

Advanced Occupant Protection System Investigation/ Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS04003
2004 Chevrolet Silverado
Colorado
February 2004

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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.

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| 16. Abstract This on-site investigation focused on the performance of the advanced occupant protection system that was installed in a 2004 Chevrolet Silverado pickup. The Chevrolet pickup was occupied by a 28-year-old male driver and a 31-year-old male front right passenger. This two vehicle angle/broadside type crash occurred within the confines of a four-leg intersection. The Chevrolet pickup was struck in the front right by a 1995 International 4900 three axle garbage truck. The impact resulted in sufficient longitudinal deceleration of the Chevrolet pickup to command the deployment of the frontal air bag system. The International truck continued forward, departed the roadway and struck a metal light pole. The Chevrolet pickup rotated in counterclockwise rotation and came to rest in the intersection. The driver and front right passenger in the Chevrolet pickup sustained neck strains. The front right passenger was transported by ambulance to a local trauma center where he was treated and released. The driver of the garbage truck sustained rib fractures and multiple contusions and abrasions. | | | |
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Dynamic Science, Inc.
Crash Investigation
Case Number: DS04003

TABLE OF CONTENTS

| | |
|--|----|
| Background | 1 |
| Description | 1 |
| Summary | 1 |
| Crash Site | 1 |
| Pre-crash | 2 |
| Crash | 2 |
| Post-crash | 3 |
| Vehicle Data - 2004 Chevrolet Silverado Pickup | 4 |
| Vehicle Damage | 5 |
| Exterior Damage | 5 |
| Interior Damage | 6 |
| Manual Restraints | 6 |
| Supplemental Restraint System | 6 |
| Occupant Demographics | 8 |
| Occupant Injuries | 10 |
| Occupant Kinematics | 11 |
| Scene Diagram | 12 |

BACKGROUND:

Description:

This on-site investigation focused on the performance of the advanced occupant protection system that was installed in a 2004 Chevrolet Silverado pickup. The Chevrolet pickup was occupied by a 28-year-old male driver and a 31-year-old male front right passenger. This two vehicle angle/broadside type crash occurred within the confines of a four-leg intersection. The Chevrolet pickup was struck in the front right by a 1995 International 4900 three axle garbage truck. The impact resulted in sufficient longitudinal deceleration of the Chevrolet pickup to command the deployment of the frontal air bag system. The International truck continued forward, departed the roadway and struck a metal light pole. The Chevrolet pickup rotated in counterclockwise rotation and came to rest in the intersection. The driver and front right passenger in the Chevrolet pickup sustained neck strains. The front right passenger was transported by ambulance to a local trauma center where he was treated and released. The driver of the garbage truck sustained rib fractures and multiple contusions and abrasions.



Figure 1. Front, 2004 Chevrolet pickup



Figure 2. Exemplar International 4900

Initially, this case was selected as a Certified Advanced 208 Compliant (CAC) case. The vehicle inspection revealed that the case vehicle was not in fact a CAC vehicle. The case was initially identified by a NHTSA review of GES police reports. DSI was notified on March 5, 2004 with instructions to determine if the case vehicle would be available for inspection. DSI obtained permission to inspect the case vehicle. This was an on-scene investigation. All field work was completed on March 20, 2004.

SUMMARY

Crash Site

This two vehicle crash occurred on February, 2004 at 1308 hours. The crash occurred at a four leg intersection of a state highway and a county road. The intersection was controlled by tri-colored traffic lights. The westbound state highway consists of a right turn lane, a through lane, a left turn lane, and a single eastbound travel lane. The speed limit for the asphalt covered

east/west state highway was 80 km/h (50 mph). The southbound county roadway consists of a right turn lane, two through travel lanes, a left turn lane, and three northbound travel lanes. The speed limit for the asphalt covered north/south county roadway was 56 km/h (35 mph). The roadways were covered with “slush.”

Pre-Crash

The case vehicle was a 2004 Chevrolet Silverado 2500 4WD Crewcab pickup. The case vehicle was being driven by a 28-year-old male. The front right seat was occupied by a 31-year-old male. The other vehicle is a 1995 International 4900 three axle garbage truck. It was being driven by 37-year-old male. The Chevrolet pickup was traveling westbound in the through lane intending to cross through the intersection with a green light at a police estimated speed of 32 km/h (20 mph). The International garbage truck was traveling southbound in the second lane from the right at a police estimated speed of 72 km/h (45 mph). The traffic light was red for southbound traffic. The driver of the garbage truck braked to stop at the intersection. He lost control of the vehicle and failed to stop before entering the intersection.



Figure 3. Case vehicle approach (west)



Figure 4. Other vehicle approach (south)

Crash

The front of the Chevrolet pickup struck (impact 1) the front left side of the International garbage truck. The impact was moderate and resulted in the deployment of the frontal air bag system. The barrier routine of the WinSmash program computed a total delta V of 12.0 km/h (7.5 mph), based on the pickup’s front end crush profile. After the initial impact, the Chevrolet pickup rotated counterclockwise and there was a second impact (side slap) between the right side of the pickup and the left side of the garbage truck. The Chevrolet pickup continued rotating counterclockwise until it had rotated 90 degrees from its original travel path. It came to rest facing west in the middle of the intersection 8.7 meters (28.4 ft) from the initial impact.

The garbage truck traveled 17.2 meters (56.5 ft) after impact, crossing through the intersection in a westbound direction. The garbage truck ran off the right side of the roadway, traveled 1.2 meters (4.0 ft) and struck a light pole on the southwest corner with its front end. The garbage truck came to final rest facing east.

Post-Crash

The driver of the case vehicle sustained a neck strain from the impact forces. He was able to exit the vehicle on his own. He later visited his personal physician who recommended that he undergo some physical therapy to alleviate the neck pain. The front right passenger may have blacked out for a few seconds immediately after the crash. He sustained a neck strain from the impact forces. He also reported soreness to his left knee and back. He was able to exit the vehicle on his own. He was transported to a local trauma center where he was treated and released. The driver of the garbage truck sustained rib fracture and multiple contusions and abrasions.

Both vehicles were towed from the scene due to damage.

Vehicle Data - 2004 Chevrolet Silverado 2500 4WD Crewcab pickup

The 2004 Chevrolet Silverado 2500 4WD Crewcab pickup was identified by the Vehicle Identification Number (VIN): 1GCHK2311Fxxxxxx. The vehicle's odometer could not be read because there was no power to the instrument panel. The Chevrolet pickup was equipped with a 6.6 L V8 engine, four wheel drive, four-speed automatic transmission, front and rear disc brakes with ABS, power steering, and a tilt steering wheel. The Chevrolet pickup was equipped with Bridgestone Duravis M773 LT245/75R16 tires. The manufacturer's recommended cold tire pressure for the front tires was 379 kPa (55 psi) and for the rear tires was 552 kPa (80 psi). The specific tire information is as follows:

| Position | Measured Pressure | Measured Tread Depth | Restricted | Damage |
|----------|-------------------|----------------------|------------|--------------------------|
| LF | 352 kPa (51 psi) | 13 mm (16/32 in) | No | None |
| LR | 386 kPa (56 psi) | 10 mm (13/32 in) | No | None |
| RR | 372 kPa (54 psi) | 10 mm (13/32 in) | No | None |
| RF | Flat | 13 mm (16/32 in) | No | Rim damage, tire flat |

The seating in the Chevrolet pickup was configured with front bucket seats with adjustable head restraints and a rear split bench seat. The driver's seat was located 10.0 cm (3.9 in) rear of the full forward track position (between middle and rear most track position). The front right passenger's seat was located 7.0 cm (2.8 in) rear of the full forward track position (middle track position).

Vehicle Damage - 2004 Chevrolet Silverado

Exterior Damage

Damage Description: The 2004 Chevrolet Silverado sustained moderate front end and right side damage as a result of the two impacts with the garbage truck. For the frontal impact, the direct damage began on the front right bumper corner and extended laterally 160.0 cm (62.9 in). The maximum crush was located at C4 and measured 33.0 cm (12.9 in). There were white and green paint transfers across the entire front end. Six crush measurements were documented at the bumper level as follows: C1 = 0 cm (0 in), C2 = 0 cm (0 in), C3 = 3.0 cm (1.2 in), C4 = 21.0 cm (8.3 in), C5 = 13.0 cm (5.1 in), C6 = 0 cm (0 in). For the side impact, the direct damage began 23.0 cm (9.0 in) forward of the rear axle and extended forward 119.0 cm (46.8 in) along the right side plane. Both right side doors were jammed shut. The right rear door was bowed outward. The front right rim was damaged and the tire was flattened

CDC: Impact 1: 01FDEW2
Impact 2: 03RZEW3

| | | |
|---------------------------|---------------------|----------------------------------|
| Delta V (Impact 1) | Total | 12.0 km/h (7.5 mph) |
| Barrier routine: | Longitudinal | -11.6 km/h (-7.0 mph) |
| | Latitudinal | -4.1 km/h (-2.6 mph) |
| | Energy | 21,452 joules (15,822 ft lbs) |



Figure 5. Chevrolet Silverado, impact 1



Figure 6. Chevrolet Silverado, impact 2

Interior Damage

The 2004 Chevrolet Silverado sustained minor damage as a result of the front air bag deployments. There was no other damage or occupant contacts visible.

Manual restraints - 2004 Chevrolet Silverado

The 2004 Chevrolet Silverado was configured with manual 3-point lap and shoulder belts for each seating position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). There was evidence of historical usage but no indications of loading. The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractor (ALR). For the front right safety belt, there was evidence of historical usage but no indications of loading.



Figure 7. Driver's air bag

Supplemental Restraint System - 2004 Chevrolet Silverado

The 2004 Chevrolet Silverado was equipped with depowered frontal air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of the longitudinal deceleration of the Silverado during the impact with the garbage truck.

The driver's air bag deployed from the center of the steering wheel hub through symmetrical I-configuration module cover flaps. Each flap measured 8.0 cm (3.1 in) across the top, 12.0 cm (4.7 in) along the side, and 5.0 cm (2.0 in) at the bottom. The deployed driver's air bag measured 55.0 cm (21.7 in) in diameter in its deflated state. The maximum rearward excursion measured 25.0 cm (9.8 in). The distance from the module cover to the driver's seat back measured 70.0 cm (27.6 in). The air bag was equipped with two internal tethers. There were two vent ports located at the 11 and 1 o'clock aspects on the rear of the air bag. There was no damage to either the air bag or the module covers. There were marks to the front of the air bag from the module cover.



Figure 8. Front right passenger's air bag

The front right passenger's air bag deployed from a front mount module with a rectangular cover flap that was hinged at the top aspect. The module cover flap measured 39.0 cm (15.4 in) in

width and 14.0 cm (5.5 in) in height. The deployed front right passenger's air bag measured 46.0 cm (18.1in) in height and 48.0 cm (18.9 in) in width. There was a single tether. Two circular vent ports were located at the 10 and 2 o'clock aspects of each side panel of the air bag. There was no damage to either the air bag or the module cover.

VEHICLE DATA - 1995 International 4900 three axle garbage truck

| | | |
|---------------------|---|---------|
| Description: | 1995 International 4900 three axle garbage truck, 4x2 | |
| VIN: | 1HTSDAAN3SHxxxxx | |
| Odometer: | Unknown | |
| Engine: | 466 CID, diesel | |
| Reported Defects: | None noted | |
| Cargo: | Unknown | |
| Damage Description: | Direct damage to front, right front, left front | |
| CDC: | Unknown | |
| Delta V: | Total | Unknown |
| | Longitudinal | Unknown |
| | Latitudinal | Unknown |
| | Energy | Unknown |

OCCUPANT DEMOGRAPHICS - 2004 Chevrolet Silverado

| | Occupant 1 | Occupant 2 |
|---------------------------------|--|--|
| Age/Sex: | 28/Male | 31/Male |
| Seated Position: | Front left | Front right |
| Seat Type: | Bucket | Bucket |
| Height: | 196 cm (77 in) | 183 cm (72 in) |
| Weight: | 98 kg (215 lbs) | 86 kg (190 lbs) |
| Occupation: | Unknown | Unknown |
| Pre-existing Medical Condition: | None | None |
| Alcohol/Drug Involvement: | None | None |
| Driving Experience: | >10 years | NA |
| Body Posture: | Normal, upright | Normal, upright |
| Hand Position: | Both hands on steering wheel, unknown o'clock position | One hand using/holding cell phone |
| Foot Position: | Right foot on accelerator, left on floor | Both feet on floor |
| Restraint Usage: | Integral lap and shoulder belt available, used | Integral lap and shoulder belt available, used |
| Air bag: | Steering wheel mounted air bag, deployed | Front mount air bag, deployed |

OCCUPANT DEMOGRAPHICS - 1995 International 4900 three axle garbage truck

| | |
|---------------------------------|---|
| | Driver |
| Age/Sex: | 37/Male |
| Seated Position: | Front left |
| Seat Type: | Unknown |
| Height: | Unknown |
| Weight: | Unknown |
| Occupation: | Truck driver |
| Pre-existing Medical Condition: | None noted |
| Alcohol/Drug Involvement: | None |
| Driving Experience: | Unknown |
| Body Posture: | Normal, upright |
| Hand Position: | Unknown |
| Foot Position: | Unknown |
| Restraint Usage: | Lap and shoulder belt available, used per police report |

OCCUPANT INJURIES - 2004 Chevrolet Silverado

Driver: Injuries obtained from the driver interview.

| <u>Injury</u> | <u>OIC Code</u> | <u>Injury Source</u> | <u>Confidence</u> |
|---------------|-----------------|----------------------|-------------------|
| Neck strain | 640278.1,6 | Impact forces | Probable |

Front right seat occupant: Injuries obtained from emergency room records.

| <u>Injury</u> | <u>OIC Code</u> | <u>Injury Source</u> | <u>Confidence</u> |
|---------------|-----------------|----------------------|-------------------|
| Neck strain | 640278.1,6 | Impact forces | Probable |

OCCUPANT INJURIES - 1995 International 4900 three axle garbage truck

Driver: Injuries obtained from emergency room records.

| <u>Injury</u> | <u>OIC Code</u> | <u>Injury Source</u> | <u>Confidence</u> |
|---|--------------------------|----------------------|-------------------|
| Contusion, left occiput (scalp) | 190402.1,2 | Unknown | Unknown |
| Abrasions, right forearm | 790202.1,1 | Unknown | Unknown |
| Anterolateral rib fractures (ribs 6,7, 8), minimally displaces, on right lateral chest wall | 450220.2,1 | Unknown | Unknown |
| Sprains, bilateral wrists | 751420.1,1 751420.1,2 | Unknown | Unknown |
| Contusion, left wrist | 751410.1,2 | Unknown | Unknown |

OCCUPANT KINEMATICS - 2004 Chevrolet Silverado

Driver kinematics

The 28-year-old driver was seated in an upright posture in the leather covered bucket seat and was restrained by the integral lap and shoulder belt. The driver's seat was located 10.0 cm (3.9 in) rear of the full forward track position (between middle and rear most track position). The seat back was adjusted to a 67 degree angle. Both hands were on the steering wheel. The right foot was on the accelerator and the left on the floorboard. At the first impact with the garbage truck, the frontal air bags deployed. The driver initiated a forward and slightly right trajectory. He was held in place by the lap and shoulder belt. He likely engaged the deployed air bag with his face and torso, but there were no residual injuries or contact evidence. The driver reported soreness to his right wrist and forearm that may have come from contact with the air bag; there were no resultant abrasions or contusions. At the second impact with the truck, the driver pitched to the right but was held in place by the lap belt. The driver sustained a neck strain from the impact forces. He was able to exit the vehicle on his own. He later visited his personal physician who recommended that he undergo some physical therapy to alleviate the neck pain.



Figure 9. Driver's seated area

Front right passenger kinematics

The 31-year-old male front right passenger was seated in an upright posture in the leather covered bucket seat and was restrained by the integral lap and shoulder belt. The front right passenger's seat was located 7.0 cm (2.8 in) rear of the full forward track position (middle track position). The seat back was adjusted to a 71 degree angle. This occupant had just finished completing a cell phone call. Both feet were on the floorboard. At the first impact with the garbage truck, the frontal air bags deployed. The front right passenger initiated a forward and slightly right trajectory. He was held in place by the lap and shoulder belt. He likely engaged the deployed air bag with his face and torso, but there were no residual injuries or contact evidence. His left knee struck the lower instrument panel but there was no resultant injury. At the second impact with the truck, this occupant pitched to the right and struck the right side of his head on the right window. He may have blacked out for a few seconds. He sustained a neck strain from the impact forces. He also reported soreness to his left knee and back. He was able to exit the vehicle on his own. He was transported to a local hospital where he was treated and released.



Figure 10. Front right passenger's seated area

Scene Diagram

