CRASH DATA RESEARCH CENTER

Calspan Corporation

Buffalo, NY 14225

CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION

SCI CASE NO.: CA11003

VEHICLE: 2007 BMW 328i COUPE

LOCATION: NORTH CAROLINA

INCIDENT DATE: DECEMBER 2010

Contract No. DTNH22-07-C-00043

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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 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 system.

TECHNICAL REPORT STANDARD TITLE PAGE

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BACKGROUND

This on-site investigation focused on the rollover dynamics and the injury source for this off-road rollover crash of a 2007 BMW 328i coupe (**Figure 1)**. This crash was identified by the Calspan Special Crash Investigations (SCI) team through a visit to a regional vehicle salvage facility on February 2, 2011. Based on the rollover of the BMW, this case was assigned by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) for investigation on February 3, 2011. The on-site investigation was initiated on February 7, 2011. The investigation involved the inspection and documentation of the BMW and the crash scene, and an interview with the front right passenger of the vehicle and the father of the driver/owner of the BMW. The parents of the driver of the BMW refused to allow the driver to be interviewed.

Figure 1: Front right oblique view of the 2007 BMW.

The crash occurred as the BMW was attempting to negotiate a left curve on a two-lane roadway and the vehicle departed the roadway to the right. The BMW traveled over an embankment and then impacted a second embankment. It subsequently initiated a counterclockwise yaw and rolled over four-quarter turns to the right. The BMW was equipped with a Certified Advanced 208-Compliant frontal air bag system (CAC), side impact air bags in the front seat backs, and side impact Inflatable Curtain (IC) air bags. The impact sequence resulted in the deployment of the driver and front right passenger side frontal air bags, the right IC air bag and the right seat mounted side impact air bag. The left IC and seat mounted side air bag did not deploy. The BMW was occupied by an 18-year-old male driver, a 17-year-old male front right passenger, a 17-year-old female second row left passenger and an 18-year-old female second row right passenger. The driver sustained minor severity injuries and was not medically transported directly from the crash scene. All other occupants sustained minor severity injuries and were transported by ground ambulance to a regional trauma center where they were treated and released.

CRASH SUMMARY

Crash Site

This crash occurred during early morning hours of December 2010 on a two-lane residential roadway with a posted 40 km/h (25 mph) speed limit.. **Figure 2** depicts the approach to the crash site. At the time of the crash, the police-reported environmental conditions were cloudy, dry and dark but lighted. The roadway extended north/south in the area in which the crash occurred and included a left curve with a radius of curvature of 95 m (311 ft). There was a negative grade of 1 percent in the northbound approach to the crash site. The roadway was not marked and was 9 m (29.5 ft) in width. Outboard of the roadway was a grass roadside and a catch basin protected by earth embankments. The roadside had a positive grade of 1 percent for 4 m (13.1 ft) before sloping uphill with a positive grade of 16 percent for 3.6 m (11.8 ft) to the top of the embankment. From the top of this embankment, the grade then transitioned to a downhill grade of -31 percent for 5.4 m (17.7 ft) to the catch basin. The catch basin was partially filled with water. At the north end of this catch basin was a second embankment that extended perpendicular to the east. This embankment had an uphill 20 percent grade and was the point of impact. A Scene Diagram is included at the end of this report.

Figure 2: Northbound trajectory view of the BMW prior to the roadside departure.

Pre-Crash

The restrained 18-year-old male driver of the BMW was operating the vehicle northeast in an "S" curve. As the vehicle approached the area of the crash, it was traveling at a police estimated speed of 56 km/h (35 mph). They were traveling to take one of the occupants home and were approximately 5 minutes from the destination. The driver reported to the police and his parents that an animal ran into the roadway in front of the BMW. The BMW departed the roadway to the right in a straight trajectory. It traveled over the roadside embankment in a tracking attitude evidenced by two tire impressions for a distance of 48 m (158 ft). As the BMW crested and traveled over the embankment, the driver steered counterclockwise (CCW) to correct the vehicle's errant trajectory. As the BMW entered the catch basin, the combination of the steering and cross-slope of the embankment resulted in a CCW rotation. The vehicle rotated approximately 25 degrees and approached the perpendicular embankment.

Crash

The right aspect of the BMW's front plane impacted the perpendicularly-oriented embankment. This resulted in the actuation of the buckle pretensioners of the BMW and the deployment of the driver's and front passenger's frontal air bags. The frontal impact increased the CCW rotational velocity of the vehicle and the right tires furrowed into the soft soil and mud of the catch basin. The BMW tripped into a right side leading rollover as it traveled up the perpendicular embankment. The right side glazing disintegrated on the first quarter turn of the rollover, depositing two debris fields of glass fragments on the embankment. This impact also resulted in the deployment of the right seat mounted side impact air bag and the right IC. As the rollover continued, the backlight and left rear tail light disintegrated on the second quarter turn of the rollover and deposited debris in the area in which those components contacted the ground. The sunroof air dam separated from the top of the BMW and was pressed into the ground in the area in which the roof contacted the ground. The BMW rolled over a total of four quarter turns over a distance of 11 m (36.1 ft.), coming to rest on its wheels. The vehicle came to rest facing northwest 20 m (66 ft) east of the road edge, north of the embankment surrounding the catch basin.

Post-Crash

Police, emergency medical and tow personnel responded to the crash. The driver and three occupants exited the vehicle with assistance from individuals who had stopped after the crash. The front right occupant stated in his interview that the rear left occupant briefly lost consciousness after exiting the vehicle. The front right and both second row occupants were transported by ground ambulance to a regional trauma center. These occupants were treated and released with minor injuries. The driver refused medical attention at the scene. The BMW was towed from the scene due to disabling damage. The vehicle was then transferred from the local tow yard to a regional vehicle-salvage facility, where it was inspected.

2007 BMW 328i COUPE

Description

The 2007 BMW was manufactured in September, 2006 and was identified by the Vehicle Identification Number (VIN): WBAWB33537Pxxxxxx. The vehicle owner reported that the odometer reading was approximately 61,142 km (38,000 mi). The digital odometer was inoperative at the time of the inspection. The rear-wheel drive BMW was powered by a 3.0-liter inline, 4-cylinder engine linked to a 6-speed automatic transmission. The braking system consisted of power-assisted front and rear disc brakes with 4-wheel antilock and electronic brakeforce distribution. The BMW was also equipped with traction control, Electronic Stability Control (ESC) and a direct Tire Pressure Monitoring System (TPMS). The front right passenger stated in his interview that he believed there were no illuminated warning lights prior to the crash. The BMW was equipped with four Bridgestone Potenza RE050A run-flat tires. The tire size was P225/40R18 on the front and P255/35R18 on the rear positions. These sizes and

locations matched the vehicle manufacturer's recommendations. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the front and 241 kPa (35 PSI) for the rear. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	186 kPa (27 PSI)	7 mm (9/32 in)	No	None
LR	179 kPa (26 PSI)	6 mm (8/32 in)	No	None
RR	255 kPa (37 PSI)	6 mm (8/32 in)	No	None
RF	Tire Flat	6 mm (7/32 in)	Yes	Wheel deformed, tire de-beaded

The interior of the BMW was configured with leather-surfaced, four-passenger seating. The front bucket seats were both separated by a center console. The second row consisted of a single bench divided by a center console, with split folding backs and a pass through in the center between the passenger compartment and the trunk. All seating positions were equipped with height adjustable head restraints. The front left head restraint was adjusted 6 cm (2.4 in) above the full-down position, the front right head restraint was adjusted 7 cm (2.8 in) above the full-down position, and the second row head restraints were both 4 cm (1.6 in) above the full-down position at the time of the SCI inspection. Both front seat tracks were power-operated and located 3 cm (1.2 in) forward of the full-rear position. The driver's seat back was adjusted 23 degrees aft of vertical, and the front right passenger's seat back was adjusted 26 cm aft of vertical.

The vehicle's occupant safety systems consisted of manual 3-point lap and shoulder safety belts for the four designated seating positions, front seat buckle pretensioners, CAC dual-stage frontal air bags, seat mounted side impact air bags in the upper outboard aspects of the front seat backs, and roof side rail-mounted side impact IC air bags that provide protection for the four outboard seating positions.

Exterior Damage

The front plane of the BMW sustained moderate severity damage as a result of the embankment impact (Event 1). Event 1 damage is depicted in **Figure 3**. The direct damage began 20 cm (7.9 in) right of the vehicle centerline, and extended right 50 cm (19.7 in). The maximum crush was located at C6, the front right bumper corner, and measured 29 cm (11.4 in). The combined direct and induced damage (Field L) extended across the full width of the front bumper. A residual crush profile was documented along the front

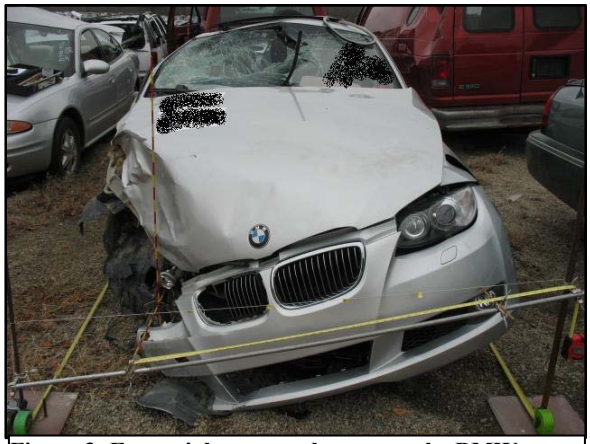

Figure 3: Front right corner damage to the BMW.

bumper and was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 3 cm (1.2 in), C4 = 16 cm (6.3 in), C5 = 22 cm (8.7 in), C6 = 29 cm (11.4 in). The right front wheel was deformed and displaced rearward. The right wheelbase was shortened by 47 cm (18.5 in). The yielding nature of the embankment invalidated the full use of the WinSMASH program to calculate the severity of the crash. A Barrier Equivalent Speed (BES) of 21 km/h (13 mph) was calculated using the Barrier Algorithm. The Collision Deformation Classification (CDC) assigned for the damage pattern was 01FZEW2.

The BMW's right, left and top planes sustained moderate severity damage as a result of the rollover **(Figure 4)**. On the right side, the direct contact damage began at the right front bumper corner and extended rearward 390 cm (153.5 in) to the trunk lid/taillight area. The direct contact damage to the roof extended 105 cm (41.3 in) laterally from the side rail to side rail. The maximum vertical and lateral deformations were located at the right C-pillar, 9 cm (3.5 in) forward of the junction of the right roof side rail and the backlight header. The maximum residual deformation measured 11 cm (4.3 in) laterally and 10 cm (3.9 in) vertically. The CDC assigned for the rollover event was 00RDAO3.

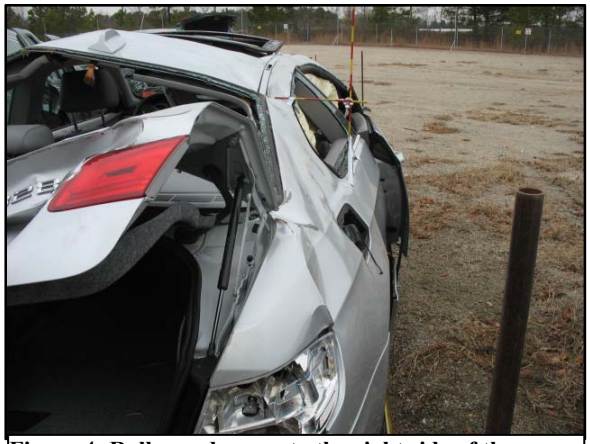

Figure 4: Rollover damage to the right side of the BMW.

Interior Damage

The BMW sustained moderate severity interior damage that was attributed to passenger compartment intrusion, occupant contact, and air bag deployment. There was a scuff mark on the left roof side rail that was attributed to the driver's head. This scuff mark was located on the interior of the roof side rail and extended 32 cm (12.6 in) forward of the B-pillar to 51 cm (20.1 in) forward of the referenced pillar. The driver's head restraint contained an area of smeared body fluid. This body fluid began at the left side of the driver's head restraint and was 11 cm (4.3 in) in width and 12 cm (4.7 in) vertically. The front right head restraint was contacted and compressed 2 cm (0.8 in) by the intruding right roof side rail. The windshield header, roof over the front and back rows and backlight header all intruded vertically. The vertical roof intrusion over the front row measured 3 cm (1.2 in), 8 cm (3.1 in), and 9 cm (3.5 in) from left to right. Over the second row, the vertical roof intrusion measured 2 cm (0.8 in) on the left and 10 cm (3.9 in) on the right. In the center of the second row the roof had displaced upward by the lateral intrusion. The A-, B-, and C-pillars on the right side intruded laterally a distance of 4 cm (1.6 in), 6 cm (2.4 in), and 8 cm (3.1 in), respectively. The right toe pan intruded longitudinally a distance of 17 cm (6.7 in). The right roof side rail intruded laterally 6 cm (2.4 in) in the front row and 8 cm (3.1 in) in the back row.

Manual Restraint Systems

The BMW was equipped with 3-point lap and shoulder belts for the four designated seating positions. All belt systems utilized continuous loop webbing and sliding latch plates. The upper D-rings for all belts were fixed. The driver's belt retracted onto an Emergency Locking Retractor (ELR); all other belts retracted onto switchable ELR/Automatic Locking Retractors (ALR). Both front safety belts and the right rear safety belt were in use at the time of the crash. The front belt systems utilized buckle pretensioners that actuated during the crash.

The driver's safety belt exhibited a 1 cm (0.4 in) frictional abrasion that was located 81 cm (31.9 in) above the lower outboard anchor. The front right passenger's safety belt exhibited a 3 cm (1.2 in) black plastic transfer from the latch plate to the webbing. This loading evidence was located 93-96 cm (36.6–37.8 in) above the lower outboard anchor. Both second row belts also contained evidence of usage during the crash. The rear right belt exhibited an imprint from the latch plate located 73 cm (28.7 in) above the bight of the seat.

Supplemental Restraint Systems

The BMW was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual-stage driver and passenger air bags, seat track positioning sensors, front seat retractor pretensioners, safety belt buckle switches and a front right occupant weight sensor. The manufacturer of the BMW certified that this vehicle was compliant with the advanced air bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Both frontal air bags deployed during this crash sequence.

Figure 5: Driver's frontal air bag.

The driver's air bag was concealed within the center hub of the three-spoke steering wheel by four cover flaps. The cover flaps opened as designed. The upper flap was 10 cm (3.9 in) in width and 9 cm (3.5 in) in height. The lower center flap was 7 cm (2.8 in) in width and 3 cm (1.2 in) in height. The lower right and left flaps were 6 cm (2.4 in) in width and 3 cm (1.2 in) in height. The driver's air bag measured 60 cm (23.6 in) in diameter in its deflated state. It was vented by two vent ports located at the upper rear aspect of the air bag at the 11:30 and 12:30 o'clock positions. There were no tethers present. Examination of the driver's air bag showed two deployment transfers and one occupant contact. The first deployment transfer was centered on the front of the air bag and measured 6 cm (2.4 in) in width and 8 cm (3.1 in) in height. The second deployment transfer was located on the lower rear aspect of the air bag and measured 8 cm (3.1 in) in height and 22 cm (8.7 in) in width. The contact was a scuff that was attributed to

the driver's face, located 5-18 cm (2-7.1 in) right of the vertical centerline of the air bag and 1-5 cm (0.4-2 in) above the horizontal centerline of the air bag. **Figure 5** depicts the deployed driver's air bag. The driver's air bag was labeled with the ID number 448906072375.

The front right air bag was concealed within the upper aspect of the instrument panel by a single cover flap measuring 21 cm (8.3 in) in width and 6 cm (2.4 in) in height. The air bag measured 49 cm (19.3 in) in width and 56 cm (22 in) in height. The passenger air bag was vented by two vent ports at the 11 and 1 o'clock positions. It did not contain any internal tethers; however, the deployment was controlled by a system of tear seams on the top and front faces of the air bag. These tear seams were arranged in a horseshoe shape and measured 18 cm (7.1 in) in width and 22 cm (8.7 in) in length. There was no damage or contact evidence to the front right air bag.

The BMW was equipped with front seatback-mounted side impact air bags and roof side rail-mounted IC air bags. The right side impact air bag and IC deployed during the first-quarter turn of the rollover event. The left side impact air bag and IC did not deploy.

The right side impact air bag deployed from a 52 cm (20.5 in) tear seam in the upper outboard aspect of the front right seatback. The air bag was 10 cm (3.9 in) in width and 48 cm (18.9 in) in height. There was no contact evidence or crash related damage to the air bag. It was labeled with the ID number 9017000009997401.

Figure 6: Outboard side of right IC air bag.

The right IC air bag deployed from the right roof side rail. The IC measured 195 cm (76.8 in) in length. It was 34 cm (13.4 in) in height at the front row and 18 cm (7.1 in) in height at the second row. Vertically, the IC air bag extended below the belt line at both seating positions. The right IC provided full coverage across the right greenhouse area of the BMW. At the forward aspect of the right IC was a non-inflated sail panel. The panel measured 20 cm (7.9 in) in height and 14 cm (5.5 in) in width at the upper aspect, curving to 26 cm (10.2 in) in width at the lower aspect. There was dirt present on the lower aspect of the inboard side of the right IC, and a scuff mark with mud on the outboard side of the right IC that resulted from contact with the ground. The mark on the outboard side was 6-17 cm (2.4-6.7 in) below the right roof side rail and 15-60 cm (5.9-23.6 in) forward of the right B-pillar. **Figure 6** depicts the outboard side of the right IC.

Rollover Discussion

The 2007 BMW 3-series was tested by the NHTSA for Rollover safety and earned a 4-star rating. In the agency's *Dynamic 80 km/h (50 mph) Reverse Steer Test*, the BMW 3-series did not "Tip-up" and the rollover risk was determined to be 10.3%. The vehicle was equipped with Electronic Stability Control (ESC) and traction control. It was not equipped with roll-sensing capabilities.

The BMW departed the right side of the road and traveled over the roadside embankment in a tracking attitude. The tracking attitude was evidenced by rolling tire impressions that measured 48 m (158 ft) in length. As the BMW crested and traveled over the embankment, the driver steered CCW in an effort to correct the vehicle's trajectory. The combination of steering and the 31% embankment grade resulted in a CCW rotation. As the rotation angle approached 25 degrees the vehicle encountered a perpendicular-oriented embankment. The front right of the vehicle impacted the embankment. This offset impact increased the rotational velocity of the vehicle and the right tires furrowed into the soft soil and mud of the catch basin. The BMW tripped into a right side leading four-quarter turn rollover as it traveled up the embankment slope. The BMW rolled four-quarter turns over a distance of 11 m (36.1 ft) coming to rest on its wheels.

2007 BMW 328i OCCUPANTS

Driver Demographics

Age/Sex:	18-year-old/Male
Height:	178 cm (70 in)
Weight:	73 kg (160 lb)
Eyewear:	None
Seat Type:	Bucket with folding back
Seat Track Position:	Mid/rear-track, 3 cm (1.2 in) forward of full-rear
Manual Safety Belt Use:	Lap and shoulder
Usage Source:	SCI vehicle inspection
Air Bags:	CAC driver frontal deployed
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Exited with some assistance
Transport from Scene:	None
Medical Treatment:	None

Driver Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	8 cm (3 in) contusion on left cheek	210402.1,2	Driver's frontal air bag	Certain

Source – Surrogate interview (driver's father)

Driver Kinematics

The 18-year-old male driver of the BMW was seated in a mid/rear-track position while operating the vehicle northbound through a series of curves. The BMW departed the roadway to the right in a tracking attitude. It traveled over an embankment and into a silt catch basin before initiating a CCW yaw and impacting an embankment with its front right corner.

The front right impact actuated the driver's buckle pretensioner and deployed the frontal air bag. The driver initiated a forward and slightly right trajectory within the front left seating position in response to the frontal impact force He loaded the safety belt with his chest and abdomen. The driver's face contacted the frontal air bag, depositing a scuff mark and resulting in the facial contusion. As the vehicle began to roll to the right, the left side of the driver's head impacted the left roof side rail, depositing a scuff mark. The driver then initiated a rebound trajectory to the right as the rollover continued. The driver rebounded again to the left as the BMW came to rest, contacting the driver's seat.

When the BMW came to rest, the driver was still restrained within the front left seating position. Witnesses opened the left door of the BMW and assisted the driver from the vehicle. The driver was not medically transported from the scene. He was taken home by his parents and did not seek follow-up medical treatment. The driver also complained of lower back strain that was attributed to the impact forces associated with the crash. It was not possible to code this injury without medical documentation.

Front Right Occupant Demographics

Age/Sex:	17-year-old/Male
Height:	183 cm (72 in)
Weight:	75 kg (165 lb)
Eyewear:	None
Seat Type:	Bucket with folding back
Seat Track Position:	Mid/rear-track, 3 cm (1.2 in) forward of full-rear
Manual Safety Belt Use:	Lap and shoulder
Usage Source:	SCI vehicle inspection
Air Bags:	CAC front right, seat back, and IC deployed
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Exited with some assistance
Transport from Scene:	Ground ambulance
Medical Treatment:	Treated in the emergency department and released the same day

Front Right Occupant Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	8 cm (3 in) abrasion of the anterior right knee, and abrasion on left knee *	810202.1,3	Right lower instrument panel	Certain
2	15 cm (6 in) contusion of the anterior right knee #	8104021.1	Right lower instrument panel	Certain

Source –*Medical Records, #interview

Front Right Occupant Kinematics

The initial impact to the front right of the BMW actuated the front right buckle pretensioner and deployed the front right air bag. The front right passenger initiated a forward and slightly right trajectory in response to the frontal impact force. He was restrained by the manual safety belt system. The front right passenger's knees impacted the instrument panel, resulting in the contusion to the right knee and abrasions to the bilateral knees. As the crash sequence progressed and the right side of the BMW impacted the embankment as the vehicle rolled to the right, the right side impact air bag and the right IC deployed. The front right occupant loaded the right IC and side impact air bag. As the BMW came to rest, the front right passenger was restrained in the front right seating position by the lap and shoulder belt.

Witnesses opened the right door of the BMW and assisted the front right passenger from the vehicle. He was transported by ground ambulance to a regional trauma center where he was treated in the emergency department and released the same day.

Rear Left Occupant Demographics

Age/Sex:	18-year-old/Female
Height:	168 cm (66 in)
Weight:	45 kg (100 lb)
Eyewear:	Eyeglasses
Seat Type:	Bench with folding back
Seat Track Position:	Not adjustable
Manual Safety Belt Use:	None
Usage Source:	SCI vehicle inspection
Air Bags:	None
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Exited the vehicle with some assistance
Transport from Scene:	Ground ambulance
Medical Treatment:	Treated in the emergency department and released the same day

Rear Left Occupant Injuries

Inj. No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Contusions over entire face*	210402.1,0	Rear right occupant	Certain
2	0.5 cm (0.2 in) laceration between the eyes*	210602.1,7	Eyeglasses contacting rear right occupant	Certain
3	Left hand small abrasion*	710202.1,2	Unknown	Unknown
4	Left hand small laceration*	710602.1,2	Fractured glass on right side panel rear of the B-pillar	Probable
5	Right forearm abrasions, dorsal aspect*	710202.1,1	Right IC	Probable
6	1.5 cm (0.6 in) laceration on dorsal aspect of the left forearm*	710602.1,2	Fractured glass on right side panel rear of the B-pillar	Probable
7	Left abdomen abrasion*	510202.1,2	Right side panel rear of the B-pillar	Probable
8	Bilateral lower extremity contusions*	810402.1,3	Front left seat back	Probable

Source – *Medical records

Rear Left Occupant Kinematics

The initial frontal impact to the BMW caused the rear left passenger to initiate a forward and slightly right trajectory within the rear left seating position. She loaded the rear aspect of the front left seat back resulting in bilateral lower extremity contusions. As the BMW rolled over, she initiated a right trajectory through the passenger compartment. The rear left occupant impacted the left side of the restrained rear right occupant resulting in soft tissue facial injuries. The rear left occupant continued her trajectory to the right and impacted the right IC and side panel. The contact to the side panel resulted in probable abdominal abrasions. The soft tissue injuries to the left hand and forearm resulted from contact with the disintegrated glazing at the side panel. As the vehicle came to final rest, she initiated a rebound trajectory to the left within the second row of the BMW. She came to rest across the center console of the second row of the BMW with her lower body in the left floor pan.

Witnesses opened the left door of the BMW and assisted the passenger from the vehicle. It was reported by interview that she contacted the front right head restraint as she exited the vehicle, depositing a smear of blood on the left half of the head restraint. Subsequent to exiting the vehicle, it was reported that the rear left occupant briefly lost consciousness as the driver and occupants waited for EMS to arrive. The rear left occupant was later transported by ground

ambulance to a regional trauma center where she was treated in the emergency department and released the same day.

Rear Right Occupant Demographics

Age/Sex:	17-year-old/Female
Height:	168 cm (68 in)
Weight:	50 kg (110 lb)
Eyewear:	None
Seat Type:	Bench with folding back
Seat Track Position:	Not adjustable
Manual Safety Belt Use:	Lap and shoulder
Usage Source:	SCI vehicle inspection
Air Bags:	IC deployed
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Exited with some assistance
Transport from Scene:	Ground ambulance
Medical Treatment:	Treated in the emergency department and released the same day

Rear Right Occupant Injuries

Inj. No.	Injury	Injury Severity (AIS 2005/08)	Injury Source	Confidence Level
1	Epistaxis*	Minor (251004.1,4)	Unrestrained rear left occupant	Probable
2	15 cm (6 in) contusion on the left side of the face#	Minor (210402.1,2)	Unrestrained rear left occupant	Probable
3	Left knee contusion*	Minor (810402.1,2)	Unrestrained rear left occupant	Probable
4	Cervical strain*	Minor (640278.1,6)	Unrestrained rear left occupant (indirect)	Probable

Source – *Medical Records, #interview

Rear Right Occupant Kinematics

The initial frontal impact to the BMW caused the rear right occupant to initiate a forward and slightly right trajectory within the rear left seating position. She loaded the safety belt with her chest and abdomen. When the BMW tripped into the right side leading rollover, the vehicle rolled around the rear right occupant, causing her to load the center console with her lower body. The unrestrained rear left passenger impacted the left side of the restrained rear right passenger's body and head. The occupant to occupant contact resulted in the facial and left knee contusion, epistaxis and indirect cervical strain. As the BMW came to final rest, she initiated a rebound

trajectory to the right within the rear right seating position. She loaded the right side panel and the right IC before coming to rest still restrained in the rear right seating position.

Witnesses opened the right door of the BMW and assisted the passenger from the vehicle. She was later transported by ground ambulance to a regional trauma center where she was treated in the emergency department and released the same day.

SCENE DIAGRAM