

On-Site Child Safety Seat Investigation  
Dynamic Science, Inc. (DSI), Case Number DS08002  
1989 GMC Jimmy S-15  
California  
December 2007

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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 dynamics of an occupant who was seated in a Child Restraint System (CRS) and who was ejected from a vehicle during a crash. The crash occurred in December 2007 in California. The crash site was in the southbound lanes of a divided north/south state highway. The subject vehicle was a 1989 GMC Jimmy S-15 sport utility vehicle. The second row right occupant was a 20-month-old male who was seated in a Cosco Protek High Back Booster Safety Seat (BSS) and restrained by the vehicle's manual lap and shoulder belt. The other vehicle was a 1993 Freightliner three-axle tractor that was pulling a 2003 Utility flatbed trailer. The Freightliner was traveling southbound in the outboard lane. The subject vehicle was entering the highway from an auxiliary lane that merged with the outboard southbound travel lane. The driver of the GMC lost control of the vehicle and the left front of the GMC contacted the right side of the flatbed trailer. The GMC departed the roadway on the right side and impacted a row of shrubbery. The second row right occupant was displaced from the BSS and was completely ejected from the vehicle through the right side window. The GMC came to final rest in contact with the shrubbery. The 20-month-old ejected occupant came to final rest approximately 3.3 m (10.8 ft) north of the vehicle and was located on the ground under the shrubbery. After the vehicle to vehicle impacts, the Freightliner continued traveling southbound for approximately 160 m (528 ft), then came to a controlled stop on the right shoulder. The driver of the Freightliner did not report any injury and the truck was driven from the scene. The three occupants of the GMC were transported to local hospitals, then were treated and released. The 20-month-old male sustained minor lacerations to the face and scalp. The GMC was towed from the scene due to damage. The vehicle was later declared a total loss by the insurance company.				
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**Dynamic Science, Inc.  
Crash Investigation  
Case Number: DS08002**

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## Background

This on-site investigation focused on the dynamics of an occupant who was seated in a Child Restraint System (CRS) and who was ejected from a vehicle during a crash. The crash occurred in December 2007 in California. The crash occurred in the southbound lanes of a divided north/south state highway. The subject vehicle was a 1989 GMC Jimmy S-15 sport utility vehicle (**Figure 1**). The driver was a 27-year-old male and the front row right seat occupant was a 26-year-old female. The second row right seat occupant was a 20-month-old male who was seated in a Cosco Protek High Back Booster Safety Seat (BSS) and was restrained by the vehicle's manual lap and shoulder safety belt.



**Figure 1.** Subject vehicle, 1989 GMC Jimmy S-15

The other vehicle was a 1993 Freightliner three-axle tractor that was pulling a 2003 Utility flatbed trailer and was being driven by a 39-year-old male. The Freightliner was traveling southbound in the outboard through lane.

The subject vehicle was entering the highway from an auxiliary lane that merged with the outboard southbound through lane. The driver of the GMC lost control of the vehicle in the auxiliary lane, and the GMC initiated a clockwise rotation. The driver of the GMC overcorrected to the left, and the left front end of the vehicle entered the outboard through lane. The left front of the GMC contacted the right side of the flatbed trailer that was being pulled by the Freightliner. A secondary impact resulted in a side-slap impact, then the GMC was displaced to the right as it initiated a clockwise rotation. The GMC departed the roadway on the right side and impacted a row of shrubbery. The second row right occupant was displaced from the BSS and was completely ejected from the vehicle through the side window. The GMC came to final rest in contact within shrubbery. The 20-month-old ejected occupant came to final rest approximately 3.3 m (10.8 ft) north of the vehicle and was located on the ground under the shrubbery.

After the impacts with the GMC, the Freightliner continued traveling southbound for approximately 160 m (528 ft), then came to a controlled stop on the right shoulder. The driver of the Freightliner did not report any injuries and the truck was driven from the scene.

The three occupants of the GMC were treated and released from local hospitals. The GMC was towed from the scene due to damage. The vehicle was later declared a total loss by the insurance company and was sold to an auto salvage company.

This on-site CRS investigation was identified by NHTSA in a review of an internet news article. The article stated that a child passenger was ejected and injured as a result of being improperly restrained in a CRS. DSI was notified on December 20, 2007 and instructed to locate the subject vehicle and the BSS. DSI obtained a copy of the police report on January 16, 2008 and obtained permission to inspect the subject vehicle and the BSS on January 18, 2008. DSI was assigned the

case and the subject vehicle and the BSS were inspected on January 21, 2008. The front row right occupant was the wife of the driver and the mother of the 20-month-old male occupant. She was interviewed in April 2009 and medical data was obtained during the interview. Efforts to obtain signed medical release forms were unsuccessful.

## Summary

### Crash Site

This two-vehicle crash occurred in the southbound lanes of a divided north/south state highway. The roadway comprised two through lanes in each direction with an auxiliary lane in the southbound direction for traffic entering the highway from an on-ramp. The on-ramp comprised a right curve alignment and joined the straight auxiliary lane, which then merged with the outboard southbound through lane (**Figure 2**).



**Figure 2.** Southbound approach, subject vehicle

The north- and southbound lanes were physically divided by a concrete jersey type barrier wall. The through lanes were straight, level, and were of asphalt composition. The southbound through lanes and auxiliary lane were separated by single dashed white stripes. The left roadway edge was bordered by a single yellow stripe, and the right roadway edge was bordered by a single white fog line. To the right of the auxiliary lane was a paved shoulder, followed by level ground that was planted with a row of shrubbery.

The speed limit at the crash site was 105 km/h (65 mph) for two-axle vehicles, and 89 km/h (55 mph) for vehicles pulling trailers. The crash occurred at 0955 hours. Conditions were daylight and the weather was cloudy. The police reported that the on-ramp, the auxiliary lane and the paved shoulder were wet, and that the southbound through lanes were dry.

### Pre-Crash

The 1989 GMC sport utility vehicle was entering the highway from an on-ramp that comprised a sharp right curve alignment. The GMC's police estimated speed prior to impact was 56-64 km/h (35-40 mph). The 27-year-old driver and the 26-year-old female front right occupant were restrained by the vehicle's lap and shoulder safety belts. The 20-month-old male who occupied the second row right position was seated in a BSS and was restrained by the vehicle's lap and shoulder belt. As the driver negotiated the right curve, the vehicle initiated a clockwise yaw on the wet roadway. The driver steered right and the vehicle turned sharply to the right. The driver then overcorrected to the left and the vehicle traveled into the path of the Freightliner that was traveling in the southbound lane.

The police documented two yaw marks deposited by the GMC's right side tires prior to the crash. The right front tire deposited a yaw mark that measured 8.9 m (29.2 ft) in length, and the right rear

tire deposited a yaw mark that measured 9.0 m (29.5 ft). The yaw marks' arc and orientation indicated that the GMC initiated a counterclockwise rotation and departed the auxiliary lane over the left lane line.

The 1993 Freightliner was traveling southbound in the outboard through lane at a police estimated speed of 80-88 km/h (50-55 mph).

### **Crash**

The left front of the GMC contacted the right side of the Utility flatbed trailer. The police documented a scrape mark on the pavement that measured 3.7 m (12.0 ft) in length that was deposited by the left front rim of the GMC. The scrape mark was then used to determine the approximate point of impact. The impact caused the GMC to rotate clockwise and a side-slap impact resulted, during which the left side and rear corner of the GMC contacted the right side of the Utility flatbed trailer.

The GMC was then displaced to the right and it initiated a clockwise rotation. The vehicle first crossed the auxiliary lane and the paved shoulder, and then departed the roadway on the right side and traveled onto the adjacent ground. The vehicle's left front rim deposited a scrape mark on the paved shoulder that measured 3.8 m (12.5 ft) in length. Another scrape mark that measured 2.1 m (7.0 ft) in length was deposited on the roadside and was probably the result of contact between the vehicle's drive shaft and the ground. The drive shaft was detached from the GMC during the crash.

The GMC's left front tire deposited a skid mark on the paved shoulder that measured 2.4 m (8.0 ft). The skid mark was immediately followed by a scrape mark that measured 1.5 m (4.9 ft) in length. The left front tire was possibly detached at the point where the skid mark changed to a scrape mark. At the time of the inspection the tire was missing from the rim.

After departing the paved shoulder, the vehicle traveled approximately 5.0 m (16.4 ft) on unpaved ground, then impacted a row of shrubbery with its right side. The vehicle then traveled forward a short distance and came to final rest while it remained in contact with the shrubbery. The GMC's total travel distance between the side slap impact and the impact with the shrubbery was approximately 22.2 m (72.8 ft). Between the two impacts the vehicle rotated clockwise 360 degrees.

During the interval between the vehicle-to-vehicle and shrubbery impacts, the second row right occupant was ejected through the second row right side glass. The ejection was due in part to the rapid rotation of the vehicle.

### **Post Crash**

The GMC came to rest off the roadway and heading south with its right side in contact with the shrubbery. The 20-month-old male came to final rest on the ground beneath the shrubbery.

The GMC's front row doors were jammed shut. The driver of the GMC forced the front left door open by kicking it from the inside, then exited the vehicle unassisted. The front right occupant then exited the vehicle unassisted through the front left door. The two front row occupants were ambulatory and began to search for the ejected child, who was crying audibly. They found the child

within the shrubbery north of the subject vehicle. The police reported the distance from the at-rest vehicle to the child to be 3.3 m (10.8 ft).

The driver of the GMC sustained an abrasion to his forehead and complained of pain to the left shoulder. The front row right occupant sustained minor lacerations to the face and complained of pain to her back. The 20-month-old male sustained minor lacerations to the scalp and forehead. The three occupants were then ground transported to local hospitals, where they were treated and released later that day.

After the crash, the Freightliner remained its original lane and traveled southbound for another 160 m (528 ft). The driver then parked the vehicle on the right shoulder.

### Vehicle Data - 1989 GMC Jimmy S-15

The 1989 GMC Jimmy S-15 was identified by the Vehicle Identification Number (VIN): 1GKCS18Z7Kxxxxxx. The vehicle's date of manufacture was March 1989. The GMC was a 2-door, four-passenger sport utility vehicle that was equipped with a 4.3-liter, 6-cylinder engine, automatic transmission, rear anti-lock brakes, and rear-wheel drive. The vehicle manufacturer's recommended tire size was P205/75R15, and the recommended pressure was 240 kPa (35 psi). The vehicle's left front tire was detached and missing. The left and right rear tires were General Touring A/S, size P215/70R15. Their maximum pressure rating was 303 kPa (44 psi). The right front tire was a Futura 875 Steel Belted, size P215/70R15, and its maximum pressure rating was 241 kPa (35 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Unknown	Unknown	Unknown	Unknown
LR	38 psi (262 kPa)	5 mm (6/32 in)	No	None
RR	18 psi (124 kPa)	5 mm (6/32 in)	No	None
RF	Tire flat	6 mm (7/32 in)	Yes	Sidewall cut

The first row seating in the GMC was configured with fabric-covered bucket seats with folding backs and integral head restraints. The second row seating was configured with a fabric-covered bench seat with a folding back and no head restraints. At the time of the vehicle inspection, the driver's seat back adjustment hardware had been compromised and it could not be set to a fixed position. The driver's seat cushion was at an 18 degree angle from horizontal. The front right passenger seat back was 24 degrees from vertical, and the seat cushion was 10 degrees from horizontal. The second row seat back was 20 degrees from vertical; the seat cushion was 14 degrees from horizontal.



## Vehicle Damage

### Exterior Damage

The GMC sustained direct damage to the left and the right planes; induced damage was sustained by all planes. The front grille was detached from the vehicle. The hood was buckled and displaced to the right. The left side view mirror was missing. The drive shaft was detached and was found inside the vehicle. The left front tire was missing and the rim flange was bent.



**Figure 3.** Subject vehicle, 1989 GMC Jimmy S-15

The crash consisted of three events: two impacts with the Utility trailer and one impact with the roadside shrubbery. The direct damage from Event 1 began at the front left bumper corner, extended 123 cm (48.4 in) down the left side, and ended 53 cm (20.9 in) aft of the left front axle (**Figure 3**).

Six crush measurements were taken at the mid-door level as follows: C1 = 0 cm, C2 = 20 cm (7.9 cm), C3 = 15 cm (5.9 in), C4 = 29 cm (11.4 in), C5 = 21 cm (8.3 in), C6 = 13 cm (5.1 in). The maximum lateral crush measured 29 cm (11.4 in) and was located at C4. The Collision Deformation Classification (CDC) for the first impact was 08LFEW3.

After the first impact with the Utility trailer, the GMC rotated clockwise and sustained a secondary impact wherein the left side of the GMC contacted the right side of the trailer in a side-slap impact. The direct damage began at the left rear bumper corner, extended 291 cm (114.6 in) up the left side, and ended 60 cm (23.6 in) rearward of the left front axle. Six crush measurements were taken at mid-door level as follows: C1 = 6 cm (2.4 in), C2 = 0, C3 = 0 cm, C4 = 0, C5 = 3 cm (1.2 in), C6 = 0. The maximum lateral crush for Event 2 measured 8 cm (3.1 in) and was located between C1 and C2 at 70 cm (27.6 in) aft of the left rear axle. The CDC for the second impact was 09LZEW1.

The GMC traveled off the right side of the roadway onto level ground and impacted a row of shrubbery with its right side. The direct damage to the vehicle began at front right bumper corner, extended 391 cm (153.9 in) rearward, and ended at 66 cm (26.0 in) rearward of the right rear axle. The estimated crush measurements for the third impact was as follows: C1 = 0, C2 = 2 cm (0.8 in), C3 = 0, C4 = 6 cm (2.4 in), C5 = 0, C6 = 0. The maximum lateral crush for Event 3 measured 6 cm (2.3 in) at C4 and was located 83 cm (32.7 in) aft of the right front axle. The CDC for the third impact was 02RDAW2.

### Interior Damage

The GMC sustained moderate interior damage as a result of impact forces, passenger compartment intrusion, occupant contacts and salvage activities. The rear view mirror was fractured and displaced from the windshield and the windshield was cracked. The steering wheel rim and steering column were deformed and the right instrument panel was fractured. The center console was fractured and detached from the anchor bolts, and the front row left seat back adjustment hardware was damaged.

The left front, left rear, right rear and backlight window glazing was disintegrated. The cover to a roof-mounted lamp as missing. The armrest cover and the window crank arm were displaced from the front left door panel. The roof intruded vertically and the left toe and intruded longitudinally. The specific passenger compartment intrusions were documented as follows:

Row	Position	Intruded Component	Magnitude of Intrusion	Direction
1	Left	Toe pan	5.0 cm (2.0 in)	Longitudinal
1	Left	Roof	3.0 cm (1.2 in)	Vertical

### Manual Restraints

The GMC was equipped with 3-point manual lap and shoulder belts for all seating positions. The front row safety belts were configured with non-adjustable D-ring anchorages at the B-pillars and sewn on latch plates. The front row safety belts' webbing and latch plates exhibited wear marks that evidenced historical usage. The safety belts were equipped with Emergency Locking Retractors (ELR).

The left safety belt was not used to restrain the driver. The D-ring, the webbing and the latch plate were examined and they did not reveal occupant loading. The stitching that held the latch plate in place was slightly frayed but intact. The right safety belt was not used to restrain the front row passenger. The D-ring, the webbing and the latch plate were examined and they did not reveal occupant loading. The stitching that held the latch plate in place was slightly frayed but intact. The police reported the front row occupants to be restrained, and the front right occupant stated in an interview that both front row occupants were restrained at the time of the crash. However, based on interior contact evidence, it was concluded that they were not belted.

The second row safety belts were configured with non-adjustable D-ring anchorages that were connected to the roof side rails slightly rearward of the second row seat backs. The safety belts were configured with sliding latch plates. The second row safety belts' webbing and latch plates exhibited wear marks that evidenced historical usage. The safety belts were equipped with ELR.

The second row right position occupant was seated in a belt positioning BSS and the vehicle's lap and shoulder safety belt was used to restrain the occupant. The D-ring, the webbing and the latch plate were examined and they did not reveal occupant loading evidence.

The GMC was not equipped with Lower Anchors and Tethers for Children (LATCH) hardware.

### Vehicle Data - 1993 Freightliner Tractor and 2003 Utility Flatbed Trailer

The 1993 Freightliner Tractor was identified by the VIN: 1FU YDCXB1PPxxxxxx. The Freightliner was a 3-axle tractor that was equipped with a 6-cylinder, 11.1 liter engine. The truck was configured with a diesel fuel system and had a Gross Vehicle Weight Rating (GVWR) in excess of 14,969 kg (33,001 lb). The Freightliner was towing a 2003 Utility flatbed trailer that was used to transport recycled scrap metal and iron. The trailer's load weight at the time of the crash was not known.

According to the police report, the Freightliner sustained no damage in the crash. The damage to the trailer was described in the police report as minor and included scrape marks and paint transfers consistent with contact from the subject vehicle to the right side of the trailer. The Freightliner and the trailer were driven from the scene.

### Occupant Demographics - 1989 GMC Jimmy S-15

	<b>Driver</b>	<b>Occupant 2</b>
Age/Sex:	27/Male	26/Female
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Seat Track:	Mid-track	Mid-track
Height:	173 cm (68 in)	173 cm (68 in)
Weight:	91 kg (200 lbs)	91 kg (200 lbs)
Alcohol/Drug Involvement	None	None
Body Posture:	Upright	Upright
Hand Position:	Both hands on steering wheel	Right hand on side grab handle, left hand on dash
Foot Position:	Right foot on brake, left foot on floor	Both feet on floor
Restraint Usage:	None	None
Air Bag:	None available	None available
Type of Medical Treatment:	Transported and released	Transported and released

**Occupant 3**

Age/Sex: 20 months/Male  
 Seated Position: Second row right  
 Seat Type: Split bench with folding back  
 Seat Track: Non adjustable  
 Height: 61 cm (24 in)  
 Weight: 13.6 kg (30 lbs)  
 Body Posture: Seated in a BSS  
 Hand Position: Both at sides  
 Foot Position: Both forward  
 Restraint Usage: Lap and shoulder belt with BSS  
 Air Bag: None available  
 Type of Medical Treatment: Transported and released

**Occupant Injuries****Driver**

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Lacerations, minor, left scalp	190602.1,2	Flying glass	Certain

**Front Row Right Occupant 2**

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Lacerations, minor, forehead	290602.1,7	Windshield	Possible
Contusion, right scalp	190402.1,1	Windshield	Possible
Laceration, minor, lip	290602.1,8	Windshield	Possible
Abrasions, bilateral knees	890202.1,3	Instrument panel	Certain

### Second Row Right Occupant 3

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Laceration, minor, right scalp	190602.1,1	Side glass	Probable
Laceration, minor, left scalp	190602.1,2		
Laceration, minor, right eyebrow	290602.1,7		
Laceration, minor, posterior scalp	190602.1,6	Ground	Probable

### Child Restraint System

The 20-month-old male occupant in the second row right position was seated in a Cosco Protek High Back BSS and was restrained by the vehicle's manual lap and shoulder safety belt. The BSS model number was 22-291-VIN and the date of manufacture was October 31, 2006. The Cosco was not equipped with a harness/shield or retainer clip, and was not equipped with LATCH features.

The BSS was equipped with stationary armrests, a padded headrest with height adjusters, a padded seat cushion, and a cup holder on the left side. The headrest and back was adjustable and was set to the lowest position.



**Figure 4.** Cosco Protek BSS as found in vehicle during inspection

At the time of the vehicle inspection, the BSS was found upright on the second row right seat cushion. The vehicle's manual lap belt was not routed through belt positioning slots and the shoulder belt was hanging across the headrest (**Figure 4**). The safety belt was equipped with an ELR retractor and the safety belt was in the buckled position. There was slack in the belt webbing. The retractor mechanism would not stop the belt from unspooling, even when the webbing was given a strong jerk by the DSI investigator. The retractor would retract to some degree but the recoil mechanism was weak. The safety belt was examined and displayed no evidence of occupant loading. The BSS was examined and exhibited no evidence of occupant contact, damage or loading from the safety belt.

The usage labels on the BSS indicated that the user should meet the following criteria:

- 86 -145 cm (34 - 57 in) in height
- 13.6 - 45.4 kg (30 -100 lb) in weight
- greater than one year in age

The 20-month-old occupant's mother estimated the child to be 61 cm (24 in) in height, and 13.6 kg (30 lb) in weight at the time of the crash. The child did not meet the height and age requirements of a BSS, and this contributed to the ejection. The child was too small to be properly secured by a

lap and shoulder safety belt. It was therefore determined that the improper restraint usage directly resulted in the ejection of the child from the BSS and from the vehicle.

## **Occupant Kinematics**

### **Driver**

The 27-year-old male driver was seated in an upright posture. The driver was not wearing the safety belt. The driver's seat track was set to the mid-position and the seat back was set to slightly reclined. The driver's hands were on the steering wheel and he was actively steering. His right foot was on the accelerator and his left foot was on the floor.

As the driver negotiated a sharp right curve on a wet roadway, the vehicle lost traction and initiated a left yaw and a clockwise rotation. The driver braked and steered right, and the back end of the vehicle was displaced to the left. The driver overcorrected his steering to the left, and the vehicle initiated a left yaw and a counterclockwise rotation. During the pre-crash phase the driver remained in his seated position, was actively steering with both hands, and was braking with his right foot.

The vehicle departed the auxiliary lane and entered the path of the Freightliner in the southbound through lane. The left front of the GMC impacted the right side of the towed Utility flatbed trailer. The driver loaded the steering wheel with his hands and arms, which resulted in deformation of the steering wheel rim and steering column. The lower half of the steering wheel rim was displaced forward 6 cm (2.4 in) and the steering column was displaced 10 degrees to the left. The steering wheel hub moved approximately 5 cm (2.0 in) to the left.

After the first impact, the GMC initiated a clockwise rotation and a side-slap impact with the trailer followed. The driver loaded the seat back in response to the direction of force, and broke the seat back recline mechanism. The first row left side glass was closed and the side-slap impact disintegrated the side glass. The driver's torso and left shoulder loaded the left door panel and his head contacted the windshield. The door panel's upper quadrants were deformed outward at a maximum measurement of 3 cm (1.2 in). After the crash, the driver complained of pain to his left shoulder. The left armrest was displaced from the vehicle and the plastic armrest support structure was fractured. The window crank arm was displaced, which was possibly due to salvage activity.

After the side-slap impact, the GMC initiated a clockwise rotation and was displaced to the right. The vehicle crossed the auxiliary lane and the paved shoulder, then departed the roadway and impacted a row of shrubbery with its right side. After the impact with the shrubbery, the GMC came to final rest facing south with its right side in contact with the shrubbery.

The driver kicked open the jammed left side door, exited the vehicle and searched for the ejected child. When rescue personnel arrived, the driver was ground transported to a local hospital where he was treated and released later that day.

### **Front Row Right Occupant 2**

The 26-year-old female occupant was seated in an upright posture and was not belted. The occupant's seat track was set to the mid-position and the seat back was set to slightly reclined. Her

hands were at rest by her sides and her feet were on the floor.

As the vehicle lost control, the occupant grasped the grab handle above the right roof side rail with her right hand and placed her left hand on the mid instrument panel in an effort to brace herself.

At impact, the occupant was displaced forward and to the left in response to the direction of force. The occupant's head contacted the windshield and mirror, resulting in minor lacerations to the forehead and lip and a contusion to the right scalp. Both knees contacted the lower instrument panel, resulting in abrasions to both knees. The windshield was cracked and the lower instrument panel was fractured at 20 cm (7.9 in) inboard of its right end.

After the side-slap impact, the GMC initiated a clockwise rotation and was displaced to the right. The vehicle crossed the auxiliary lane and the paved shoulder, then departed the roadway and impacted a row of shrubbery with its right side. The occupant was displaced right and rearward in response to the direction of force. After the impact with the shrubbery, the GMC came to final rest facing south with its right side in contact with the shrubbery.

The front row right occupant exited the vehicle unassisted and searched for the ejected child. When rescue personnel arrived, the occupant was ground transported to a local hospital where she was treated and then released later that day. She then missed two days of work due to her injuries.

### Second Row Right Occupant 3

The 20-month-old male occupant was seated in a Cosco Protek High Back BSS and was restrained by the 3-point manual lap and shoulder belt. The safety belt retractor was in ELR mode. The bench seat back was at a 70 degree angle from vertical; the seat cushion was at a 14 degree angle from horizontal.

During the impacts with the trailer, the child was displaced to the left in response to the directions of force. The child loaded the safety belt and remained in the CSS. After the side slap impact, the GMC initiated a clockwise rotation and was displaced to the right. Due to the rotational dynamics of the vehicle, the child was displaced to the right and displaced from the BSS and contacted the right side glass. The occupant's contact with the side glass disintegrated the glazing and the child exited the vehicle through the window (**Figure 5**). The contact of the child's head and face with the side glass resulted in minor lacerations to the left and right scalp and the right eyebrow.



**Figure 5.** Area of Occupant 3 ejection, right rear window

After the occupant was ejected he landed in the shrubbery and then contacted the ground with his head. He sustained a minor laceration to the posterior scalp as a result of contact with the ground, and he came to final rest at 3.3 m (10.8 ft) from the back end of the GMC's final rest location. The occupant was ground transported to a local hospital, treated, then released later that day.



**Attachment 1. Scene Diagram**

