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ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN99-114
LOCATION - IOWA
VEHICLE - 1999 PONTIAC MONTANA
CRASH DATE - December, 1999

Submitted:

March 7, 2003

Contract Number: DTNH22-94-D-17058

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National Highway Traffic Safety Administration
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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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15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1999 Pontiac Montana, four-door APV, with manual safety belts and dual front and front side air bags, and a 1990 Honda Civic LX, four-door sedan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1999 Pontiac Montana APV (case vehicle) and a 1990 Honda Civic LX (other vehicle). This crash is of special interest because the case vehicle was equipped with side impact air bags and the case vehicle's driver (37-year-old female), who was eight months pregnant, sustained only minor injuries in a crash in which there was significant intrusion into her seating position. The case vehicle had been traveling east in the eastbound lane of a two-lane, undivided, city roadway and had stopped at a partially-controlled, four-leg intersection prior to entering the intersection. The Honda was traveling south in the southbound lane of a two-lane, undivided, city roadway and entered the same, four-leg intersection. The crash occurred in the southwest quadrant of the four-leg intersection of the two roadways. The left side of the case vehicle was impacted by the front of the Honda, causing the case vehicle's driver, seat back-mounted, side impact air bag to deploy. The case vehicle's dual front air bags did not deploy. The case vehicle was redirected in a southeasterly direction and came to rest on the south leg of the intersection, heading southeast. The Honda rotated counterclockwise and came to rest in the intersection. The case vehicle's driver was seated with her seat track located between its middle and rearmost positions, and the tilt steering wheel was located between its middle and down-most positions. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview and her medical records, minor medically-reported injuries which included: a muscle contusion to her left hip area with nerve root damage, and a sprain and contusion to her left ankle. The second seat left passenger (2-year-old female) was seated in a forward facing child safety seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system. The second seat right passenger (3-year-old female) was also seated and was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The second seat's seat track was not adjustable. The back center passenger (4-year-old female) was seated with her seat track located in its rearmost position. The back center passenger was restrained by her available, active, two-point, lap belt. All three child passengers were transported by ambulance to the hospital for a precautionary examination and, according to the case vehicle's driver and their medical records, they did not sustain any injuries as a result of this crash.

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This on-site investigation was brought to NHTSA's attention on December 28, 1999 by the husband of the case vehicle's driver. This crash involved a 1999 Pontiac Montana APV (case vehicle) and a 1990 Honda Civic LX (other vehicle). The crash occurred in December, 1999, at 11:41 a.m., in Iowa and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with side impact air bags and the case vehicle's driver [37-year-old, White (non-Hispanic) female], who was eight months pregnant, sustained only minor injuries in a crash in which there was significant intrusion into her seating position. This contractor inspected the vehicles on 4-5 January, 2000. This contractor interviewed the driver for the case vehicle on January 6, 2000. This report is based on the Police Crash Report, interviews with both vehicle drivers and the investigating police officer, vehicle inspections[1], occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle had been traveling east in the eastbound lane of a two-lane, undivided, city roadway and had stopped as it approached a partially-controlled, four-leg intersection (i.e., there was a regulatory STOP sign for only the east and westbound traffic). The case vehicle entered into the intersection, intending to continue traveling east. The Honda was traveling south, down a grade (unknown percent), in the southbound lane of a two-lane, undivided, city roadway and was approaching the same, four-leg intersection, intending to continue traveling southward through the intersection. The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred in the southwest quadrant of the four-leg intersection of the two roadways; see **CRASH DIAGRAM** below.

The left side of the case vehicle was impacted by the front of the Honda, causing the case vehicle's driver, seat back-mounted, side impact air bag to deploy. The case vehicle's dual front air bags did not deploy. The case vehicle was redirected in a southeasterly direction and came to rest on the south leg of the intersection with its front left tire against the eastern curb, heading southeast. Presumably, the Honda rotated counterclockwise off the case vehicle and came to rest in the intersection, but the Honda's exact heading is unknown.

The 1999 Pontiac Montana APV was a front wheel drive, extended, four-door minivan (VIN: 1GMDX03E1XD------). The case vehicle was equipped with four-wheel, anti-lock brakes. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **09-LYEW-3 (280)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23.5 km.p.h. (14.6 m.p.h.), -4.1 km.p.h. (-2.6 m.p.h.), and + 23.2 km.p.h. (+ 14.4 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's contact with the Honda involved the left side and extended from the front axle rearwards to the rear axle. Direct damage began 120 centimeters (47.2 inches) forward of

[1] The crash site was not inspected by this contractor because location of the crash was on the opposite side of the state from where the case vehicle was located and would have required an additional two man-days of investigative effort.

the left rear axle (i.e., just behind the left "B"-pillar) and extended, a measured distance of 153 centimeters (60.2 inches), along the left side to just behind the left front axle. Residual maximum crush was measured as 39 centimeters (15.4 inches) at C_4. The wheelbase on the case vehicle's left side was shortened 13 centimeters (5.1 inches) while the right side was extended approximately 2 centimeters (0.8 inches). The case vehicle's damage was concentrated at the sill area and extended upwards from the ground approximately 65 centimeters (25.6 inches). The case vehicle's left fender, left front door, and left rear sliding door were directly damaged and crushed inward. The left front door was torn off its hinge. The case vehicle's left front tire was deflated. The case vehicle's hood, left fender, left quarter panel, and left "A" and "B"-pillars sustained induced damage. The left front window glazing was disintegrated, and there was remote buckling to the right quarter panel.

The case vehicle's driver, side impact air bag was mounted in the outside portion of the driver's seat back. An inspection of the air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The driver's side air bag was designed without any tethers. The driver's side air bag had one vent port approximately 5 centimeters (2.0 inches) in diameter, located on the exterior surface of the air bag's fabric beginning 8 centimeters (3.1 inches) forward of the cover flap and 2 centimeters (0.8 inches) down from the top seam. The deployed driver's side impact air bag was rectangular with a height of approximately 26 centimeters (10.2 inches) and extended outward from the seat back a distance of approximately 42 centimeters (16.5 inches). There was no contact evidence readily apparent on the interior surface of the driver's, seat back-mounted, side impact air bag.

The case vehicle's driver and front right passenger supplemental restraints (air bags) did not deploy as a result of the case vehicle's left side impact. The driver air bag was located in the steering wheel hub. The front right passenger air bag was located in the top of the instrument panel. In addition, the front right passenger's seat back-mounted, side impact air bag also did not deploy.

Inspection of the case vehicle's interior revealed that there was no other apparent evidence of occupant contact on the interior surfaces of the case vehicle. The impact resulted in significant lateral intrusion to the driver and second seat left seating areas. Specifically, there was greater than 30 centimeters (11.8 inches) of intrusion to the left "B"-pillar, left side panel forward of the left "A"-pillar, and to the left front and left rear door sills [maximum intrusion was 41 centimeters (16.1 inches) to left rear door sill]. Between 15 and 30 centimeters (5.9 to 11.8 inches) of lateral intrusion occurred to the left front and left rear door panels and to the driver's seat back and seat cushion. The driver's seat and the second seat left were both deformed by intrusion. Furthermore, the driver's seat was rotated counterclockwise, but no assessment was made of the seat's frame. In addition, there was vertical intrusion [less than 30 centimeters (11.8 inches)] to the case vehicle's floor pan. Finally, there was no evidence of compression of the energy absorbing shear capsules in the base of the steering column and no deformation to the steering wheel rim.

The 1990 Honda Civic LX was a front wheel drive, four-door sedan (VIN: 1HGED3652LA------). Based on the vehicle inspection, the CDC for the Honda was determined to be: **12-FDEW-1 (10)** [maximum crush was 19 centimeters (7.5 inches)]. The Honda was towed due to damage.

Immediately prior to the crash the case vehicle's driver [170 centimeters and 88 kilograms (67 inches, 195 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the accelerator, and both hands on the steering wheel. Her seat track was located between its middle and rearmost positions, the seat back was upright, and the tilt steering wheel was located between its middle and down-most positions.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. In addition, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed trace evidence of loading (i.e., stretching to the webbing and a heat transfer on the "D"-ring).

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's driver to move leftward and slightly forward toward the case vehicle's **280** degree Direction of Principal Force as the case vehicle decelerated. As a result, the case vehicle's driver loaded her deploying, seat back-mounted, side impact air bag, and the side air bag protected her upper torso. Post-crash, the case vehicle was redirected southeastward. The case vehicle's redirection in conjunction with the intrusion into the driver's seating area caused the driver to rebound rightward and forward. The driver loaded her safety belts, and her belts helped keep her in her seat. According to the case vehicle's driver, at final rest she was seated, leaning towards the right half of her seat because of the intrusion at the sill level.

The impact from the Honda was primarily to the case vehicle's left sill, well below the driver's center of gravity and, as a result, lessened the shock to the driver's chest and abdominal areas. The seat back-mounted, side impact air bag helped to further protect the driver's chest and abdomen.

The driver was transported by ambulance to the hospital. She sustained minor medically-reported injuries but was hospitalized for nine days post-crash. According to her interview and her medical records, the injuries sustained by the case vehicle's driver included: a muscle contusion to her left hip area with nerve root damage, and a sprain and contusion to her left ankle. As previously mentioned, the case vehicle's driver was 8 months pregnant. Subsequent to the crash, she delivered a healthy baby girl.

According to the case vehicle's driver, the second seat left passenger [2-year-old, White (non-Hispanic) female; 97 centimeters and 14 kilograms (38 inches, 30 pounds)] was seated in a forward facing child safety seat in an upright posture with her back against the seat back, both feet dangling over the front edge of the child seat angled downward, and both hands on her lap. The second seat's seat track was not adjustable, and the seat back was upright.

This contractor's investigation indicates that the case vehicle's second seat left passenger was restrained in a forward facing child safety seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system. According to the husband of the case vehicle's driver, the forward facing child safety seat was a convertible seat manufactured by Cosco (on May 16, 1996), and the model number was: **02094GCK**. This contractor was not able to inspect the child safety seat because the seat had been removed prior to this contractor's inspection.

The second seat left passenger was transported by ambulance to the hospital for a precautionary examination. According to the case vehicle's driver (i.e., Mother) and her medical records, she did not sustain any injuries as a result of this crash, despite the intrusion into her seating position.

According to the case vehicle's driver, the second seat right passenger [3-year-old, White (non-Hispanic) female; 99 centimeters and 14 kilograms (39 inches, 30 pounds)] was seated in an upright posture with her back against the seat back, her feet dangling over the front edge of the seat's cushion, and both hands on her lap. Likewise, her seat track was not adjustable, and her seat back was upright.

According to the case vehicle's driver and her medical records, the second seat right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; although, the exact location of how she had the torso portion of her safety belt, in relation to her body, is unknown. However, the inspection of the second seat right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of usage during this crash.

The second seat right passenger was transported by ambulance to the hospital for a precautionary examination. According to the case vehicle's driver and her medical records, this occupant (i.e., a girlfriend of the driver's children) did not sustain any injuries as a result of this crash.

According to the case vehicle's driver, the back center passenger [4-year-old, White (non-Hispanic) female; 112 centimeters and 17 kilograms (44 inches, 37 pounds)] was seated in an upright posture with her back against the seat back, both feet hanging down over the front edge of the seat's cushion angled downward, and both hands on her lap. Her seat track was located in its rearmost position, and the seat back was upright.

This contractor's investigation indicates that the case vehicle's back center passenger was restrained by her available, active, two-point, lap belt. The inspection of the back center passenger's seat belt webbing and latch plate showed trace evidence of usage during this crash.

The back center passenger was transported by ambulance to the hospital for a precautionary examination. Once again, according to the case vehicle's driver (i.e., Mother) and her medical records, she did not sustain any injuries as a result of this crash.

The case vehicle had been traveling east in the eastbound lane of a two-lane, undivided, city roadway and had stopped as it approached a partially-controlled, four-leg intersection (i.e., there was a regulatory STOP sign for only the east and westbound traffic). The case vehicle entered into the intersection, intending to continue traveling east. The Honda was traveling south, down a grade (unknown percent), in the southbound lane of a two-lane, undivided, city roadway and was approaching the same, four-leg intersection, intending to continue traveling southward through the intersection. The case vehicle's driver made no avoidance maneuvers prior to the crash. The crash occurred in the southwest quadrant of the four-leg intersection of the two roadways; see **CRASH DIAGRAM** below.

Based on the Police Crash Report and the interview with the case vehicle's driver, the case vehicle's city roadway was straight and level at the area of impact. The pavement was bituminous, but the width of the travel lanes are unknown. The other vehicle's city roadway was straight and had an unknown percent grade negative to the south (i.e., a downgrade in the Honda's direction of travel) at the area of impact. The pavement was bituminous, but the width of the travel lanes are unknown. It is unknown if either of these roadways were bordered by curbs or had pavement markings or edge lines present. There is no estimated coefficient of friction for either roadway. As indicated above, the east and west legs of the four-leg intersection were controlled by regulatory STOP signs. The speed limits for each of the roadways are unknown. At the time of the crash the light condition was daylight, the atmospheric condition was raining, and the road pavement was wet. Traffic density was light, and the site of the crash was a combination of urban residential and commercial.

Figure 1: Case vehicle's left side deformation viewed from left of back (case photo #03)

Figure 2: Case vehicle's left side deformation; Note: green lines indicates width of direct damage (case photo #02)

Figure 3: Overhead view of case vehicle's left side deformation showing crush relative to string line (case photo #06)

The left side of the case vehicle (**Figures 1**, **2** and **3**) was impacted by the front of the Honda (**Figure 4** below), causing the case vehicle's driver, seat back-mounted, side impact air bag to deploy. The case vehicle's dual front air bags did not deploy. The case vehicle was redirected in a southeasterly direction and came to rest on the south leg of the intersection with its front left tire

against the eastern curb, heading southeast. Presumably, the Honda rotated counterclockwise off the case vehicle and came to rest in the intersection, but the Honda's exact heading is unknown.

Figure 4: Honda's frontal damage viewed at eye level with contour gauge placed at bumper level (case photo #40)

CASE VEHICLE

The 1999 Pontiac Montana APV was a front wheel drive, seven-passenger, four-door minivan (VIN: 1GMDX03E1XD------) equipped with a 3.4L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 305 centimeters (120.0 inches), and the odometer reading at inspection was 8,352 kilometers (5,190 miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with integral head restraints; non-adjustable second seating area bucket seats with integral head restraints, an adjustable back bench seat with separate back cushions and integral head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front, second seating area, and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front right passenger had their upper anchorage adjusters located in the down-most positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed from occupant contact. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. In addition, the vehicle was equipped with front, seat back-mounted, side impact air bags. Neither frontal air bag deployed as a result of the case vehicle's left side impact with the Honda. On the other hand, the driver's seat back-mounted side air bag did deploy as a result of the case vehicle's left side impact with the Honda.

CASE VEHICLE DAMAGE

The case vehicle's contact with the Honda involved the left side and extended from the front axle rearwards to the rear axle (**Figure 5** and **Figure 6** below). Direct damage began 120 centimeters (47.2 inches) forward of the left rear axle (i.e., just behind the left "B"-pillar) and extended, a measured distance of 153 centimeters (60.2 inches), along the left side to just behind the left front axle (**Figure 2** above). Residual maximum crush was measured as 39 centimeters

Figure 5: Deformation to case vehicle's left side, viewed from left of front, as a result of impact by front of Honda (case photo #01)

(15.4 inches) at C_4. The wheelbase on the case vehicle's left side was shortened 13 centimeters (5.1 inches) while the right side was extended approximately 2 centimeters (0.8 inches). The case vehicle's damage was concentrated at the sill area and extended upwards from the ground approximately 65 centimeters (25.6 inches). The case vehicle's left fender, left front door, and left rear sliding door were directly damaged and crushed inward. The left front door was torn off its hinge. The case vehicle's left front tire was deflated. The case vehicle's hood, left fender, left quarter panel, and left "A" and "B"-pillars sustained induced damage. The left front window glazing was disintegrated, and there was remote buckling to the right quarter panel.

Figure 6: Vertical elevated view along case vehicle's damaged left side showing stringline placement (case photo #12)

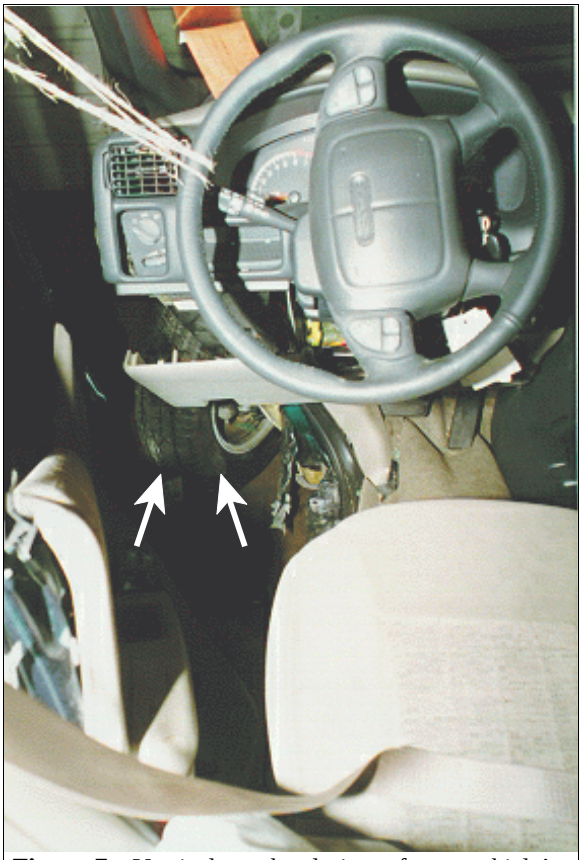

Figure 7: Vertical overhead view of case vehicle's driver seating area from in front of second seat left showing sill intrusion into driver's seating area and displacement of driver's seat toward vehicle's center; Note: arrows mark outline of left front tire (case photo #23)

Inspection of the case vehicle's interior revealed that there was no other apparent evidence of occupant contact on the interior surfaces of the case vehicle. The impact resulted in significant lateral intrusion to the driver and second seat left seating areas (**Figure 6**). Specifically, there was greater than 30 centimeters (11.8 inches) of intrusion to the left "B"-pillar, left side panel forward of the left "A"-pillar, and to the left front and left rear door sills [maximum intrusion was 41 centimeters (16.1 inches) to left rear door sill]. Between 15 and 30 centimeters (5.9 to 11.8 inches) of lateral intrusion occurred to the left front and left rear door panels and to the driver's seat back and seat cushion (**Figure 7**). The driver's seat and the second seat left were both deformed by intrusion. Furthermore, the driver's seat was rotated counterclockwise, but no

assessment was made of the seat's frame. In addition, there was vertical intrusion [less than 30 centimeters (11.8 inches)] to the case vehicle's floor pan. Finally, there was no evidence of compression of the energy absorbing shear capsules in the base of the steering column and no deformation to the steering wheel rim.

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **09-LYEW-3 (280)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23.5 km.p.h. (14.6 m.p.h.), -4.1 km.p.h. (-2.6 m.p.h.), and + 23.2 km.p.h. (+ 14.4 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. In addition, the vehicle was equipped with front, seat back-mounted, side impact air bags. Neither frontal air bag deployed as a result of the left side impact with the Honda while the driver's seat back-mounted side air bag did deploy as a result of the same impact.

Figure 8: Case vehicle's front seating area showing driver's deployed side impact air bag and non-deployed frontal air bags (case photo #19)

Figure 9: Exterior surface of case vehicle's deployed, driver, seat back-mounted, side impact air bag; Note: vent port was located near top back of air bag's fabric (case photo #37)

The case vehicle's driver, side impact air bag was mounted in the outside portion of the driver's seat back (**Figure 8**). An inspection of the air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The driver's side air bag was designed without any tethers. The driver's side air bag had one vent port approximately 5 centimeters (2.0 inches) in diameter, located on the exterior surface of the air bag's fabric, beginning 8 centimeters (3.1 inches) forward of the cover flap and 2 centimeters (0.8 inches) down from the top seam (**Figure 9**). The deployed driver's side impact air bag was rectangular with a height of approximately 26 centimeters (10.2 inches), and it extended outward from the seat back a distance of approximately 42 centimeters (16.5 inches). There was no contact evidence readily

apparent on the interior surface of the driver's, seat back-mounted, side impact air bag (**Figure 10**).

Figure 10: Interior side of case vehicle's deployed, driver, seat back-mounted, side impact air bag showing no apparent evidence of contact (case photo #36)

The case vehicle's driver and front right passenger supplemental restraints (air bags) did not deploy as a result of the case vehicle's left side impact (**Figure 8** above). The driver air bag was located in the steering wheel hub. The front right passenger air bag was located in the top of the instrument panel. In addition, the front right passenger's seat back-mounted, side impact air bag also did not deploy.

CHILD SAFETY SEAT

This contractor's investigation indicates that the case vehicle's second seat left passenger was restrained in a forward facing child safety seat. According to the husband of the case vehicle's driver, the forward facing child safety seat was a convertible seat manufactured by Cosco (on May 16, 1996), and the model number was: **02094GCK**. This contractor was not able to inspect the child safety seat because the seat had been removed prior to this contractor's inspection.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [170 centimeters and 88 kilograms (67 inches, 195 pounds)] was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the accelerator, and both hands on the steering wheel. Her seat track was located between its middle and rearmost positions, the seat back was upright, and the tilt steering wheel was located between its middle and down-most positions.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. In addition, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed trace evidence of loading (i.e., stretching to the webbing and a heat transfer on the "D"-ring).

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of her available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's driver to move leftward and slightly forward toward the case vehicle's **280** degree Direction of Principal Force as the case vehicle decelerated. As a result, the case vehicle's driver loaded her deploying, seat back-mounted, side impact air bag, and the side air bag protected her upper torso. Post-crash, the case vehicle was redirected southeastward. The case vehicle's redirection in conjunction with the intrusion into the driver's seating area caused the driver to rebound rightward and forward. The driver loaded her safety belts, and her belts helped keep her in her seat. According to the

case vehicle's driver, at final rest she was seated, leaning towards the right half of her seat because of the intrusion at the sill level (**Figure 7** above).

The impact from the Honda was primarily to the case vehicle's left sill, well below the driver's center of gravity and, as a result, lessened the shock to the driver's chest and abdominal areas. The seat back-mounted, side impact air bag helped to further protect the driver's chest and abdomen.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained minor medically-reported injuries but was hospitalized for nine days post-crash. According to her interview and her medical records, the injuries sustained by the case vehicle's driver included: a muscle contusion to her left hip area with nerve root damage, and a sprain and contusion to her left ankle. As previously mentioned, the case vehicle's driver was 8 months pregnant. Subsequent to the crash, she delivered a healthy baby girl.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion, severe[2], left buttock (gluteal muscle) without obvious bruising or ecchymosis on skin	840602.1 minor	Left side hardware or armrest	Certain	Hospitalization records
2	Sprain left ankle	850206.1 minor	Other: side panel forward of the "A"-pillar	Certain	Hospitalization records
3	Contusion left ankle, not further specified[3]	890402.1 minor	Other: side panel forward of the "A"-pillar	Certain	Hospitalization records

[2] This patient was hospitalized in part because of her left hip area injury but primarily because she was over 36 weeks pregnant (gravida 4, para 3). However, when she was discharged 9 days post-crash, she was only able to ambulate using a walker, despite the finding of no skeletal abnormalities.

[3] The physician who made this diagnosis never indicated whether the contusion was to the joint or the skin. Other physicians never indicated the presence of any bruising or ecchymosis at the site of the patient's complaint of pain which was actually the left distal fibula. The diagnosing physician did indicate that there was no bony abnormality which makes this contractor suspect that a joint contusion was what the physician had in mind, but following the NASS CDS injury coding conventions, an integumentary injury is encoded.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
4	Damage nerve root or sacral plexus[4], not further specified	630699.2 moderate	Left side hardware or armrest	Possible	Interviewee (same person)

CASE VEHICLE SECOND SEAT LEFT PASSENGER KINEMATICS

According to the case vehicle's driver, the second seat left passenger [2-year-old, White (non-Hispanic) female; 97 centimeters and 14 kilograms (38 inches, 30 pounds)] was seated in a forward facing child safety seat in an upright posture with her back against the seat back, both feet dangling over the front edge of the child seat angled downward, and both hands on her lap. The second seat's seat track was not adjustable, and the seat back was upright.

This contractor's investigation indicates that the case vehicle's second seat left passenger was restrained in a forward facing child safety seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the second seat left passenger's seat belt webbing, "D"-ring, and latch plate showed trace evidence of usage during this crash.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use by the second seat left passenger of a child safety seat and available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's the second seat left passenger to move leftward and slightly forward toward the case vehicle's **280** degree Direction of Principal Force as the case vehicle decelerated. As a result, the case vehicle's second seat left passenger loaded her child seat's restraints and the left side shell of her child seat,

Figure 11: Vertical view from back left seat showing displacement of driver's seat inward and intrusion into left second seating area from left door panel and left "B"-pillar (case photo #32)

[4] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
plexus (plek′sus) pl plexus or plexuses: a network or tangle; a general term for a network of lymphatic vessels, nerves, or veins.
sacral p., p. sacra′lis: sacral plexus: a plexus arising from the ventral branches of the last two lumbar nerves (which form the lumbosacral trunk) and the first four sacral nerves. The plexus, which lies in front of the piriformis, has twelve named branches; five supply pelvic structures (the nerves to the piriformis, to levator ani and coccygeus, and to sphincter ani muscles, the pelvic splanchnic nerves and the pudendal nerve); seven help to supply the buttock and lower limb (superior and inferior gluteal, posterior femoral cutaneous, perforating cutaneous, and sciatic nerves, and nerves to the quadratus femoris and obturator internus muscles).

which limited her leftward movement and most likely prevented the child from possible injury by the intruding left "B"-pillar and side interior surface[5] (**Figure 11** below). Post-crash, the case vehicle was redirected southeastward. The case vehicle's redirection in conjunction with the intrusion into this occupant's seating area caused the second seat left passenger to rebound rightward and forward. Once again, the second seat left passenger loaded her child seat restraints and the vehicle's safety belts, which helped keep her in her child seat. The case vehicle's driver was unaware of this child's final rest position, but based on her lack of injuries, she was most likely near her original pre-crash position in the chid seat.

CASE VEHICLE SECOND SEAT LEFT PASSENGER INJURIES

The second seat left passenger was transported by ambulance to the hospital for a precautionary examination. According to the case vehicle's driver (i.e., Mother) and her medical records, she did not sustain any injuries as a result of this crash, despite the intrusion into her seating position (**Figure 11** above).

CASE VEHICLE SECOND SEAT RIGHT PASSENGER KINEMATICS

According to the case vehicle's driver, the second seat right passenger [3-year-old, White (non-Hispanic) female; 99 centimeters and 14 kilograms (39 inches, 30 pounds)] was seated in an upright posture with her back against the seat back, her feet dangling over the front edge of the seat's cushion, and both hands on her lap. Likewise, her seat track was not adjustable, and her seat back was upright.

According to the case vehicle's driver and her medical records, the second seat right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; although, the exact location of how she had the torso portion of her safety belt, in relation to her body, is unknown. However, the inspection of the second seat right passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of usage during this crash.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of the second seat right passenger's available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's the second seat right passenger to move leftward and slightly forward toward the case vehicle's **280** degree Direction of Principal Force as the case vehicle decelerated. As a result, the case vehicle's second seat right passenger loaded her safety belts, which helped keep her from impacting the back of the driver's seat back. Post-crash, the case vehicle was redirected southeastward. The case vehicle's redirection caused the second seat right passenger to rebound rightward and forward. She re-loaded her safety belts, and her belts helped keep her in her seat. The case vehicle's driver was unaware of this child's final rest position, but based on her lack of injuries, she was most likely near her original pre-crash position.

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[5] In Figure 11 (above) the left armrest for the left second seating position is shown. It is unknown if this armrest was positioned as shown (i.e., up or down) at the time of the crash. In addition, there was no evidence of contact to either side of the depicted armrest.

The second seat right passenger was transported by ambulance to the hospital for a precautionary examination. According to the case vehicle's driver and her medical records, this occupant (i.e., a girlfriend of the driver's children) did not sustain any injuries as a result of this crash.

CASE VEHICLE BACK CENTER PASSENGER KINEMATICS

According to the case vehicle's driver, the back center passenger [4-year-old, White (non-Hispanic) female; 112 centimeters and 17 kilograms (44 inches, 37 pounds)] was seated in an upright posture with her back against the seat back, both feet hanging down over the front edge of the seat's cushion angled downward, and both hands on her lap. Her seat track was located in its rearmost position, and the seat back was upright.

This contractor's investigation indicates that the case vehicle's back center passenger was restrained by her available, active, two-point, lap belt. The inspection of the back center passenger's seat belt webbing and latch plate showed trace evidence of usage during this crash.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of the back center passenger's available safety belts, her pre-impact body position did not change just prior to impact. The case vehicle's impact with the Honda enabled the case vehicle's the back center passenger to move leftward and slightly forward toward the case vehicle's **280** degree Direction of Principal Force as the case vehicle decelerated. As a result, the case vehicle's back center jackknifed forward over her belt her lap belt while loading it. The lap belt kept her from impacting the back of the second seat passenger's seat back. Post-crash, the case vehicle was redirected southeastward. The case vehicle's redirection caused the back center passenger to rebound rightward and forward. She re-loaded her safety belts, and her belts helped keep her in her seat. The case vehicle's driver was unaware of this child's final rest position, but based on her lack of injuries, she was most likely near her original pre-crash position.

CASE VEHICLE BACK CENTER PASSENGER INJURIES

The back center passenger was transported by ambulance to the hospital for a precautionary examination. Once again, according to the case vehicle's driver (i.e., Mother) and her medical records, she did not sustain any injuries as a result of this crash.

Figure 12: Honda's frontal damage from impact with case vehicle's left side–viewed from left of front (case photo #44)

OTHER VEHICLE

The 1990 Honda Civic LX was a front wheel drive, five-passenger, four-door sedan (VIN: 1HGED3652LA------) equipped with a 1.5L, I-4 engine and a four-speed automatic

transmission. The case vehicle's wheelbase was 250 centimeters (98.4 inches), and the odometer reading is unknown because the interior of the Honda was not inspected.

Based on the vehicle inspection (**Figure 12** above and **Figure 13**), the CDC for the Honda was determined to be: **12-FDEW-1 (10)** [maximum crush was 19 centimeters (7.5 inches)]. The Honda was towed due to damage.

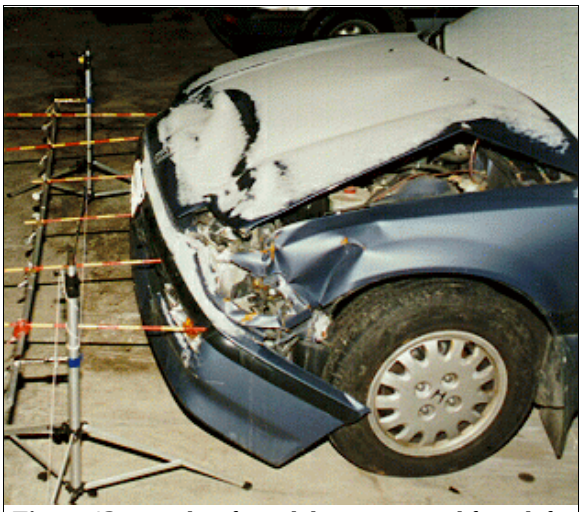
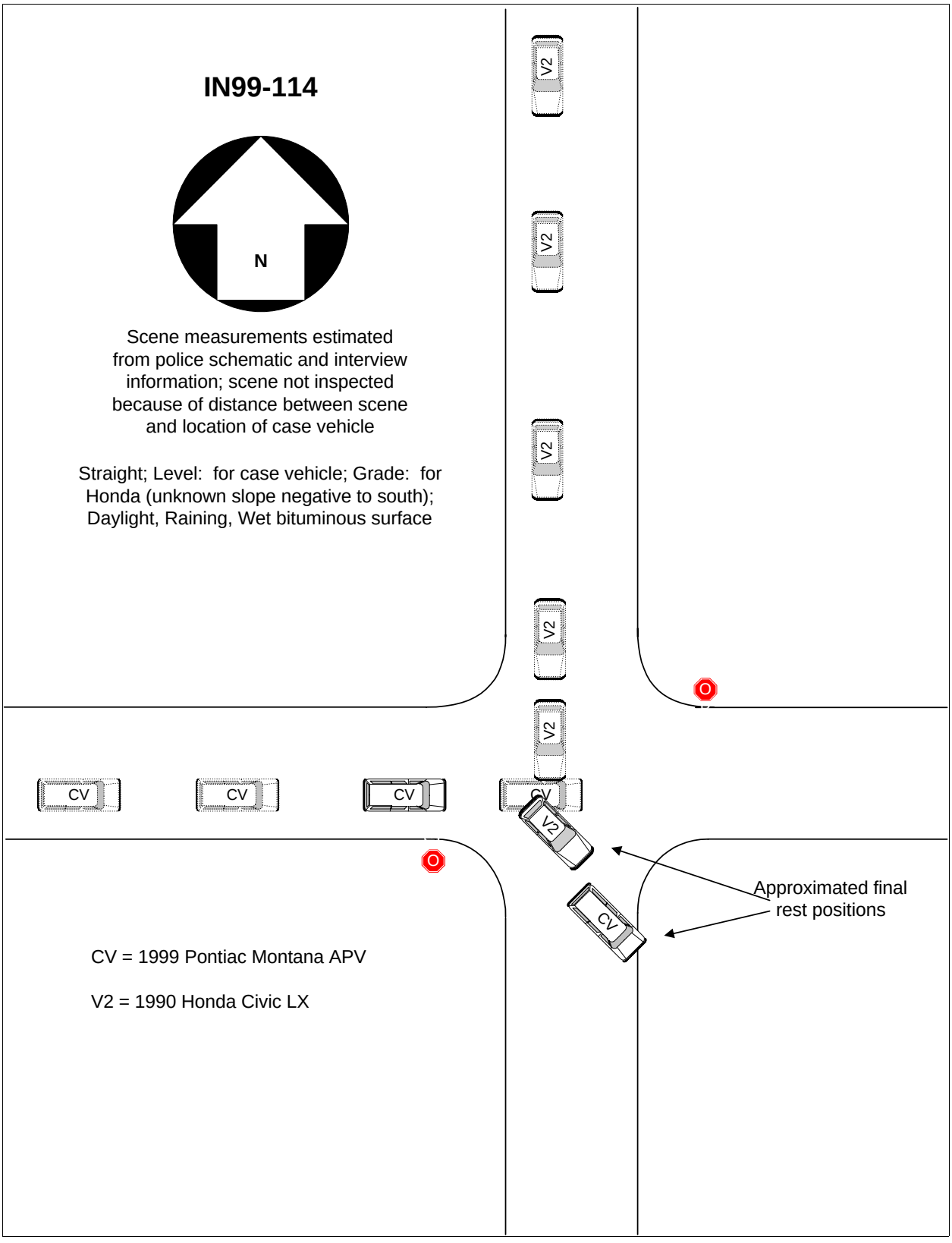


Figure 13: Honda's frontal damage viewed from left along front reference line, with contour gauge present showing deformation (case photo #42)


IN99-114
N
Scene measurements estimated from police schematic and interview information; scene not inspected because of distance between scene and location of case vehicle
Straight; Level: for case vehicle; Grade: for Honda (unknown slope negative to south); Daylight, Raining, Wet bituminous surface
V2
V2
V2
V2
V2
CV
CV
CV
CV
V2
CV
Approximated final rest positions
CV = 1999 Pontiac Montana APV
V2 = 1990 Honda Civic LX