion {bruise}, 7.6 cm (3 in) over left breast	minor 490402.1,2	Torso portion of safety belt system	Certain	Emergency room records
2	Contusion {bruise} 10.2 cm (4 in) upper left back	minor 690402.1,7	Seat back, driver's {intruded <sup>1</sup> }	Certain	Interviewee (same person)
3 4 5	Fracture left transverse processes of L <sub>2</sub> , L <sub>3</sub> , and L <sub>4</sub> , with lower back pain from tail bone to buttocks, primarily on left side	moderate 650620.2,8 650620.2,8 650620.2,8	Seat back, driver's {intruded <sup>1</sup> }	Certain	Emergency room records
6	Abrasion {friction burn}, 10.2 to 12.7 cm (4-5 in), from top of left collarbone to just below collarbone	minor 790202.1,2	Torso portion of safety belt system	Certain	Interviewee (same person)
7	Contusions x 3 {bruises}, small, on posterior {back side} upper left arm	minor 790402.1,2	Seat back, driver's {intruded <sup>1</sup> }	Certain	Interviewee (same person)

<sup>1</sup> The vehicle's second row seat dynamically intruded in the back of the driver's seat.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
8	Laceration {cut}, 1.3 cm (0.5 in) over left elbow/lower triceps	minor 790602.1,2	Left side interior hardware and/or armrest	Possible	Interviewee (same person)
9	Laceration {cut}, 5.1 cm (2 in), jagged, posterior {back} right forearm	minor 790602.1,1	Noncontact injury: flying glass, back light	Probable	Interviewee (same person)
10	Contusion {bruise}, 7.6 cm (3 in) on back of upper right leg (thigh)	minor 890402.1,1	Seat cushion, driver's {intruded <sup>1</sup> }	Certain	Interviewee (same person)

#### CASE VEHICLE SECOND ROW LEFT PASSENGER KINEMATICS

The Chevrolet's second row left passenger was seated in an upright position restrained in the CSS. Her back was against the CSS seat back and her feet were dangling over the front edge of the CSS. The position of her hands and arms is not known. She was asleep at the time of the crash.

The Hyundai's impact with the back of the Chevrolet displaced the second row left passenger rearward opposite the 180 degree direction of principal force and she loaded the back of the CSS. The vehicle's front impact with the back of the Ford displaced the passenger forward opposite the 0 degree direction of principal force. There were no load marks on the CSS harness; however, based on occupant kinematics principles, the passenger loaded the harness. The passenger remained restrained in the CSS throughout the crash.

#### CASE VEHICLE SECOND ROW LEFT PASSENGER INJURIES

The second row left passenger was not injured. She was examined in a hospital emergency room and released. She was also examined by the family's doctor and no injuries were diagnosed.

#### CASE VEHICLE SECOND ROW CENTER PASSENGER KINEMATICS

The Chevrolet's second row center passenger was seated in a reclined position, restrained in a rear facing infant CSS. He was asleep at the time of the crash.

The Hyundai's impact with the back of the Chevrolet displaced the second row center passenger rearward opposite the 180 degree direction of principal force. There were no load marks on the CSS harness and no contact evidence was found on the vehicle's seat back; however, based on occupant kinematic principles, the passenger loaded the harness and his face probably contacted the intruded seat back. The contact with the seat back caused contusions on his forehead and nose. The vehicle's front impact with the back of the Ford displaced the passenger forward

opposite the 0 degree direction of principle force, and he loaded the CSS seat back. The passenger remained restrained in the CSS throughout the crash.

**CASE VEHICLE SECOND ROW CENTER PASSENGER INJURIES**

The second row center passenger sustained minor injuries. He was examined in a hospital emergency room and released. He was also examined by the family’s doctor and no additional injuries were reported. The table below shows the passenger’s injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Contusion {bruise}, 1.3 cm (0.5 in) on right corner of forehead	minor 290402.1,7	Seat back, second row {intruded}	Probable	Emergency room records
	Redness spot on left side of face {whole cheek}	Not coded	Seat back, second row {intruded}	Possible	Interviewee (driver)
2	Contusion {bruise} on bridge of nose	minor 290402.1,4	Seat back, second row {intruded}	Possible	Interviewee (driver)

**CASE VEHICLE SECOND ROW RIGHT PASSENGER KINEMATICS**

The Chevrolet’s second row right passenger was seated in an upright position, restrained in the CSS with his back against the CSS seat back. He was asleep at the time of the crash.

The Hyundai’s impact with the back of the Chevrolet displaced the second row right passenger rearward opposite the 180 degree direction of principal force, and he loaded the back of the CSS. The vehicle’s front impact with the back of the Ford displaced the passenger forward opposite to the vehicle’s 0 degree direction of principle force. There were no load marks on the CSS harness; however, based on occupant kinematic principles, the passenger loaded the harness. The passenger remained restrained in the CSS throughout the crash.

**CASE VEHICLE SECOND ROW RIGHT PASSENGER INJURIES**

The second row left passenger sustained no injuries. He was examined in a hospital emergency room and released. He was also examined by the family’s doctor and no injuries were diagnosed.

**1<sup>ST</sup> OTHER VEHICLE**

The 2007 Hyundai Tiburon GS was a front wheel drive, 2-door coupe (VIN: KMHHM66D07U-----). The Hyundai was equipped with driver and front right passenger frontal air bags and 4-wheel anti-lock brakes.

**Exterior Damage:** The Hyundai's impact with the tractor-semitrailer involved its left side (**Figure 17**). The vehicle's left front door and quarter panel were directly damaged. The direct damage began 5 centimeters (2 inches) forward of the left rear axle and extended 92 centimeters (36.2 inches) along the left quarter panel and door. The crush measurements were taken at the mid-door level and the residual maximum crush was 11 centimeters (4.3 inches) occurring at C<sub>3</sub>. The Hyundai's wheelbase was not changed as a result of this impact. Induced damage involved only the left front door and quarter panel. The table below shows the vehicle's left side crush profile.

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	92	11	104	0	5	11	8	2	0	-70	-66
in		36.2	4.3	40.9	0.0	2.0	4.3	3.2	0.8	0.0	-27.6	-26.0

The Hyundai's impact with the Chevrolet involved its front plane. The front bumper, bumper fascia, hood, grille, radiator, both turn signal and headlamp assemblies, the right fender and door were directly damaged. The direct damage began at the front right bumper corner and extended 63 centimeters (24.8 inches) across the front end. The crush measurements were taken on the metal bumper bar, and the residual maximum crush was 46 centimeters (18.1 inches) occurring 11 centimeters (4.3 inches) left of C<sub>5</sub>. The table below shows the vehicle's front crush profile.

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	2	63	46	111	0	8	21	35	42	35	21	0
in		24.8	18.1	43.7	0.0	3.2	8.3	13.8	16.5	13.8	8.3	0.0

The vehicle's left side wheelbase was extended 2 centimeters (0.8 inches) while the right side wheelbase was reduced 6 centimeters (1.2 inches). The induced damage involved the hood, left fender, windshield, right front door, and right A-pillar.

**Damage Classification:** The CDCs for the Hyundai were **09-LZEW-2 (280 degrees)** for the impact with the tractor-semitrailer and **12-FZEW-2 (0 degrees)** for the impact with the Chevrolet. The WinSMASH reconstruction program, Damage Only Algorithm was used to determine a Barrier Equivalent Speed (BES) for the Hyundai's left side impact with the tractor-semitrailer. The BES was 9 km/h (5.6 mph). The WinSMASH reconstruction program, Damage Only Algorithm was used to determine the Delta V for the Hyundai's front impact to the back of the Chevrolet. The Total Delta V was 48 km/h (29.8 mph), and the Longitudinal and Lateral components were -48 km/h (-29.8 mph), and 0 km/h. The Hyundai was towed from the crash scene due to damage.

The Hyundai's manufacturer recommended tire size was P205/55R16. The vehicle was equipped with P215/40R18 size tires. The vehicle's tire data are shown in the table below.

Tire	Measured Pressure		Vehicle Manufacturer's Recommended Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	317	46	207	30	6	8	None	No	No
LR	262	38	207	30	6	8	None	No	No
RR	234	34	207	30	7	9	None	No	No
RF	303	44	207	30	6	8	None	No	No

**Hyundai's Driver:** According to the police crash report, the Hyundai's driver (21-year-old, male) was not restrained by the lap-and-shoulder seat belt. The driver sustained C (possible) injuries and was transported by ambulance to the hospital.

**Hyundai's Front Right Passenger:** The front right passenger (26-year-old, male) was restrained by the lap-and-shoulder seat belt. He sustained C (possible) injuries and was transported by ambulance to the hospital.

## 2<sup>ND</sup> OTHER VEHICLE

This vehicle was an unidentified tractor-semitrailer, which did not stop following the crash.

## 3<sup>RD</sup> OTHER VEHICLE

The 1983 Ford F-100 XLT was a rear wheel drive, 2-door pickup truck (VIN: 1FTCF10F6DP-----) equipped with a 5.0L, V-8 engine and a 3-speed automatic transmission.

**Exterior Damage:** The Ford's impact with the front of the Chevrolet involved its back end. The back bumper, tailgate, and right side of the truck bed were directly damaged. The direct damage began at the back right bumper corner and extended 54 centimeters (21.3 inches) to the left along the bumper. The crush measurements were taken at the back bumper and residual maximum crush was 39 centimeters (15.4 inches) at C<sub>6</sub>. The table below shows the Ford's back crush profile.



Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	4	54	39	172	0	1	7	12	22	39	61	0
in		21.3	15.4	67.7	0.0	0.4	2.8	4.7	8.7	15.4	24.0	0.0

The right side wheelbase was shortened 3 centimeters (1.2 inches) and the left wheelbase was extended 1 centimeter (0.4 inch). Induced damage included the back bumper, tailgate, and right side of the truck bed.

The Ford's left side impact with the Chevrolet involved its left front door. The direct damage began 158 centimeters (62.2 inches) forward of the left rear axle and extended 60 centimeters (23.6 inches) forward along the door. The crush measurements were taken at the mid-door level, and the residual maximum crush was 9 centimeters (3.5 inches) occurring at C<sub>3</sub>. The table below shows the Ford's left side crush profile.

Units	Event	Direct Damage		Field L	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	5	60	9	110	0	7	9	4	2	0	21	46
in		23.6	3.5	43.3	0.0	2.8	3.5	1.6	0.8	0.0	8.3	18.1

**Damage Classification:** The CDCs for the Ford were **06-BREW-2 (180 degrees)** for the impact with the front of the Chevrolet and **09-LPEW-2 (280 degrees)** for the impact with the Chevrolet's left quarter panel. The WinSMASH reconstruction program, Damage Only Algorithm was used to reconstruct the Ford's Delta V for its back impact (i.e., most severe). The Total Delta V was 21 km/h (13.0 mph), and the Longitudinal and Lateral components were 21 km/h (13.0 mph) and 0 km/h. The WinSMASH reconstruction program, Missing Vehicle Algorithm was used to reconstruct the Ford's Delta V for the impact with Chevrolet's left quarter panel. The Total Delta V was 5 km/h (3.1 mph), and the Longitudinal and Lateral components were -0.9 km/h (-0.6 mph), and 4.9 km/h (3 mph). The Ford was towed from the crash scene due to damage.

The manufacturer's recommended tire size was P215/75R15. The Ford was equipped with tires of this size and the vehicle's tire data are shown in the table below.

Tire	Measured Pressure		Vehicle Manufacturer's Recommended Pressure		Tread Depth		Damage	Restricted	Deflated
	kPa	psi	kPa	psi	milli-meters	32 <sup>nd</sup> of an inch			
LF	269	39	241	35	8	10	None	No	No
LR	262	38	241	35	7	9	None	No	No
RR	310	45	241	35	8	10	None	No	No
RF	276	40	241	35	8	10	None	No	No

**Ford's Driver:** According to the police crash report, the Ford's driver (37-year-old, female) was restrained by lap-and-shoulder seat belt. The driver sustained C (possible) injuries, but there was no mention of transport or medical treatment on the police crash report.

#### PEDESTRIANS

The pedestrian who had been the front right passenger in the Chevrolet Malibu (22-year-old, male) sustained B (non-incapacitating) injuries and was transported by ambulance to the hospital. The other pedestrian who was the front right passenger of the Ford (15-year-old, male) sustained A (incapacitating) injuries and was transported by ambulance to the hospital. According to a news report, he sustained a leg injury (unknown which leg) and lost the leg.

