**TRANSPORTATION SCIENCES**
**CRASH DATA RESEARCH CENTER**

Advanced Information Engineering Services
A General Dynamics Company
Buffalo, NY 14225

# SCI-1 ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
# SCI TECHNICAL SUMMARY REPORT

**CASE NO. CA02-049**

**VEHICLE – 1998 VOLKSWAGEN BEETLE**

**LOCATION - STATE OF IDAHO**

**CRASH DATE – OCTOBER 2002**

Contract No. DTNH22-01-C-17002

Prepared for:

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

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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 systems.

# TECHNICAL REPORT STANDARD TITLE PAGE

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| *16. Abstract*<br>This on-site investigation focused on the performance of a forward-facing convertible child safety seat (CSS) that was installed in a 1998 Volkswagen Beetle. The Beetle was occupied by a 24-year-old female driver and a 14-month-old female child passenger. The driver was unrestrained and the child was restrained in a forward-facing convertible CSS in the rear right position. The driver was operating the vehicle during nighttime hours under the influence of alcohol and failed to negotiate a left curve. The vehicle departed the right roadside and the driver overcorrected by steering left. The Beetle initiated a counterclockwise yaw and rolled over two complete turns. The unrestrained driver was ejected from the vehicle and sustained fatal injuries. The 14-month-old child sustained right temporal scalp contusions, a right ear contusion, and a right upper posterior arm contusion from contact with the right aspect of the CSS. She also sustained right shoulder abrasions from the harness strap and a forehead abrasion as a result of contact with the tray shield. The crash was not discovered until daylight hours, due to heavy brush cover surrounding the Volkswagen. Police reported that the child was found seated next to the CSS by the first arriving officer. The child also sustained mild hypothermia due to the duration of time between the crash and the discovery of the crash. She was transported by ambulance to a local hospital and admitted. | | | |
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## *BACKGROUND*

**Figure 1. On-scene photograph of the 1998 Volkswagen Beetle at rest**

This on-site investigation focused on the performance of a forward-facing convertible child safety seat (CSS) that was installed in a 1998 Volkswagen Beetle. The Beetle was occupied by a 24-year-old female driver and a 14-month-old female child passenger. The driver was unrestrained and the child was restrained in a forward-facing convertible CSS in the rear right position. The driver was operating the vehicle during nighttime hours under the influence of alcohol and failed to negotiate a left curve. The vehicle departed the right roadside and the driver overcorrected by steering left. The Beetle initiated a counterclockwise yaw and rolled over two complete turns. The unrestrained driver was ejected from the vehicle and sustained fatal injuries. The 14-month-old child sustained right temporal scalp contusions, a right ear contusion, and a right upper posterior arm contusion from contact with the right aspect of the CSS. She also sustained right shoulder abrasions from the harness strap and a forehead abrasion as a result of contact with the tray shield. The crash was not discovered until daylight hours, due to heavy brush cover surrounding the Volkswagen **(Figure 1)**. Police reported that the child was found seated next to the CSS by the first arriving officer. The child also sustained mild hypothermia due to the duration of time between the crash and the discovery of the crash. She was transported by ambulance to a local hospital and admitted.

The SCI-1 team identified the potential CSS case through a web-based news group. The news article was forwarded to the NHTSA SCI headquarters and the case was assigned as an on-site investigation.

## *SUMMARY*

### Crash Site

This single-vehicle crash occurred during the nighttime hours of October 2002. At the time of the crash, the weather was cloudy and overcast, and the asphalt roadway was dry. The National Weather Service reported the temperature to have been 6 degrees Celsius (44 degrees Fahrenheit) at the estimated time of the crash. The crash occurred on the west roadside of a four-lane divided north/south state roadway. At the crash site, the roadway was straight with a level grade. A four-leg intersection was located north of the crash site and the southbound lanes curved left on approach to the point of the roadside departure. The travel lanes were bordered by asphalt shoulders and divided by a grassy median. The roadside environment was primarily flat

and consisted of packed dirt, rocks, and sagebrush. Reflective delineator posts were spaced along the roadside and the posted speed limit was 97 km/h (60 mph). There was no traffic control at the crash scene. The scene schematic is included as Figure 25 at the end of this report.

**Pre-Crash**

The 24-year-old female driver was operating the vehicle in a southbound direction on the state roadway during the nighttime hours **(Figure 2)**. Police reported that the driver was operating the vehicle under the influence of alcohol. As the vehicle approached the crash site, the driver failed to negotiate the left curve and traveled onto the roadside in a tracking motion. Police estimated the vehicle's pre-crash speed to be 106 km/h (66 mph). The Volkswagen Beetle traveled in a south direction along the roadside for approximately 52 m (170'). The driver attempted to regain control by steering left. She overcorrected which caused the vehicle to initiate a counterclockwise (CCW) yaw for approximately 47 m (154').

**Figure 2. Southbound approach for the Volkswagen Beetle**

**Crash**

The right side tires furrowed into the roadside, which tripped a rollover with the right side leading. The vehicle rolled eight quarter-turns over a distance of approximately 57 m (186') and came to rest upright facing northeast on the roadside **(Figure 3)**. The unrestrained driver was ejected through the backlight during the rollover event. Miscellaneous clothes and store-bought items that were present in the vehicle were also ejected and deposited along the vehicle's rollover trajectory **(Figure 4)**. The vehicle's final rest position was behind tall sagebrush, which made it difficult to detect the vehicle from the roadway. The driver came to rest 6.4m (21.0') south of the vehicle's final rest position and 11.3 m (37.0') west of the roadside.

**Figure 3. Southbound view of the rollover trajectory**

**Figure 4. Miscellaneous contents ejected from the vehicle**

**Post-Crash**

The crash was not discovered for approximately eight hours. A passing motorist detected the vehicle's reflection behind the sagebrush and determined that a crash had occurred. The passing motorist telephoned the police and reported the crash. Police found the female driver of the Volkswagen south of the vehicle's final rest position. She was found face-down and was

wearing only undergarments when she was discovered. Police reported that her clothing had come off during her ejection from the vehicle and were found in the roadside sagebrush. Post-crash inspection of the clothing noted a pair of black coveralls that exhibited torn seams on the back aspect, separation of the top rear aspect, and deformity of the front left metal clasp. The driver was reported to have been wearing a grey, fleece, hooded pullover, with long sleeves. The pullover exhibited dirt transfers, minor scuffs, and minor tears.

The 14-month-old female child passenger was reported by police to have been found seated in the back seat of the Volkswagen next to the CSS. It was believed that the child was able to crawl out of the harness straps and climb out of the seat after the vehicle came to rest, although it could not be confirmed. She sustained police-reported minor contusions and a mild case of hypothermia. She was transported by ambulance to a local hospital where she was treated and released.

***VEHICLE DATA – 1998 Volkswagen Beetle***

The 1998 Volkswagen Beetle was identified by the Vehicle Identification Number (VIN): 3VWBB61C6WM (production sequence omitted). The Beetle was manufactured in March 1998. The vehicle was a two-door coupe equipped with a 2.0 liter, 4 cylinder engine, five-speed manual transmission, front-wheel drive, power four-wheel disc brakes, power heated mirrors, power windows, power door locks, anti-theft system, power steering, and a tilt/telescoping steering wheel. The vehicle was equipped with alloy wheels and Kelly Charger 205/55R16 tires on the left front, left rear, and right rear wheels. The right front wheel was equipped with a Goodyear Eagle 205/55P16 tire. The specific tire data is as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|---|---|---|---|---|
| LF | 193.1 kpa (28.0 psi) | 7.1 mm (9/32”) | No | None |
| LR | 0.0 kpa | 7.1 mm (9/32”) | No | Debeaded |
| RF | 0.0 kpa | 6.4 mm (8/32”) | No | Debeaded |
| RR | 0.0 kpa | 7.1 mm (9/32”) | No | Debeaded |

The front seating positions in the 1998 Volkswagen Beetle were configured with bucket seats with folding backs and adjustable head restraints. Both front seat tracks and seat backs had been adjusted by rescue personnel and the pre-crash seat positions were not known. The seat tracks had a total fore and aft travel distance that measured 17.8 cm (7.0”). The rear seating positions consisted of a bench seat with a folding back and adjustable head restraints for the outboard positions. The head restraints for the front and rear seating positions were trapezoidal in shape and measured 19.1 cm (7.5”) in width at the top aspect, 29.2 cm (11.5”) in width at the bottom aspect, and 18.4 cm (7.3”) in height. The center aspect of each head restraint was open and the opening measured 16.5 cm (6.5”) in width and 7.6 cm (3.0”) in height.

Both front seat backs were configured with after-market seat covers **(Figure 5)**. There were no identifying labels on the seat covers indicating the manufacturer. It appeared that the outboard aspects of the covers were cut to gain access to the release levers on the upper outboard aspects of the seat backs. The covers were installed over the seat back from the top and subsequently pulled over the seat cushion. Elastic loops were present on the inboard and outboard aspects of the seat covers near the rear aspect of the cushion, but were not secured at the time of the vehicle inspection. The underside of the seat cover revealed a clear plastic pouch with plastic hooks for the elastic loops, however, the plastic pouch had not been opened and the hooks were not in use. A content label was also present on the underside of the seat cover adjacent to the hooks and instructions that included a warning that read "Warning: Not recommended for use on seats equipped with air bags." In addition, a warning label was present on the forward aspect of both B-pillars that read, "ATTENTION-SAFETY INFORMATION! This vehicle is equipped with SIDE-AIRBAG in the seats. DO NOT USE SEAT COVERS. For further IMPORTANT INFORMATION see OWNER'S MANUAL."

**Figure 5. View of driver's aftermarket seat cover**

Additional cargo in the vehicle at the time of the crash included numerous plastic bags of new clothing, a large box of powder laundry detergent, a television game system, quarts of motor oil, bags of snack foods, audio tapes, video tapes, and a pizza **(Figure 6)**.

**Figure 6. Additional cargo items found in the vehicle**

## *VEHICLE DAMAGE*

### Exterior Damage – 1998 Volkswagen Beetle

The 1998 Volkswagen Beetle sustained moderate damage as a result of the rollover **(Figure 7)**. The front bumper fascia and both head lamp assemblies were separated from the vehicle. The left mirror was separated. Heavy abrasions from ground contact were present on the upper left A-pillar, left roof side rail, upper left B-pillar, and upper left C-pillar. Minor diagonal abrasions were present on the left front fender, left door, and left rear quarter panel. The left rear fender was fractured and separated. Grass was deposited in the left front door area and the left rear window frame. The left front and left rear alloy wheels were abraded. The left front wheel was turned inward

**Figure 7. Damaged 1998 Volkswagen Beetle**

approximately 30 degrees and the left rear wheel was displaced slightly rearward. The left C-pillar and left rear aspect of the roof were crushed vertically with a lateral component due to the rollover. The maximum roof crush was located at the left C-pillar area. The roof exhibited lateral abrasions. The rear hatch was displaced. The right roof side rail and right C-pillar sustained moderate abrasions. The top aspect of the right door was displaced outward which created a gap between the top aspect of the door frame and the roof side rail that measured 17.8 cm (7.0”). The right front fender was fractured and separated. The right sill sustained lateral crush that measured 10.2 cm (4.0”) and was located 78.7 cm (31.0”) rear of the right A-pillar. The right front and right rear alloy wheels were abraded and the right rear wheel was fractured. The right side suspension components were damaged as a result of the CCW yaw and resistance from the right side tires. The damage to the suspension components resulted in inward lateral deflection of the lower aspects of the right side wheels **(Figure 8)**. The Collision Deformation Classification for the rollover event was 00-TDDO-3.

**Figure 8. Right side view of damaged Volkswagen Beetle**

**Interior Damage - 1998 Volkswagen Beetle**

The interior damage to the 1998 Volkswagen Beetle was attributed to passenger compartment intrusion and occupant contact. Both side doors were operational. The rear hatch was displaced and jammed. The windshield laminate exhibited a minor fracture on the right aspect. The left door glazing, right door glazing, left rear glazing, and backlight glazing disintegrated from impact forces. The bottom half of the steering wheel rim was deformed forward 2.5 cm (1.0”) from occupant contact and there were no identifiable contacts to the knee bolster **(Figure 9)**. The rear view mirror assembly was separated from the roof and hanging by the wiring harness. The driver’s head restraint was deformed slightly CW, but exhibited no contact evidence. The front right head restraint was completely separated from the seat back. Heavy body fluid transfers (blood) were present on the head restraint fabric, and it appeared to have pulled vertically out of the seat back during the rollover **(Figure 10)**. Two heavy lateral dirt transfers were present above

**Figure 9. View of deformed steering wheel rim and knee bolster**

**Figure 10. View of front right seat and separated front right head restraint**

the front seating area. The transfer over the driver's seat was located 52.1 cm (20.5") rear of the windshield header and began 30.5 cm (12.0") inboard of the left roof side rail. The transfer measured 11.4 cm (4.5") in length and extended laterally 30.5 cm (12.0") toward the centerline. The second transfer was located 53.3 cm (21.0") rear of the windshield header and began 58.4 cm (23.0") inboard of the right roof side rail. The transfer measured 17.8 cm (7.0") in length and extended 27.9 cm (11.0") laterally to the right. What appeared to be stains from the pizza were also present on the head liner.

The rear left head restraint was displaced as a result of the lateral left C-pillar intrusion and subsequent ejection of the driver **(Figure 11)**. The head restraint rotated CCW approximately 170 degrees, based on the on-scene photographs, and the outboard stainless steel post was completely separated from the head restraint and seat back. The inboard post was displaced and partially separated from the seat back. Scuff marks were present on the interior trim panel of the left C-pillar from probable contact with the driver during the ejection.

**Figure 11. Damaged rear left head restraint**

The right rear interior plastic panel/armrest sustained a 14.6 cm (5.8") long scuff on the top aspect from contact with the CSS. A small tear was present 4.4 cm (1.8") below the top aspect of the armrest. The tear began 12.7 cm (5.0") aft of the forward aspect of the armrest and measured 1.6 cm (0.6") in length **(Figure 12)**.

**Figure 12. View of abrasion and laceration on right rear armrest**

The rollover event resulted in several intruded components. Lateral intrusions included the left front door, the left roof side rail, the left rear side panel, and the left C-pillar. Vertical intrusions included the roof, left roof side rail, the left C-pillar, and the backlight header.

The specific intrusions are as follows:

| Position | Intruded Component | Magnitude of Intrusion | Direction |
|---|---|---|---|
| Front left | Roof | 14.0 cm (5.5”) | Vertical |
| Front left | Roof side rail | 12.1 cm (4.8”) | Vertical |
| Rear left | Interior left side panel | 7.0 cm (2.8”) | Lateral |
| Rear left | Roof | 12.7 cm (5.0”) | Vertical |
| Rear left | Left C-pillar | 18.4 cm (7.3”) | Lateral |
| Rear left | Left C-pillar (top aspect) | 12.1 cm (4.8”) | Vertical |
| Rear left | Backlight header | 21.6 cm (8.5”) | Vertical |
| Rear center | Backlight header | 10.8 cm (4.3”) | Vertical |
| Rear right | Roof | 4.4 cm (1.8”) | Vertical |
| Rear right | Right C-pillar (top aspect) | 7.6 cm (3.0”) | Vertical |

***MANUAL RESTRAINT SYSTEMS – 1998 Volkswagen Beetle***

The 1998 Volkswagen Beetle was configured with manual 3-point lap and shoulder belts with sliding latch plates and fixed D-ring anchors for each outboard seating position. The rear seat was not configured with a center seat position, and was not equipped with a manual restraint. The lap portions of the front seat restraints were anchored to steel bars mounted longitudinally along the inboard lower sill areas. The bars measured 27.9 cm (11.0”) in length and 1.0 cm (0.4”) in diameter. The driver’s seat belt was configured with an Emergency Locking Retractor (ELR) and the remaining seat belts were configured with switchable ELR/Automatic Locking Retractors (ALR). Retractor pretensioners were present for the driver and front right passenger seat belts, but it could not be determined if they fired as a result of the rollover. The driver’s seat belt was found in the stowed position at the time of the vehicle inspection, and was not utilized by the driver in the crash **(Figure 13)**. In its stowed position, the driver’s seat belt webbing exhibited minor body fluid (blood) transfers that were consistent with a body fluid pattern on the adjacent interior B-pillar panel. The driver’s latch plate showed signs of minor historical usage.

**Figure 13. View of post-crash driver's seat belt**

The front right passenger's seat belt and rear left seat belt were found operable in their stowed position during the vehicle inspection.

The rear right seat belt **(Figure 14)** was found buckled and routed through the forward-facing belt path of the CSS during the vehicle inspection. In the buckled position, the length of the shoulder belt webbing measured 62.2 cm (24.5") between the D-ring and the latch plate. The lap belt portion measured 58.4 cm (23.0") between the latch plate and outboard anchor. The retractor was found to be in the locked mode. The Volkswagen's rear right latch plate showed no abrasions indicative of historical usage. The plastic housing on the latch plate was abraded due to the loading of the webbing during the rollover. Stretching of the webbing began at the stop button and extended 21.6 cm (8.5") upward. A black linear transfer that extended laterally across the webbing was adjacent to the stop button, which was a result of loading against the right side plastic surface of the CSS belt path.

**Figure 14. View of rear right seat belt**

***CHILD SAFETY SEAT – Cosco Regal Ride***

The Cosco Regal Ride **(Figure 15)** was a convertible CSS with a tray shield installed forward-facing in the rear right position of the Volkswagen Beetle. A locking clip was not required due to the use of the ALR, and the locking clip was found attached to the rear aspect of the CSS. The CSS manufacture date was June 2002 and the CSS was not listed on the NHTSA recall list. The 1998 Volkswagen Beetle was not equipped with lower anchors, but was configured with tether anchors on the rear outboard positions. Although the CSS was originally configured with a tether strap, it was not present on the CSS at the time of the inspection. The harness system was routed through the lowest harness slots that were intended for rear-facing use rather than through the top reinforced slots. The harness retainer clip was positioned 19.1 cm (7.5") above the latch plate.

**Figure 15. Cosco Regal Ride CSS**

The left harness strap was permanently routed through the retainer clip and the right harness strap was inserted from the front aspect versus the rear aspect **(Figure 16)**. Since the right harness strap was routed through the retainer clip from the front, it was not held in position by the plastic locking tab on the retainer clip. The left harness strap had two complete twists in the webbing between the rear harness bracket and the retainer clip. It had two additional complete twists between the retainer clip and the latch plate. The right harness strap had one complete twist between the rear harness bracket and the retainer clip and one complete twist between the retainer clip and the latch plate. It was not known how tight the harness straps were in relation to the child passenger, however, the harness adjustment webbing on the front aspect of the CSS was extended 35.6 cm (14.0”). The latch plate showed abrasions indicative of regular usage.

**Figure 16. View of harness straps and harness retainer clip**

The CSS was found in the rear right seating position and installed forward-facing with the manual 3-point lap and shoulder belt **(Figure 17)**. The vehicle seat belt was in the locked mode and was routed through the forward-facing belt path. At the time of the vehicle inspection, the CSS had not been moved since the time of the crash. The CSS was found leaning to the left toward the center of the vehicle at a 20 degree angle from vertical and rotated slightly CW within the vehicle seat belt. The right front aspect of the CSS was resting directly against the right rear interior panel. Although the vehicle seat belt was buckled, the CSS was able to move greater than 2.5 cm (1.0”) side-to-side and fore-and-aft. The kickstand was in the down position for forward facing use. The distance between the seat back and kickstand measured 16.5 cm (6.5”) on the left side and 2.5 cm (1.0”) on the right side.

**Figure 17. Post-crash position of the CSS**

The Cosco convertible CSS sustained moderate damage as a result of the crash **(Figures 18 and 19)**. Abrasions on the left outboard aspect of the tray shield began 11.4 cm (4.5”) below the pivot point and extended 17.8 cm (7.0”) forward along the left arm of the tray shield. A heavy abrasion from loading against the vehicle seat belt webbing was present on the left outboard aspect of the forward-facing belt path that measured 7.6 cm (3.0”) in width along the contour of the belt path and 0.6 cm (0.3”) in length **(Figure 20)**. The right outboard aspect of the belt path was moderately abraded on the top aspect from loading against the shoulder belt and on the bottom aspect from loading against the lap belt. The shoulder belt abrasion measured 3.8 cm (1.5”) in width and the lap belt abrasion measured 5.1 cm (2.0”) in width. A large “V”-shaped abrasion was located below and forward of the forward-facing belt path on the right side of the CSS as a result of engagement against the plastic right rear side panel of the Volkswagen Beetle. The abrasion measured 7.6 cm (3.0”) in height and 7.0 cm (2.8”) in width. Contact with the plastic right side panel of the vehicle interior also resulted in scuffs on the right outboard aspect of the tray shield that measured 20.3 cm (8.0”) along the tray shield arm and scuffs on the right front side plane of the CSS that measured 19.1 cm (7.5”) in length.

**Figure 18. View of right side damage on the CSS**

**Figure 19. View of left side damage to the CSS**


**Figure 20. Close-up of left side seat belt scuff**

There was no loading evidence on the right harness strap, however minor stretching of the left harness strap was present above the harness retainer clip as a result of the child's loading to the harness system. Plastic sleeves were secured in each harness slot by plastic tabs on the rear upper and rear lower aspects of the sleeves. Due to the loading of the left harness strap, the lower left plastic sleeve was displaced forward from the harness slot 1.3 cm (0.5"). **Figure 21** depicts the displaced left plastic sleeve.

**Figure 21. Close up of displaced left plastic sleeve and harness straps**

***FRONTAL AIR BAG SYSTEM – 1998 Volkswagen Beetle***

The 1998 Volkswagen Beetle was equipped with redesigned frontal air bags for the driver and front right passenger positions. The redesigned frontal air bag system did not deploy as a result of this crash. The Beetle was also equipped with retractor safety belt pretensioners for the front seating positions. The front safety belts were fully operational, and although it did not appear that the pretensioners fired in this crash, it could not be confirmed due to their location behind the B-pillar trim panel. The owner's manual stated that the safety belt pretensioners would not activate in light frontal collisions, or in any side, rollover, or rear collision.

***SIDE IMPACT AIR BAG SYSTEM – 1998 Volkswagen Beetle***

The 1998 Volkswagen Beetle was equipped with seat back-mounted side impact air bags that deployed as a result of the rollover crash. The side impact air bags were designed to offer torso protection. The deployment of the side impact air bags was impeded due to the after-market seat covers that were installed on the front bucket seats.

**Figure 22. Deployed driver's side impact air bag**

The side impact air bags deployed forward from the respective seat backs through a vertical tear seam on the forward aspect of the seat backs. The tear seam measured 57.2 cm (22.5") in height. The side impact air bag was housed in a plastic module surrounded by Styrofoam filler within the seat back. The interior plastic cover flap measured 22.9 cm (9.0") in height and 10.2 cm (4.0") in width and exhibited three small tabs on the forward aspect **(Figure 22)**.

The side impact air bags measured 55.9 cm (22.0”) in height and 33.0 cm (13.0”) in width and extended vertically from the seat cushion to the top of the seat back. The air bags were not tethered and were vented back through the module. The inboard aspect of the driver’s side impact air bag exhibited an area of light abrasion that measured 19.7 cm (7.8”) in height and 10.2 cm (4.0”) in width **(Figures 23 and 24)**. The abrasion was a result of engagement against the outboard aspect of the interior seat back due to the impeded deployment caused by the seat cover.

**Figure 23. Area of abrasion on the driver's side impact air bag**

**Figure 24. Close-up of the abraded area on the air bag**

Both after-market seat covers sustained damage as a result of the side impact air bag deployment. The side impact air bags deployed within the seat covers that stretched to accommodate the air bag expansion and relaxed as the air bags deflated. Lacerations in seat-cover fabric were noted on the lower outboard aspects near the seat bight. In addition, the outboard aspects showed significant stretch marks in the polyester fabric along the entire height of the seat back.

***OCCUPANT DEMOGRAPHICS – 1998 Volkswagen Beetle***

**Driver**

| | |
|---|---|
| Age/Sex: | 24-year-old female |
| Height: | 155 cm (61”) |
| Weight: | 54 kg (120 lb) |
| Seat Track Position: | Unknown |
| Manual Restraint Use: | Unrestrained |
| Usage Source: | Ejection, vehicle inspection |
| Eyewear: | None |
| Type of Medical Treatment: | Expired at scene and transported to morgue |

**Driver Injuries**

| Injury | Injury Severity (AIS 90/Update 98) | Probable Injury Mechanism |
|---|---|---|
| Complete alanto occipital disarticulation with separation of the base of the skull from the cervical spine. There is transverse laceration of underlying spinal cord near the medulla and extensive surrounding perispinus and soft tissue hemorrhage. | Maximum (640274.6,6) | Impact with ground |
| 20 cc left subdural hematoma | Severe (140652.4,2) | Impact with ground |
| Extensive pulmonary contusions involving the upper lobes of both lungs | Severe (441410.4,3) | Impact with ground |
| Two separate linear lacerations to the anterior surface of the right lobe of the liver with a resultant 200 cc hemoperitoneum | Moderate (541822.2,1) | Impact with ground |
| Transverse fracture of the neck of the left humerus | Moderate (752602.2,2) | Impact with ground |
| Linear abrasions to the left side of the abdomen | Minor (590602.1,2) | Backlight frame |
| A 15 x 20 cm (6 x 8”) area of brush type abrasion to the back of the left buttocks, centered near the posterior iliac crest | Minor (690202.1,2) | Contact with brush prior to impact with the ground |
| Brush-type abrasions to the mid back | Minor (690202.1,4) | Contact with brush prior to impact with the ground |
| Multiple linear abrasions surrounding the humerus fracture site | Minor (790202.1,2) | Impact with ground |
| Extensive contusion to the back of the right hand | Minor (790402.1,1) | Impact with ground |
| Extensive contusion to the thenar surface of the left thumb with extension over the left wrist | Minor (790402.1,2) | Impact with ground |

| Injury | Injury Severity (AIS 90/Update 98) | Probable Injury Mechanism |
|---|---|---|
| 2.5 cm (1.0”) laceration overlying the humerus fracture | Minor (790602.1,2) | Impact with ground |
| Multiple irregular shaped abrasions overlying the left kneecap and linear to irregular abrasions overlying the left tibia | Minor (890202.1,2) | Contact with brush prior to impact with the ground |
| Linear abrasions to the anterior surface of both thighs | Minor (890202.1,3) | Contact with brush prior to impact with the ground |
| Brush-type abrasions on both buttocks | Minor (890202.1,6) | Contact with brush prior to impact with the ground |
| Extensive contusion to the back of the right calf | Minor (890402.1,1) | Impact with ground |
| A 15 x 8 cm (6 x 3”) rectangular contusion to the anterior surface of the left thigh above the left knee | Minor (890402.1,2) | Impact with ground |

Injury source: Autopsy report

**Driver Kinematics**

The 24-year-old female driver was presumed to have been seated in an upright posture. The pre-crash seat track position was not known. She was not restrained by the available manual 3-point lap and shoulder belt, evidenced by her ejection. It was not known how alert she was prior to the crash, as the police indicated that she was intoxicated. As the vehicle began to roll with the right side leading, she was displaced laterally throughout the passenger compartment due to her lack of restraint usage. As she was displaced laterally, she loaded the steering wheel rim, evidenced by the forward deflection of the lower half of the rim. She impacted the front right head restraint evidenced by its separation from the front right seat back and body fluid (blood) transfers. As the vehicle continued to roll along the curved path of travel, the driver was displaced into the rear seat area. She was ejected through the backlight during the rollover. The rear left head restraint was displaced from probable contact as the driver was ejected. Based on the post-crash condition of the driver’s clothing, it appears that the denim coveralls snagged the backlight frame as the driver was ejected, which caused multiple tears on the rear aspect of the coveralls. The left front buckle on the coveralls was also distorted from the driver loading the top harness of the coveralls while they snagged on the backlight frame. There was no contact evidence on the backlight frame, which suggested the driver’s ejection was otherwise unobstructed. She sustained linear abrasions to the left side of the abdomen as a result of probable contact with the backlight frame during the ejection. The driver was ejected into an area of heavy sagebrush and contacted many sharp branches prior to impact with the ground. She sustained a 15 x 20 cm (6 x 8”) area of brush type abrasion to the back of the left buttocks that was centered near the posterior iliac crest,

brush-type abrasions to the mid back, multiple irregular shaped abrasions overlying the left kneecap and linear to irregular abrasions overlying the left tibia, linear abrasions to the anterior surface of both thighs, and brush-type abrasions on both buttocks as a result of contact with the heavy brush. She subsequently impacted the ground, which resulted in the complete alanto occipital disarticulation with separation of the base of the skull from the cervical spine with a transverse laceration of underlying spinal cord near the medulla and extensive surrounding perispinus and soft tissue hemorrhage, a 20 cc left subdural hematoma, extensive pulmonary contusions involving the upper lobes of both lungs, two separate linear lacerations to the anterior surface of the right lobe of the liver with a resultant 200 cc hemoperitoneum, a transverse fracture of the neck of the left humerus, multiple linear abrasions surrounding the humerus fracture site, extensive contusion to the back of the right hand, extensive contusion to the thenar surface of the left thumb with extension over the left wrist, a 2.5 cm (1.0") laceration overlying the humerus fracture, an extensive contusion to the back of the right calf, and a 15 x 8 cm (6 x 3") rectangular contusion to the anterior surface of the left thigh above the left knee. The driver was found face-down in a shallow depression in the ground 6.4 m (21.0') south of the vehicle's final rest position. She was found with only undergarments on, and police reported that her clothing was found hanging in the brush within her trajectory. The driver was found several hours after the crash and pronounced dead at the scene.

**Rear Right Child Passenger**

| | |
|---|---|
| Age/Sex: | 14-month-old female |
| Height: | Unknown |
| Weight: | Unknown |
| Seat Track Position: | Fixed |
| Manual Restraint Use: | Forward-facing convertible CSS |
| Usage Source: | Vehicle inspection, injury data |
| Eyewear: | None |
| Type of Medical Treatment: | Transported by ambulance to a local hospital and treated and released |

**Rear Right Child Passenger Injuries**

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Right temporal scalp contusions | Minor (190402.1,1) | Right aspect of the CSS shell |
| Abrasion on center of forehead | Minor (290202.1,7) | Tray shield |
| Right ear contusion | Minor (290402.1,1) | Right aspect of the CSS shell |

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Right shoulder abrasions | Minor (790202.1,1) | CSS shoulder harness |
| Right upper posterior arm contusion | Minor (790402.1,1) | CSS shell |

Injury source: Hospital records

**Rear Right Child Passenger Kinematics**

The 14-month-old child passenger was restrained in a forward-facing convertible CSS that was positioned on the right rear seat of the Volkswagen Beetle. The CSS was installed with the vehicle's manual 3-point lap and shoulder belt. The harness straps were routed through the lower slots and not through the reinforced upper slots, designed for forward-facing use. It was not known how tight the harness straps were at the time of the crash.

As the vehicle rolled over, the child initiated a lateral trajectory to the right and loaded the harness system in the CSS. The right aspect of her head contacted the right aspect of the padded CSS shell, which resulted in a right ear contusion and right side temporal scalp contusions. Her right arm also struck the right interior shell which resulted in a right upper posterior arm contusion. Her loading to the shoulder harness produced abrasions on her right shoulder. The CSS loaded the manual 3-point lap and shoulder belt, evidenced by stretch marks and a plastic transfer on the webbing. Although the right harness strap was threaded backward through the harness retainer clip, it appeared to have remained in place during the rollover. The right side rollover resulted in more significant loading to the left harness strap, evidenced by stretch marks on the left harness webbing. During the rollover event, the child's head probably flexed forward and contacted the top aspect of the padded plastic tray shield, which resulted in a forehead abrasion. The child came to rest in the CSS.

When the crash was discovered, police reported that the child was found seated next to the CSS in the rear seat of the Volkswagen Beetle. The CSS latch plate was still engaged in the buckle, and it was not known how the child exited the seat. She may have been able to crawl out of the CSS if there was sufficient slack in the harness system.

The child was transported by ambulance to a local hospital where she was treated and released. In addition to the minor soft-tissue injuries previously described, she was treated for mild hypothermia.

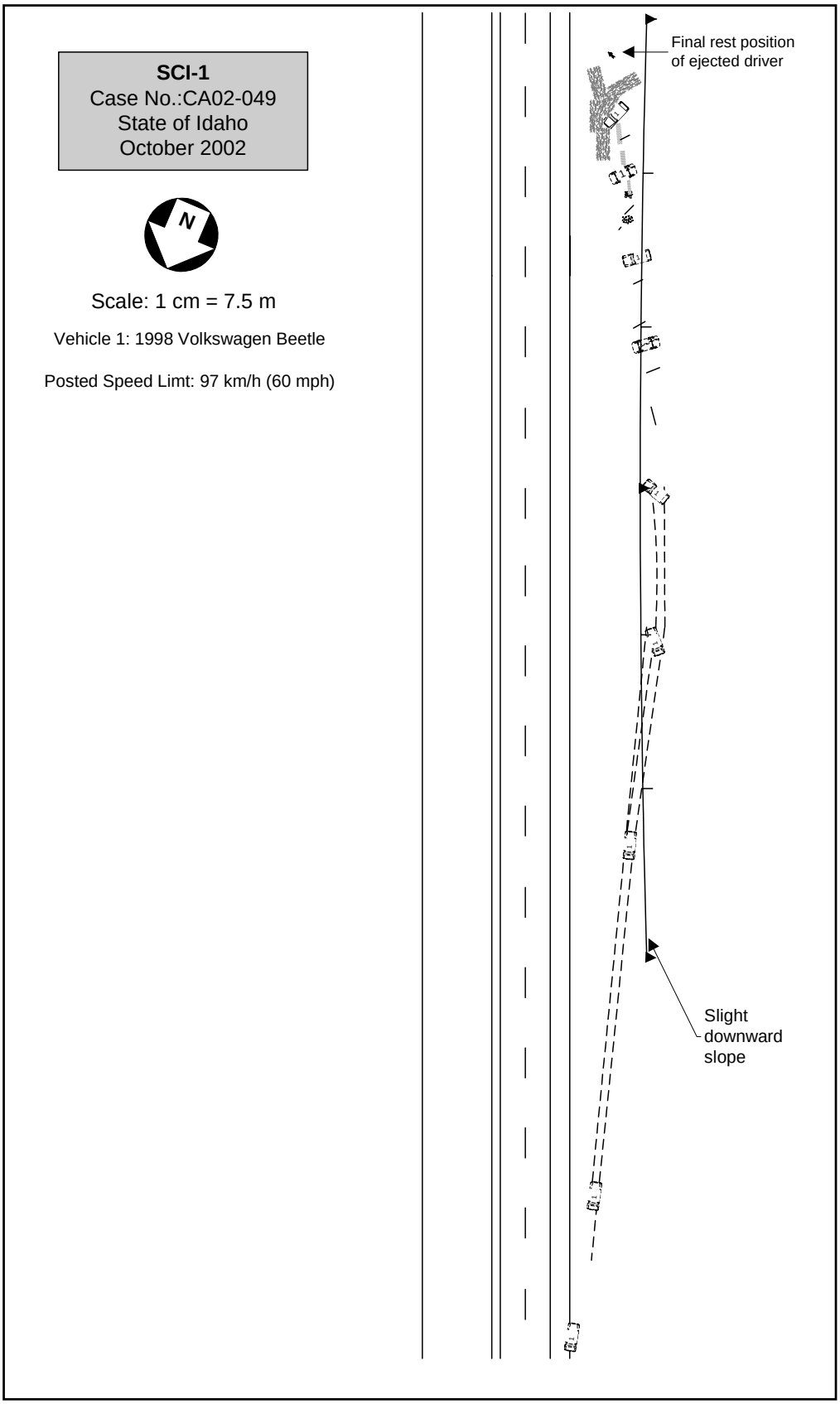


**Figure 25. Scene schematic**