

**CRASH DATA RESEARCH CENTER**

Calspan Corporation  
Buffalo, NY 14225

**CALSPAN ON-SITE CHILD SAFETY SEAT  
VEHICLE CRASH INVESTIGATION**

**CASE NO: CA05-030**

**VEHICLE: 2004 CHEVROLET COLORADO PICKUP TRUCK**

**LOCATION: PENNSYLVANIA**

**CRASH DATE: DECEMBER 2004**

Contract No. DTNH22-01-C-17002

Prepared for:

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

## **DISCLAIMER**

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

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

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

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

## TECHNICAL REPORT STANDARD TITLE PAGE

|  |  |   |                  |
|--|--|---|------------------|
| <p>1. Report No.<br/>CA05-030</p>  | <p>2. Government Accession No.</p>                           | <p>3. Recipient's Catalog No.</p>   |                  |
| <p>4. Title and Subtitle<br/>Calspan On-Site Child Safety Seat Vehicle Crash Investigation<br/>Vehicle: 2004 Chevrolet Colorado Pick-up<br/>Location: State of Pennsylvania</p>  |  | <p>5. Report Date:<br/>June 2006</p>  |                  |
|  |  | <p>6. Performing Organization Code</p>  |                  |
| <p>7. Author(s)<br/>Crash Data Research Center</p>   |  | <p>8. Performing Organization Report No.</p>  |                  |
| <p>9. Performing Organization Name and Address<br/>Crash Data Research Center<br/>Calspan Corporation<br/>P.O. Box 400<br/>Buffalo, New York 14225</p>   |  | <p>10. Work Unit No.<br/>C00410.0000.0293</p>   |                  |
|  |  | <p>11. Contract or Grant No.<br/>DTNH22-01-C-17002</p>  |                  |
| <p>12. Sponsoring Agency Name and Address<br/>U.S. Department of Transportation<br/>National Highway Traffic Safety Administration<br/>Washington, D.C. 20590</p>  |  | <p>13. Type of Report and Period Covered<br/>Technical Report<br/>Crash Date: December 2004</p> |                  |
|  |  | <p>14. Sponsoring Agency Code</p>   |                  |
| <p>15. Supplementary Note<br/>This on-site investigation focused on the severity of the crash, the installation and reported failures of a Rear-Facing Child Safety Seat (RFCSS).</p>  |  |   |                  |
| <p>16. Abstract<br/>This on-site investigation focused on the severity of the crash, the installation and reported failures of a Rear-Facing Child Safety Seat (RFCSS). The crash involved a 2004 Chevrolet Colorado Crew Cab pickup truck that was driven by a 26-year old female driver. Her one-month old infant son was restrained in a rear-facing Cosco Designer 22 series infant safety seat and secured to the vehicle by the LATCH belt system. The driver lost directional control on an ice covered roadway and rotated in a counterclockwise direction into the opposing travel lane. The right side of the Colorado was struck by a 1997 Ford E-250 cargo van. The restrained driver of the Colorado sustained an occipital condyle fracture, a left lung contusion, a scalp contusion and laceration, and comminuted fractures of the left radius and ulna. Her infant son was ejected from the RFCSS and contacted the right rear door panel. He sustained bilateral parietal skull fractures, a right subdural hematoma, a left intraventricular hemorrhage, left subarachnoid hemorrhage, and a left intraparenchymal contusion. Both occupants were transported by ambulance to a local trauma center where they were admitted for four days for treatment of their injuries. Both vehicles sustained disabling damage and were towed from the crash site.</p> |  |   |                  |
| <p>17. Key Words<br/>Child safety seat serious injury.<br/>Right side impact</p>   |  | <p>18. Distribution Statement<br/>General Public</p>  |                  |
| <p>19. Security Classif. (of this report)<br/>Unclassified</p>   | <p>20. Security Classif. (of this page)<br/>Unclassified</p> | <p>21. No. of Pages<br/>14</p>  | <p>22. Price</p> |

## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>BACKGROUND.....</b>                      | <b>1</b>  |
| <b>SUMMARY.....</b>                         | <b>2</b>  |
| CRASH SITE.....                             | 2         |
| VEHICLE DATA .....                          | 2         |
| 2004 CHEVROLET COLORADO PICKUP TRUCK .....  | 2         |
| 1997 FORD E-250 ECONOLINE .....             | 3         |
| CRASH SEQUENCE.....                         | 3         |
| PRE-CRASH .....                             | 3         |
| CRASH.....                                  | 3         |
| POST-CRASH .....                            | 4         |
| EXTERIOR – 2004 CHEVROLET COLORADO .....    | 4         |
| INTERIOR – 2004 CHEVROLET COLORADO .....    | 5         |
| MANUAL SAFETY BELT SYSTEMS .....            | 6         |
| 2004 CHEVROLET COLORADO.....                | 6         |
| FRONTAL AIR BAD SYSTEM .....                | 7         |
| 2004 CHEVROLET COLORADO.....                | 7         |
| EVENT DATA RECORDER.....                    | 7         |
| CHILD SAFETY SEAT TYPE/INSTALLATION.....    | 7         |
| OCCUPANT DEMOGRAPHICS – DATA.....           | 9         |
| DRIVER 2004 CHEVROLET COLORADO.....         | 9         |
| DRIVER INJURIES.....                        | 10        |
| DRIVER KINEMATICS .....                     | 10        |
| REAR LEFT INFANT PASSENGER .....            | 11        |
| REAR LEFT INFANT PASSENGER INJURIES .....   | 11        |
| REAR LEFT INFANT PASSENGER KINEMATICS ..... | 12        |
| <b>FIGURE 14 – SCENE SCHEMATIC.....</b>     | <b>14</b> |

**CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION**  
**SCI CASE NO. - CA05-030**  
**VEHICLE – 2004 CHEVROLET COLORADO PICKUP TRUCK**  
**CHILD SAFETY SEAT – COSCO DESIGNER 22 INFANT SAFETY SEAT**  
**LOCATION – PENNSYLVANIA**  
**CRASH DATE – DECEMBER 2004**

**BACKGROUND**

This on-site investigation focused on the severity of the crash, the installation and reported failures of a Rear-Facing Child Safety Seat (RFCSS). The crash involved a 2004 Chevrolet Colorado Crew Cab pickup truck (**Figure 1**) that was driven by a 26-year old female driver. Her one-month old infant son was restrained in a rear-facing Cosco Designer 22 series infant safety seat in the left rear position and secured to the vehicle by the LATCH belt system. The driver lost directional control on an ice covered roadway and rotated in a counterclockwise direction into the opposing travel lane. The right side of the Colorado was



**Figure 1. 2004 Chevrolet Colorado pickup truck.**

struck by a 1997 Ford E-250 cargo van. The restrained driver of the Colorado sustained an occipital condyle fracture, a left lung contusion, a scalp contusion and laceration, and comminuted fractures of the left radius and ulna. Her infant son was ejected from the RFCSS and contacted the right rear door panel. He sustained bilateral parietal skull fractures, a right subdural hematoma, a left intraventricular hemorrhage, left subarachnoid hemorrhage, and a left intraparenchymal contusion. Both occupants were transported by ambulance to a local trauma center where they were admitted for four days for treatment of their injuries. Both vehicles sustained disabling damage and were towed from the crash site.

NHTSA received notification of the December 2004 crash from a pediatric hospital study of child injuries from car crashes on May 13, 2005. The notification was immediately forwarded to the Calspan Special Crash Investigations (SCI) team for on-site investigation. Cooperation was established with the driver of the Colorado who retained possession of the RFCSS and the insurance carrier who retained the Colorado at a regional salvage auction facility. The Ford E-250 van could not be located. The on-site aspects of this investigation were conducted on May 23-24, 2005, which included the inspection and documentation of the Chevrolet Colorado and the crash site, a detailed in-person interview with the driver, and the inspection of the infant safety seat.

## SUMMARY

### *Crash Site*

The crash occurred on a two lane roadway during daylight hours. At the time of the crash weather conditions were clear and the ambient temperature was reported by the driver at -19 degree C (-2 degrees F). The worn asphalt road surface was clear with intermittent ice. The travel lanes were 3.7 m (12') in width and bordered by 2.1 m (7') paved shoulders. The travel lanes were delineated by double yellow centerlines and bordered by solid white edge lines. The grade was four percent, negative to the north. The posted speed limit was 89 km/h (55 mph). At the time of the SCI inspection, there was no physical evidence at the crash site. **Figure 2** is a northbound view of the crash site. The Crash Schematic is included as **Figure 14** of this narrative report.



**Figure 2.** Northbound view of the crash site.

### *Vehicle Data*

#### *2004 Chevrolet Colorado Pickup Truck*

The subject vehicle in this crash was a 2004 Chevrolet Colorado Crew Cab pickup truck. The vehicle was manufactured in April 2004 and was identified by Vehicle Identification Number (VIN) 1GCDT136248 (production number deleted). The vehicle was powered by a 3.5 liter, inline five-cylinder engine linked to a four-speed automatic transmission with four-wheel drive. The service brakes consisted of front disc/rear drum with anti-lock (ABS). The Gross Vehicle Weight Rating was 2,404 kg (5,300 lb). At the time of the crash, the odometer reading was 16,038 km (9,966 miles). The Colorado was equipped with OEM alloy wheels and General Ameritrac TR tires, size P265/75R15. The manufacturer recommended tire pressure was 210 kPa (30 PSI). The specific tire data at the time of the SCI inspection was as flows:

| <b>Position</b> | <b>Measured Pressure</b> | <b>Measured Tread Depth</b> | <b>Damage</b>   |
|-----------------|--------------------------|-----------------------------|---|
| Left Front      | 221 kPa (32 PSI)         | 8 mm (10/32")               | None  |
| Left Rear       | 217 kPa (31.5 PSI)       | 9 mm (11/32")               | None  |
| Right Front     | 228 kPa (33 PSI)         | 8 mm (10/32")               | None  |
| Right Rear      | 0 kPa                    | 6 mm (8/32")                | Outer bead of alloy wheel deformed and cracked, inner bead gouged |

The interior of the Colorado was configured as a six-passenger vehicle with a split bench front seat with integral head restraints and a fold-down center armrest. The rear seat was a split bench with forward folding seat backs and integral head restraints for the outboard positions. The Chevrolet was equipped with an adjustable steering wheel, power windows and door locks, and manually adjusted front seats. The rear seat was equipped

with Lower Anchors and Tethers for CHildren (LATCH) for the two outboard positions. The LATCH system was utilized to restrain the RFCSS in this vehicle.

### ***1997 Ford E-250 Econoline***

The striking vehicle in this crash was a 1997 Ford E-250 Econoline cargo van. The vehicle was not located for this SCI investigation; therefore it was not inspected. Based on the VIN of 1FTHE24LZVH (production number deleted), the Ford van was a rear-wheel drive platform, powered by a 5.4 liter V-8 engine. The GVWR was in the (8,501-9,000 lb) range.

### ***Crash Sequence***

#### ***Pre-Crash***

The 26-year old female driver of the Chevrolet Colorado entered the vehicle in sub-freezing temperature and started the vehicle to let it warm-up for several minutes prior to departing her residence. She placed the child in the RFCSS in the house and secured the child with the integrated harness system. The driver carried the RFCSS to the vehicle and engaged the RFCSS into the base that was secured with the LATCH system. She entered the vehicle, buckled her manual safety belt system, and exited her driveway. The driver traveled to the two-lane state route which was located less than 1 km (0.6 mile) from her residence. She initiated a right turn and accelerated to a driver reported speed of 80 km/h (50 mph). While traveling on the two-lane roadway, the driver overrode an icy section which resulted in a loss of directional control. The Colorado initiated a counterclockwise yaw across the centerline and into the southbound travel lane.

The driver of the 1997 Ford cargo van was traveling in a southerly direction on the two-lane roadway. As he approached the impending crash site, the Colorado yawed across his path of travel. It was not known if the driver's initiated avoidance actions.

### ***Crash***

The frontal area of the Ford cargo van impacted the right side area of the Colorado. The initial engagement involved the front right corner area of the Ford and the right rear axle position of the Colorado. The force of the crash fractured the right rear axle at the outboard aspect of the axle housing which resulted in separation of the tire and wheel, brake drum, and axle hub. The corner area of the Ford crushed the cargo bed to a maximum depth of 70 cm (27.5"), located at the mid point of the cargo box. This impact formed a pocket which allowed the right front side area of the Ford to engage the right side doors of the Colorado. The impact, located rearward of the Chevrolet's center of gravity, reversed the Colorado's rotation to clockwise. The Missing Vehicle Algorithm of the WINSMASH program computed a total delta V for the Colorado of 32 km/h (19.9 mph) with respective longitudinal and lateral components of -16 km/h (-9.9 mph) and -28 km/h (-17.3 mph).

The impact rotated the Colorado in a CW direction as it departed the left (west) road edge. The Chevrolet came to rest off-road, facing in a southwesterly direction. At rest, the Colorado rotated approximately 270 degrees CW of its heading at impact. There was no physical evidence to support the final rest positions of the vehicles.

### ***Post-Crash***

Witnesses to the crash stopped at the site and observed the driver seated in the front left position of the Colorado. She rebounded back into position when observed. The infant was ejected from the RFCSS and was found lying face-down on the rear right seat cushion. The RFCSS was rotated on its side and was positioned on the rear center seat cushion. A witness up-righted the safety seat and placed the infant back in the CSS. Following the arrival of the investigating officer, the driver of the Colorado exited her vehicle from the left front door and retrieved the infant from the safety seat and walked to the police cruiser where she waited for emergency medical personnel to arrive on-scene. The driver and her infant son were transported by ground ambulance to a regional trauma center where they were admitted for treatment. Both occupants were released four days following the crash.

### ***Exterior – 2004 Chevrolet Colorado***

The 2004 Chevrolet Colorado sustained severe right side damage (**Figure 3**) as a result of the impact with the Ford cargo van. Maximum crush was measured at 70 cm (27.5”) located at the mid point of the cargo bed. The direct contact damage began on the right front door 153 cm (60.25”) aft of the right front axle and extended 213 cm (84”) onto the cargo bed, terminating 23 cm (9”) aft of the lower wheel opening. The combined induced and direct contact damage began 55 cm (21.75”) rearward of the right front axle and extended 364 cm (143.25”) to the rear bumper corner. The crush profile (**Figure 4**) was measured at six equidistant points along this damage length. The crush values at the level of the vehicle’s rub strip were as follows: C1 = 26 cm (10.25”), C2 = 67 cm (26.4”), C3 = 58 cm (23”), C4 = 34 cm (13.25”), C5 = 7 cm (2.75”), C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact event was 02-RZEW-4.



**Figure 3. Right side damage to the Colorado.**



**Figure 4. Overhead view of the crush profile.**

The initial engagement involved the front right corner of the Ford against the right rear tire and wheel of the Colorado. This engagement fractured the right rear axle at the outboard aspect of the housing and drum brake backer plate. The alloy wheel, tire, brake drum, and axle hub remained intact, bolted together by the wheel lugs.



The impact shifted the rear frame of the Colorado which resulted in a lateral left offset of 28 cm (11”) between the left side of the cab and the leading edge of the cargo bed.

All four doors of this crew cab were conventionally hung with forward mounted hinges. Both left side doors remained closed and operation post-crash. The right front door was jammed closed by deformation. The right rear door was jammed closed; however, it appeared to have been pried open post-crash.

The laminated windshield was intact and not damaged. The left front, left rear, and right front door windows were closed at the time of the cold weather crash and remained intact. The right rear door and the backlight were shattered by the impact. The truck was not equipped with a roof window.

***Interior – 2004 Chevrolet Colorado***

The interior of the Colorado sustained moderate severity damage as a result of exterior deformation and occupant contact. The interior was reduced in size by intrusion of the right side doors and the lower B-pillar. Maximum intrusion involved 18 cm (7”) of lateral displacement of the right lower B-pillar into the front right occupant space. The intruding components and the magnitudes are identified in the following table:

| <b>Position</b> | <b>Component</b>           | <b>Direction</b> | <b>Magnitude</b> |
|-----------------|----------------------------|------------------|------------------|
| Front Right     | Right lower B-pillar       | Lateral          | 16 cm (6”)       |
| Front Right     | Right B-pillar at beltline | Lateral          | 16 cm (6”)       |
| Front Right     | Right front door panel     | Lateral          | 13 cm (5”)       |
| Front Right     | Right sill                 | Lateral          | 8 cm (3”)        |
| Front Right     | Right roof side rail       | Lateral          | 3 cm (1”)        |
| Rear Right      | Right sill                 | Lateral          | 8 cm (3”)        |
| Rear Right      | Right rear door panel      | Lateral          | 5 cm (2”)        |
| Rear Right      | Right C-pillar             | Lateral          | 6 cm (2.5”)      |
| Rear Right      | Right rear floor           | Vertical         | 10 cm (4”)       |

The driver loaded the manual safety belt system with her pelvic region and left arm as she slid out of the shoulder belt and snagged the belt webbing with her left forearm. Loading evidence consisted of frictional abrasions at the latch plate and belt webbing. An additional abrasion/scuff was noted to the upper outboard aspect of the left seat back. The driver contacted and deformed the center armrest 5 cm (2”) to the right as she responded to the lateral crash forces. Her head impacted and fractured the right door panel at the area of the integral armrest. A horizontally oriented fracture of the upper door panel resulted from the exterior deformation of the door. The driver’s seat rotated in a clockwise direction as a result of the crash forces. The rear positioned RFCSS impacted the seat back; however, this engagement did not deform the front seat. **Figure 5** is a lateral view of the driver’s contact points.

The RFCSS impacted and scuffed the rear aspects of the front seat backs. Laterally orientated scuff marks were present on both seat backs. The infant passenger was ejected from the RFCSS and impacted the right rear door panel. This occupant contact fractured the mid portion of the plastic panel at the area of the armrest. The lower panel was fractured from the exterior deformation and resulting intrusion. This damage is depicted in **Figure 6**.



**Figure 5. Lateral view of the driver's trajectory and contact points.**



**Figure 6. Lateral view of the rear seat area damage and intrusion.**

### ***Manual Safety Belt Systems 2004 Chevrolet Colorado***

The Colorado Crew Cab pickup truck was configured as a six-passenger vehicle. The four outboard seated positions were equipped with continuous loop, 3-point lap and shoulder belt systems with sliding latch plates. The driver's safety belt system retracted onto a B-pillar mounted Emergency Locking Retractor (ELR) while the front right belt utilized a switchable ELR/Automatic Locking Retractor (ALR). The front outboard belt systems were equipped with adjustable D-rings. The driver's D-ring was adjusted to the full-down position. The center front position was equipped with a lap belt with a locking latch plate.

The driver was restrained by the manual safety belt system at the time of the crash. Belt usage was supported by loading evidence on the safety belt system and seat back. The latch plate contained subtle frictional abrasions from the webbing. A matching frictional transfer was present on the belt webbing in the area of the latch plate, located 103-107 cm (40.5-42") above the floor anchor. A secondary area of loading was noted at the top outboard area of the fabric seat back. An abrasion/scuff mark from shoulder belt loading was noted during the SCI inspection. There was no physical damage to the driver's belt system.

The rear outboard belts were configured with ELR/ALR retractors. The center rear 3-point belt was detachable at the seat bight for the forward folding option of the seat back. At the time of the SCI inspection, the lap belt was detached from the buckle that was mounted to the left side of this center position. The ELR/ALR retractor was mounted to the back wall of the cab. The rear belts were not used to secure the RFCSS in the crash. The safety seat was secured to the rear left position using the LATCH system. The LATCH anchors at the seat bight location were visible and were not labeled on the seat backs.

***Frontal Air Bag System***  
***2004 Chevrolet Colorado***

The Chevrolet Colorado was equipped with dual stage frontal air bags for the driver and front right passenger positions. The frontal air bag system did not deploy in this right side impact crash. The driver's air bag was mounted within the four-spoke steering wheel rim and was concealed by I-configuration module cover flaps. The front right air bag was mounted in the mid right instrument panel and concealed by a single, top hinge cover flap. The Colorado was not equipped with safety belt pretensioners or side impact air bag protection.

***Event Data Recorder***

The 2004 Chevrolet Colorado was equipped with an Event Data Recorder (EDR) that was incorporated into the Sensing and Diagnostic control Module (SDM). The EDR was downloaded through the vehicle's J1962 diagnostic link connector during the SCI investigation. A Non-Deployment event was captured by the EDR at ignition cycle 875. The ignition cycle at the time of the investigation was 1,026. Based on these cycles, this Non-Deployment event was not associated with this crash. This Non-Deployment file is not attached to this SCI report.

***Child Safety Seat Type/Installation***

The infant passenger was restrained in a RFCSS in the rear left position of the vehicle. The infant was one-month old and was positioned in a Cosco Designer 22 infant seat. The seat utilized a detachable base which was part of the Cosco Spirit travel system. The RFCSS was purchased new by the driver at a local retailer. The RFCSS was manufactured on 3/12/04 and was identified by Model No. 22-300-JOS. The RFCSS was designed for child weights of 2.3-10 kg (5-22 lb) and a height range of 48-74 cm (19-29"). The safety seat was configured with an integrated 5-point harness system with a chest retainer clip, a forward folding carry handle, and a forward folding sun shade. The driver purchased an elastic bunting that stretched over the perimeter of the shell to provide additional warmth to the infant. This was in use at the time of the crash.

At the time of this SCI investigation, the RFCSS was removed from the vehicle and stored at the driver's residence. The safety seat was previously inspected by an independent research effort and was recalled for a possible design flaw on April 15, 2005, a month prior to the assignment of this SCI investigation, by the manufacturer. Therefore, the safety seat was not in its exact post-crash state of adjustment or use at the time of this investigation.

The driver stated that the base was installed in the vehicle secured by the LATCH belt system. Her husband installed the base and placed a folded towel at the seat bight to gain a better recline angle of the RFCSS. He stated that he used his hand to compress the base into the vehicle's seat cushion and tightened the LATCH belt with his other hand. Once secured, he noted that the lateral movement at the belt path did not exceed 3 cm (1"). The parents did not read the instructional manual and they could not recall if the registration card was mailed to the manufacturer. The base was in the vehicle which was parked outdoors on the night preceding the crash when temperatures dropped below -19 degrees C (-2 degrees F). The driver noted that the RFCSS was used approximately 20 times prior to this crash.

On the morning of the crash, the driver dressed the infant in a snow suit and placed him in the RFCSS. She then secured the infant with the integrated five-point harness system. The driver stated that the harness straps were positioned in the lowest of four slots in the back of the CSS. She noted that the harness straps were adjusted with approximately 2-3 fingers (placed flat) of slack between the child and the shoulder straps at the anterior shoulder level. The adjustment of the harness straps was achieved by looping the straps through a buckle on the back side of the safety seat shell. A sliding saw-tooth locking mechanism was incorporated into the buckle unit, which was designed to firmly hold the adjusted position of the harness straps. The driver placed a small blanket over the infant and the harness system. She then stretched a form-fitting bunting over the shell of the safety seat and carried the restraint to the vehicle. The driver placed the RFCSS into the base unit and clicked the shell of the restraint into position.

The post-crash inspection of the RFCSS and the base unit provided the following information:

*Base Unit* – The base unit was fractured at the left side of the LATCH belt path (**Figure 7**). The fracture line extended 15 cm (6") along the back side of the base and 8 cm (3") on the left side. This separated the corner of the base and the back side of the LATCH belt path loop (**Figure 8**). A second fracture line extended 5 cm (2") vertically down the center rear aspect of the base and continued 7 cm (2.8") onto the bottom aspect toward the left.



**Figure 7. Fractured base at LATCH belt path.**



**Figure 8. LATCH belt with base unit.**

*Safety Seat Shell* – The CSS shell was not damaged during the crash. The locking and release mechanism remained intact and operational. The carry handle remained attached at both pivot points.

*Harness System* – The harness straps were not damaged. It was reported that the left (on child) or inboard harness strap (referenced with RFCSS installed in vehicle) separated from the adjustment buckle prior to, or during the crash event. This adjustment buckle (**Figure 9**) did not firmly secure the harness strap in its adjusted position. The saw-tooth locking bar (**Figure 10**) floated which would allow the belt to loosen and/or disengage during vibration associated with vehicle travel, or possibly a crash. This was the scope of the recall campaign for this seat. The term applied to it was “webbing creep”.



**Figure 9. Harness adjustment buckles.**



**Figure 10. Close-up view of the buckle and saw-tooth locking bar.**

### *Occupant Demographics – Data*

#### *Driver 2004 Chevrolet Colorado*

|                               |  |
|-------------------------------|--|
| Age/Sex:                      | 26-year old/Female   |
| Height:                       | 150 cm (59.25")  |
| Weight:                       | 62 kg (137 lb)   |
| Eyewear:                      | Contact lenses   |
| Seat Track Position:          | Mid track  |
| Manual Safety Belt Usage:     | 3-point lap and shoulder belt  |
| Usage Source:                 | Vehicle inspection   |
| Egress from Vehicle:          | Exited vehicle unassisted  |
| Mode of Transport From Scene: | Ambulance  |
| Type of Medical Treatment:    | Transported by ground ambulance to a regional trauma center where she was admitted for four days for treatment of her injuries |

***Driver Injuries***

| <b>Injury</b>                                    | <b>Injury Severity (AIS 90/Update 98)</b> | <b>Injury Source</b>                             |
|--|---|--|
| Comminuted fracture of the proximal left radius  | Serious (752804.3,2)                      | Shoulder belt webbing                            |
| Comminuted mid-shaft fracture of the left ulna   | Serious (753204.3,2)                      | Shoulder belt webbing                            |
| Left pulmonary contusion                         | Serious (441402.3,2)                      | Probable rebound contact into steering wheel rim |
| Non-displaced left occipital condyle fracture    | Moderate (150200.3,8)                     | Right door panel                                 |
| Right posterior cepalohematoma (scalp contusion) | Minor (190402.1,1)                        | Right door panel                                 |
| Sutured right posterior scalp laceration         | Minor (190602.1,1)                        | Right door panel                                 |

*Source - Hospital medical records*

***Driver Kinematics***

The 26-year old female driver of the 2004 Chevrolet Colorado pickup truck was seated in a mid track position with the seat back reclined 10 degrees aft of vertical. The slope of the seat cushion was 10 degrees and the leading edge of the cushion was 28 cm (11”) above the floor. In this position, the horizontal distance between the center of the driver air bag module and the seat back was 48 cm (19”), measured 39 cm (15.5”) above the seat bight. The driver was dressed in a long-sleeved T-shirt, a fleece shirt, and a heavy-weight coat with denim jeans and sneakers. She was restrained by the manual safety belt system. The driver noted that the belt was positioned over her left shoulder with the lap belt positioned across her hips. Belt usage was verified by frictional abrasions on the belt webbing at the location of the latch plate, and an abrasion of the side surface on the seat back surface.

Immediately prior to impact, the pickup truck initiated a counterclockwise yaw which would have displaced the driver minimally to her right. At impact with the Ford van, the driver responded to the lateral impact force by moving to her right. Her upper torso slid out of the manual shoulder belt webbing as her right hip area impacted the fold-down center armrest. This contact displaced the armrest approximately 5 cm (2”) to the right. The driver’s pelvic area loaded the lap belt webbing which was evidence by a frictional abrasion on the belt webbing.

As the driver continued laterally (**Figure 11**), her left forearm snagged the shoulder belt webbing, resulting in comminuted fractures of the left radius and ulna. This



**Figure 11. Driver’s trajectory and contact points.**

shoulder belt snagging was evidenced by a webbing abrasion to the upper outboard aspect of the seat back. The driver continued laterally across the interior and struck the right posterior aspect of her head on the right mid door panel and armrest. This contact fractured the rigid plastic panel and resulted in a right posterior scalp contusion, a right posterior scalp laceration, and a left occipital condyle fracture.

The driver rebounded from this contact as the Colorado was rotated in a clockwise direction by the impact that was focused rearward of the vehicle’s center of gravity. The left posterior aspect of the driver’s torso probably impacted the right edge of the steering wheel rim which resulted in a left pulmonary contusion. There were no overlying rib fractures or soft tissue injuries associated with this contact.

As the vehicle came to rest, the driver was observed by witnesses and the investigating officer as restrained and alert, seated on the driver’s position of the vehicle. She exited the vehicle and walked to the police vehicle with her infant son where they waited for an ambulance to arrive on-scene. She was transported by ground ambulance to a regional trauma center where she was admitted for four days and underwent open reduction, internal fixation of the left forearm fractures. The scalp laceration was sutured.

***Rear Left Infant Passenger***

Age/Sex: 1-month old/Male  
 Length: 51 cm (20”)  
 Weight: 4 kg (8 lb, 9 oz)  
 Restraint Use: Restrained in a rear-facing child safety seat  
 Usage Source: Vehicle and safety seat inspection  
 Egress from Vehicle: Removed by driver  
 Mode of Transport From Scene: Ambulance  
 Type of Medical Treatment: Admitted for four days for treatment of his injuries

***Rear Left Infant Passenger Injuries***

| <b>Injury</b>  | <b>Injury Severity (AIS 90/Update 98)</b> | <b>Injury Source</b>  |
|--|---|-----------------------|
| Small right subdural hematoma                          | Severe (140652.4,1)                       | Rear right door panel |
| Left intraventricular hemorrhage of the posterior horn | Severe (140678.4,2)                       | Rear right door panel |
| Small left intraparenchymal contusion                  | Severe (140640.4,2)                       | Rear right door panel |
| Left subarachnoid hemorrhage                           | Serious (140684.3,2)                      | Rear right door panel |
| Bilateral parietal skull fractures                     | Moderate (150402.2,1; 150402.2,2)         | Rear right door panel |
| Left parietal cephalohematoma                          | Minor (190402.1,2)                        | Rear right door panel |

*Source – Hospital medical records*

### ***Rear Left Infant Passenger Kinematics***

The one-month old infant passenger was restrained in the RFCSS in the rear left position of the Colorado. He was dressed in a snow suit, positioned in the safety seat and secured by the five-point integral harness. The driver stated that the harness straps were adjusted with approximately 2-3 fingers of slack at the anterior shoulder level. A blanket was placed over the infant and the harness system to keep him warm from the sub-freezing temperatures. A form fitted bunting was stretched over the shell of the CSS (**Figure 12**) for added warmth.

The base was installed in the vehicle by the driver's husband. He noted that he installed the base with a folded towel placed at the belt path and secured the base with the LATCH belt. The husband compressed the base with one hand and tightened the LATCH belt with the other. He estimated the lateral movement of the base at the belt path at 3 cm (1").

The driver placed the safety seat in the base and clicked it into its locked position, securing the safety seat in the rear left of the vehicle. She then proceeded to leave her residence and travel in a northerly direction. She traveled approximately 3-5 km (2-3 miles) prior to the crash. During this travel time, it was suspected that the inboard (left) harness strap that was positioned over the infant's left shoulder loosened or disengaged from the adjustment buckle.



**Figure 12. Bunting placed over RFCSS.**



**Figure 13. Trajectory of the infant and contact damage to the right rear door panel.**

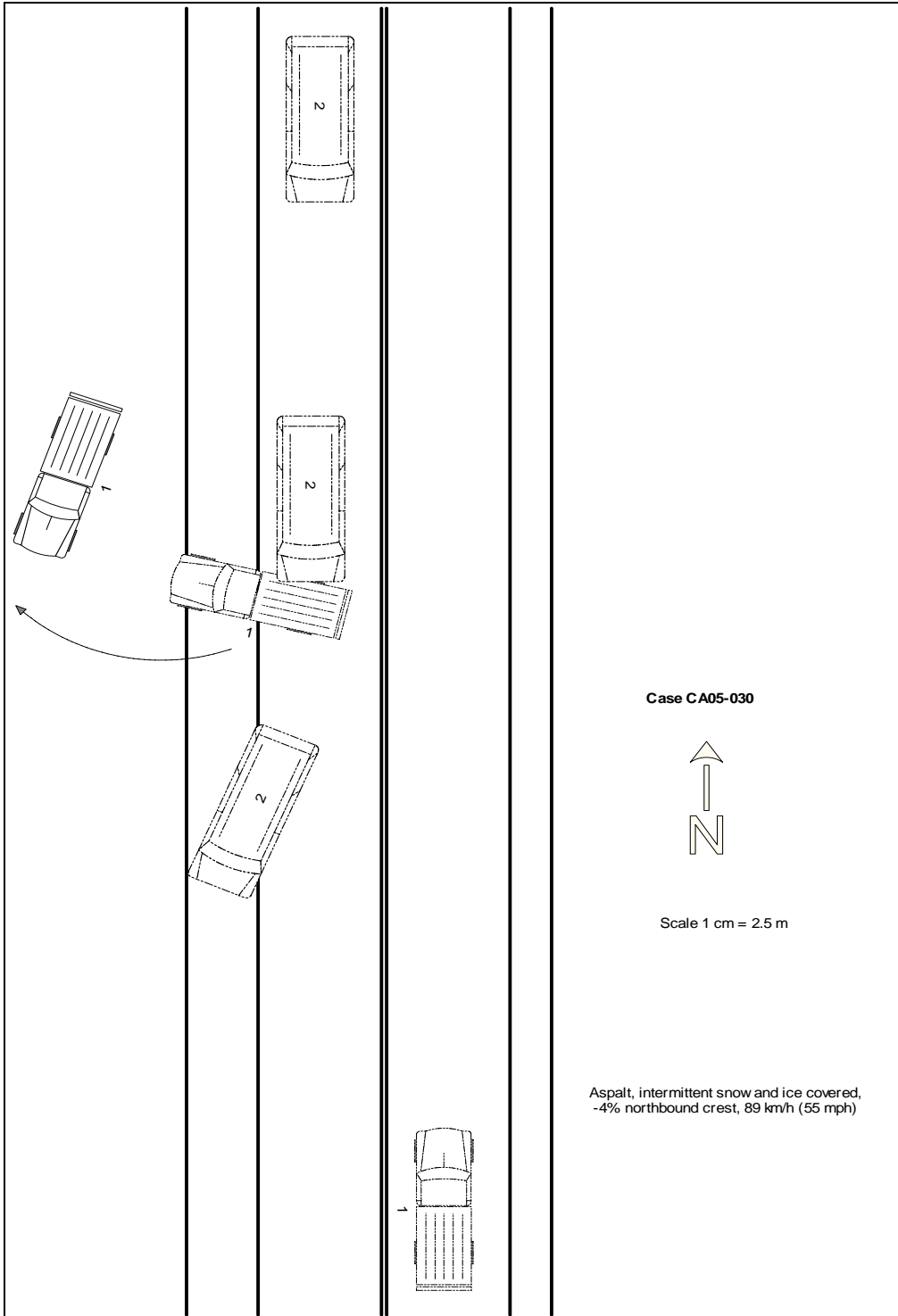
At impact, the infant and the RFCSS responded to the lateral crash forces by moving right and slightly forward with respect to the vehicle. The loading force exerted on the LATCH belt fractured the rear outboard corner of the base at the belt path. This allowed the base to disengage from the LATCH belt as the base and safety seat shell rotated clockwise with respect to the vehicle. The base remained engaged to the LATCH belt at the inboard loop of the belt path. This allowed the safety seat shell to roll into the center rear position and impact the front seat backs.



The inboard safety seat harness strap separated from the adjustment buckle, which resulted in a complete ejection of the infant as he responded laterally across the interior of the vehicle. Based on the rotation of the RFCSS, the infant probably rolled to his left as he was ejected from the safety seat. The infant's head impacted and fractured the rear right door panel at the mid point of the armrest (**Figure 13**). Door panel damage was a combination of exterior deformation and infant contact. As a result of this contact, the infant sustained bilateral parietal skull fractures, a left parietal scalp contusion, a left intraparenchymal contusion, left parietal subarachnoid hemorrhage, left intraventricular hemorrhage, and a right subdural hematoma.

The child was found by witnesses to the crash lying face down on the rear right seat cushion, totally separated from the infant seat. The infant restraint was positioned on its side, toward the center of the rear seat area. The LATCH belt remained engaged to the inboard belt path loop of the base. It was reported that the CSS separated from the base; however, witness statements indicate that the restraint remained intact as a unit, shell and base. The driver did not believe the safety seat separated from the base.

A witness up-righted the safety seat and placed the infant back in the safety seat. As the investigating officer arrived on-scene, the driver exited the vehicle and retrieved the infant from the safety seat and walked to the police vehicle where she waited for emergency medical personnel to arrive on scene. The infant was transported by ground ambulance to a regional medical center where he was admitted for four days for treatment and observation of his injuries.



**Figure 14 – Scene Schematic**