

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE NASS/SCI COMBO ADAPTIVE CONTROL
VEHICLE CRASH INVESTIGATION**

CASE NO: 2004-13-108D

VEHICLE: 1998 FORD E-150 VAN

LOCATION: MICHIGAN

CRASH DATE: APRIL 2004

Contract No. DTNH22-01-C-17002

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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.

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**CALSPAN ON-SITE NASS/SCI COMBO ADAPTIVE CONTROL
VEHICLE CRASH INVESTIGATION
NASS CASE NO.: 04-13-108D
VEHICLE: 1998 FORD E-150 VAN
LOCATION: MICHIGAN
CRASH DATE: APRIL 2004**

BACKGROUND

This SCI on-site investigation focused on the type and performance of the adaptive control equipment (**Figure 1**) that was installed in a 1998 Ford E-150 conversion van. The vehicle was involved in a roadside departure crash with a guardrail and a subsequent rollover. The driver of the van was a 72-year old male who was restrained by a modified manual safety belt system. The driver was a paraplegic with limited mobility of his upper extremities. He was seated in a motorized wheelchair that was secured to the vehicle with an E-Z Lock wheelchair restraint system. The driver was exiting an interstate roadway onto a highway at



Figure 1 - Overall view of adaptive control equipment.

a three-leg intersection. He claimed that the brakes failed as he applied a braking force through the left hand controlled adaptive unit. The vehicle traveled through a stop sign and initiated a wide left turn at the intersection. The van exited the right roadside and impacted a guardrail and then overturned in a right-side leading event, completing six-quarter turns. As the vehicle overturned, the driver remained secured in his chair by the safety belt systems. He sustained bilateral hand contusions from contact with interior components. The driver was suspended by the safety belt systems and was removed from the vehicle by emergency personnel. He was transported to a local hospital where he was evaluated for possible injury and released.

The crash was initially selected for investigation as NASS CDS Case No. 04-13-108D. The NASS researcher performed the vehicle inspection, scene inspection, and the driver interview. The NASS researcher notified the Calspan Zone Center and the Special Crash Investigations team of the adaptive controls. Details of the crash and the driver's report of an alleged vehicle malfunction were forwarded to NHTSA. The case was assigned to the Calspan SCI team as a NASS/SCI combo case on June 7, 2004. The Ford van was transferred to an insurance salvage yard in Indiana and permission to inspect the vehicle was granted by the insurance company. The SCI on-site investigation was conducted on June 14, 2004. The SCI investigation enhanced the NASS CDS file with a detailed documentation of the vehicle damage patterns, the adaptive driving equipment, and additional images.

SUMMARY

Crash Site

This single vehicle crash occurred during daylight hours of April 2004 in the state of Michigan. At the time of the crash there were no adverse weather conditions and the asphalt roadway was dry. The crash site consisted of a one lane exit ramp from an interstate highway that intersected a two lane road forming a T-intersection. A stop sign the mouth of the exit ramp regulated traffic flow onto the two lane road. A guardrail was positioned on the north roadside bordering the two-lane roadway. It was located 3 m (9.8') outboard of the roadway. Beyond the guardrail, the roadside sloped downward into a ditch. Multiple small diameter trees and other natural growth were present beyond the roadway. There was no posted speed limit for the exit ramp traffic. The SCI revised scene schematic is included as **Figure 18** at the end of this narrative report.

Vehicle Data – 1998 Ford E-150 Van

The 1998 Ford E-150 van was a post-manufacturer conversion van (**Figure 2**). The conversion company was Adventure Vans, a member of the Recreational Vehicle Industry Association (RVIA) with a Member No. of 2538023. The Ford was manufactured in 9/98 and was identified by Vehicle Identification Number (VIN): 1FDRE1429WH. The vehicle's odometer read 65,126 km (40,469 miles) at the time of the SCI inspection. The vehicle was four-door, full-size van with a second (double) two side hinged rear doors. The van was equipped with a 6-cylinder, 4.3-liter engine linked to an automatic transmission. The rear-wheel drive vehicle was equipped with 38 cm (15") alloy wheels and Michelin LTX M/S P235/75R15 tires. The specific tire information at the time of the SCI vehicle inspection was as follows:



Figure 2. Ford E-150 conversion van.

| Position | Measured Pressure | Measured Tread Depth | Restricted | Damage |
|-----------------|--------------------------|-----------------------------|-------------------|---------------|
| LF | 276 kPa (40 PSI) | 6 mm (8/32") | No | None |
| LR | 152 kPa (22 PSI) | 6 mm (8/32") | No | None |
| RF | 193 kPa (28 PSI) | 6 mm (8/32") | No | None |
| RR | 255 kPa (37 PSI) | 5 mm (6/32") | No | None |

The interior of the E-150 was initially configured with seven-passenger seating as a conversion van. The interior had been significantly modified to meet the driving requirements of the driver. These modifications and adaptive controls are addressed the section that follows.

Adaptive Controls

The interior of the E-150 was modified from the original OEM and was configured with a drop-floor that extended from the base of the toe pan to 25 cm (10") aft of the centerline

of the left C-pillar. The floor was tapered to a depth of 15 cm (6") at the rearmost aspect of the drop floor rising to a depth of 10 cm (4") at the toe pan. Extension panels were added to the lower aspect of the rear sliding doors to accommodate the drop floor modification. The drop floor design required the installation of a fabricated fuel tank that was mounted aft of the axle. The fabricated fuel tank had a rated capacity of 98 liters (26 gallons). It was manufactured on 4/98 and identified with a Part No. of 9956.

The third row, three-person bench seat remained in the vehicle in its original position. The second row seating was removed to facilitate wheelchair travel from the ramp position to the driver's position. The front right seat was the captain's chair from the conversion van that was mounted to box platform to accommodate the depth of the drop floor. The seat was designed with an integrated head restraint, manual recline, and an adjustable lap belt with a cinching latch plate. Nomenclature on the restraint identified it as an Allied Signal Safety Restraint (Code 100274-34296). The front seat was equipped with hard plastic wheels that were 13 cm (5") in diameter enabling it to be moved within the vehicle and secured in both the driver and front right positions. This seat was retained in position by an EZ-Lock restraint system.

The Ford E-150 was equipped with a wheelchair platform lift. The electro-hydraulic lift folded upward from its deployed position to its stowed position within the vehicle. The lift was manufactured by Crow River Industries and was listed with a Model Number of 7684L and a Serial Number of 99060127. The platform lift control panel was mounted to the center mid instrument panel. The lift platform was 74 cm (29") in width and 118 cm (46.5") in depth. Entrance to the E-150 was controlled by a remote key-fob that would unlock the doors and deploy the lift.

The adaptive hand controls included a left hand operated remote throttle and brake controller. The throttle and brake controller had a T-handle that moved forward for throttle and aft for braking (**Figure 3**). The T-handle had a fore-and-aft travel of 5 cm (2.1") and returned to the center neutral position. The unit was labeled EMC EGB-SS with the Serial Number of 4122. The hand control was mounted on a steel stalk that was bolted to the left floor of the vehicle adjacent to the sill. A servo motor/controller was mounted under the left instrument panel to the toe pan of the Ford. This unit transferred the left hand inputs to the throttle and brake system of the vehicle. A nylon roller was mounted on a cam to the right side of the servo unit. This roller engaged the brake pedal arm to apply the brakes following driver input. The van was equipped with a zero or low-effort braking system. A cable transferred inputs from the servo unit to the top arm of the OEM accelerator pedal.

A touch pad control panel was mounted on a stalk at the center area of the frontal passenger compartment. This unit provided the driver with touch pad functions for vehicle ignition, wiper, horn, power windows, power door locks, HVAC, and transmission selection functions (**Figure 4**). These units were not damaged in the crash.



Figure 3. Adaptive hand control for throttle and brake functions.



Figure 4. Vehicle function touch pads.

Two steering wheel assist devices were mounted to the wheel rim at the 10 and 2 o'clock positions. There was no appliance attached to the bracket at the 10 o'clock sector. This bracket typically accepts a spinner knob or a tri-pin device. At the 2 o'clock sector was a swivel wrist pad with a cuff that presumably fit the right wrist or hand of the driver (**Figure 5**). The adaptive controls were monitored by the AEVIT system, which utilized two computers to monitor the steering and throttle/brake systems.



Figure 5 - Steering assembly with Velcro fastener.

Motorized Wheelchair

The driver operated the adaptive control Ford E-150 from a motorized wheelchair. The wheelchair was identified as a Permobil Chair-Man CIIS with a Serial No. of 305500 and a Model No. of TILLV.NR. 03156. The front-wheel drive chair was equipped with a joystick control that was mounted on the right armrest. Four toggle switches were mounted forward of the armrest which provided adjustment of the vertical height of the cushion, fore and aft adjustment of the footrests, and recline of the backrest. The front and rear wheels had diameters of 34 cm (13.5") and 19 cm (7.5"), respectively. It was also equipped with taillights and a rear brake light. Rib cage stabilizers flanked the chair on both sides and an internal two-piece Velcro strap with 5 cm (2") webbing was present to hold the driver's torso upright with lateral stability. In addition to the Velcro strap, an internal lap belt was provided that was bolted to the lower framework of the chair with a 10 mm (7/16") Grade 8 bolt near the wheelchair's rear bumper. The lap belt was a Q'Strain and met the applicable FMVSS/CMVSS regulations and the SAE J2249 standard. The belt Part Number was S5-6323 and the date of manufacture was 11/01. This lap belt replaced the vehicle mounted lap belt. Calf pads and footrests were present

to accommodate the occupant's legs. The calf pads were positioned 13 cm (5") forward of the seat cushion and were 17 cm (6.5") in length and 11 cm (4.5") in width. The footrests were 23 cm (9") in length and 19 cm (7.5") in width and were power adjustable. The footrests were positioned under and behind the OEM brake pedal. The wheelchair was not damaged in the crash. **Figures 6 and 7** are views of the motorized wheel chair secured in the driver's position.



Figure 6. Motorized wheelchair secured into the EZ-Lock restraint device.



Figure 7. Right lateral view of the wheelchair.

EZ-Lock Wheelchair Restraint System

The wheelchair was secured to the vehicle by a floor mounted EZ-Lock restraining device. This electro-mechanical locking device was centered between two aluminum guide ramps that were fastened longitudinally to the floor of the vehicle to guide the motorized wheelchair into the locking device. The unit was identified by Model No. BL6290. The EZ-Lock was an electro-mechanical device that was secured to the drop floor by four 9 mm (3/8") diameter Grade 5 bolts. A mechanical emergency release lever was located at the upper right aspect of the unit. The wheelchair was equipped with a 25 mm (1") bolt that was fastened to a plate on the bottom aspect of the chair. This bolt would engage the locking mechanism as the driver motored the wheelchair into his driving position. The system would automatically lock the wheelchair into the EZ-Lock once engaged into the device. A manually operated electric release would release the locking mechanism prior for exit from the vehicle.

Crash Sequence ***Pre-Crash***

The 72-year old male driver of the 1998 Ford E-150 van was traveling north on an exit-ramp from an interstate and was approaching a "T" intersection. The driver stated that he attempted to brake by pulling back on the hand-activated throttle/brake controller as he was approaching the intersection and the braking system failed to engage. The SCI vehicle inspection revealed that the power-adjustable wheelchair foot rests were inadvertently positioned under and behind the OEM brake pedal (**Figure 17**). The

wheelchair foot rests interfered with the brake pedal travel, thus limiting the braking function of the vehicle. In response to the absence of braking, the driver steered sharply left at the intersection at a driver-estimated speed of 56 km/h (35 mph) and departed the right side of the intersecting roadway (**Figure 8**).



Figure 8 - Vehicle's approach to impact.



Figure 9 - Area of impact and subsequent rollover.

Crash

As the vehicle departed the roadway, the front right bumper corner impacted the guardrail. The impact resulted in minor damage to the right corner of the bumper. Following the initial impact, the vehicle sideswiped the guardrail resulting in minor contact damage abrasions to the right front fender. The vehicle then mounted the guardrail, and while still engaged with the guardrail, began to overturn right-side leading. The vehicle descended down the ditch slope and overturned six-quarter turns (**Figure 9**). As the vehicle was rolling into the ditch, the left front fender and left roof side rail areas impacted small diameter trees resulting in minor damage. Due to the non-horizontal aspect of these impacts, delta-Vs were not computed. The vehicle came to final rest on its roof facing westbound.

Post-Crash

Emergency personnel arrived on-scene and observed the 72-year old male driver still restrained within the wheelchair upside down in the vehicle. The rescue team was not familiar with the operation of the wheelchair and the restraint systems. They secured the driver and cut the shoulder belt webbing and unbuckled the lap belt prior to removing the driver from the vehicle. He was placed on a backboard and transported by ambulance to local hospital where he was evaluated for possible injury and released.

Vehicle Damage

Exterior Damage – 1998 Ford E-150 Van

The 1998 Ford E-150 van sustained minor damage to its front plane from contact with the guardrail and moderate damage to both side planes and roof area as a result of the rollover and tree impacts. The SCI inspection identified frontal and right side damage from the impact with the guardrail, left side damage from impacting the small diameter tree, and several areas of damage on the side and top planes attributable to the rollover.

The SCI investigation determined that the direct contact frontal damage began at the front right bumper corner and extended 9 cm (3.5") to the left (**Figure 10**). The damage was limited to the bumper with white paint transfers from the guardrail present. The maximum crush was located at the front right bumper corner and was 3 cm (1") in depth. The combined direct and induced damage encompassed the entire front end measuring 175 cm (69") in width. The SCI revised Collision Deformation Classification (CDC) for this frontal impact was 01-FRLS-1. Six equidistant crush measurements were documented across the full width of the chrome bumper and were as follows: C1 = 0 cm, C2 = 0 cm, C3 = 0 cm, C4 = 1 cm (0.4"), C5 = 1 cm (0.5"), C6 = 3 cm (1").



Figure 10 – Frontal damage to the 1998 Ford E-150



Figure 11 - Right side damage.

After the initial impact, the E-150 began to rotate counterclockwise around the guardrail. The guardrail began to yield from the force of the impact and provided a tripping point for the vehicle. While engaged with the guardrail, the van began to overturn and sustained direct contact damage in the form of abrasions along its right side (**Figure 11**). White paint transfers from the guardrail were embedded within the abrasions on the vehicle. The direct contact damage to the vehicle's right side and began 56 cm (22") forward of the front right axle and extended rearward 196 cm (77"). Vertically, damage was present from the running board along the lower aspect of the vehicle's baseline upwards to the roof side rail. No crush measurements were obtained for this impact due to its sideswiping nature and overlapping damage. The CDC for this event was 00-RFAS-2.

As the vehicle separated from the guardrail, the first area to engage the ground was the back aspect of the right roof side rail. The direct contact damage for this impact began 32 cm (13") aft of the right B-pillar and extended rearward 107 cm (42"), terminating 25 cm (10") forward of the right C-pillar. The maximum crush for this impact was 4 cm (1.75") and was located 36 cm (14") aft of the B-pillar. Six equidistant crush measurements were documented across the roof side rail and were as follows: C1 = 0 cm, C2 = 1 cm (0.4"), C3 = 2 cm (0.6"), C4 = 4 cm (1.75"), C5 = 1 cm (0.5"), C6 = 0 cm. This impact was part of the rollover sequence and is subsequently included in the rollover CDC of 00-TDDO-2.

The roof side rail sustained a second area of direct contact damage resulting in vertical crush that began at the right C-pillar and extended rearward to the right D-pillar. The combined direct and induced damage measured 160 cm (63") in length and began 70 cm forward of the right rear axle. The crush measurements for this impact were as follows: C1 = 23 cm (9"), C2 = 18 cm (7"), C3 = 14 cm (6"), C4 = 8 cm (3"), C5 = 4 cm (1.5"), C6 = 0 cm. This impact was included in the rollover event and was linked to the rollover CDC.

The backlight header sustained vertical crush that extended from the D-pillar to the D-pillar across the back roof. The combined direct and induced damage to this component was 141 cm (55.5") in length. The crush measurements for this impact were as follows: C1 = 0 cm, C2 = 2 cm (0.6"), C3 = 5 cm (2"), C4 = 10 cm (4"), C5 = 15 cm (6"), C6 = 19 (7") cm. This impact was included in the rollover event and was linked to the rollover CDC. Rollover abrasions associated with this impact were present and began 5 cm (2") left of the vehicle's centerline and extended 71 cm (28") to the right.

As the vehicle was on its roof in the second quarter turn of this six-quarter turn rollover event, the left front fender contacted a small diameter tree located off the roadside (**Figure 12**). The direct contact damage for this impact began 28 cm (11") forward of the front left axle and extended forward 10 cm (4"). The combined direct and induced damage began 37 aft the front left axle and extended forward 88 cm (35"). The maximum crush was located 32 cm forward of the front left axle and measured 5 cm (2") in depth. The crush measurements for this impact were as follows: C1 = 0 cm, C2 = 1 cm (0.25"), C3 = 2 cm (0.6"), C4 = 2 cm (0.8"), C5 = 5 cm (2"), C6 = 0 cm. The vehicle was on its roof during this event and therefore the CDC was 00-LFEN-2.



Figure 12 –Tree impact damage to the left front fender.

As the vehicle continued to overturn the vehicle contacted a second small diameter tree with its left roof side rail. The direction of force entered through the top plane and the vertical crush to the left roof side rail was located between the C- and D-pillars. The direct contact damage for this impact began 16 cm (6") aft of the left rear axle and extended rearward 16 cm (6"). The combined direct and induced damage began 67 cm (26") forward of the left rear axle and extended rearward 144 cm (57"). The maximum crush was located 23 cm (9") rear of the left rear axle and was 8 cm (3") in depth. The crush measurements for this impact were as follows: C1 = 0 cm, C2 = 3 cm (1"), C3 = 7 cm (3"), C4 = 3 cm (1"), C5 = 1 cm (0.5"), C6 = 0 cm. The CDC for this impact was 00-TBLN-2.

A second area of damage to the left roof side rail located 209 cm (82") forward of the left rear axle and was 60 cm (24") in length. The maximum crush was located at the left A-pillar juncture and was 11 cm (4.5") in depth. The crush measurements for this impact

were as follows: C1 = 0 cm, C2 = 2 cm (0.8”), C3 = 4 cm (1.6”), C4 = 6 cm (2.4”), C5 = 9 cm (3.6”), C6 = 11 cm (4.5”). This impact was included in the rollover event and was linked to the rollover CDC.



Figure 13 - Left side and roof damage.



Figure 14 - Right side and roof damage.

The front left door remained closed during the crash; however, after being opened post-crash, it would not re-latch. Both rear side doors were jammed closed due to impact forces. The front right door and back hatch remained closed and operational. The laminated windshield was completely cracked but remained intact with no bond separation. The front left, left rear quarter, right rear quarter, and backlight tempered glazing shattered during the rollover sequence. **Figures 13 and 14** are oblique views of the vehicle back left and back right areas.

Interior Damage

The interior of the 1998 Ford E-150 van sustained moderate damage as a result of the multiple impacts to the vehicle. Emergency personnel cut the B-pillar mounted shoulder belt webbing to remove the driver. Moderate intrusion resulted from the rollover event and was identified during the SCI inspection and detailed by the seat location in the following table:

| Position | Component | Magnitude | Direction |
|----------------------------|---------------------|------------------|------------------|
| Front left | Left upper A-pillar | 10 cm (4") | Vertical |
| Front left | Left roof side rail | 8 cm (3.3") | Vertical |
| Front left | Windshield header | 8 cm (3") | Vertical |
| 3 rd row left | Roof | 8 cm (3") | Vertical |
| 3 rd row center | Roof | 1 cm (0.5") | Vertical |
| 3 rd row right | Roof side rail | 10 cm (4") | Lateral |
| 3 rd row right | Roof side rail | 9 cm (3.5") | Vertical |
| 3 rd row right | Roof | 8 cm (3") | Vertical |

Note: There was no driver contact points noted to the interior surfaces of the vehicle.

Manual Restraints

The driver’s position of the Ford E-150 van was equipped with a modified manual shoulder belt that retracted onto an Emergency Locking Retractor (ELR) located at the

OEM lower B-pillar location. The belt was routed through the B-pillar mounted D-ring that was adjustable. At the time of the SCI vehicle inspection, the D-ring was adjusted to the full-up position. The OEM-style sliding latch plate was identified by a stamped number of L058 and was sewn to the shoulder belt webbing in an OEM type pattern. The wavy stitch pattern indicated that the belt was sewn with a machine, but fed through by hand. Rescue personnel cut the shoulder belt webbing 120 cm (47") above the sliding latch plate. The remainder of the belt webbing retracted onto the retractor. **Figure 15** is a view of the shoulder belt routed through the wheelchair.

The shoulder belt webbing was worn and cupped in the vicinity of the rigid lateral chest stabilizer that was mounted to the wheelchair. A black vinyl abrasion from frequent use was located immediately below the wear point on the webbing (**Figure 16**).

Both front OEM buckle systems were relocated from the original OEM seat mounts to the drop floor of the vehicle, mounted in a fabricated bracket that was secured to the floor with four Grade 8 10 mm (3/8") diameter bolts. The buckles were equipped with pretensioners that did not activate as a result of the crash.

The front right safety belt was configured the same as the driver's belt. The OEM 3-point, continuous loop webbing was altered with the sliding latch plate re-sewn to the webbing with a wavy stitch pattern that was 15 cm (5.9") in length and 4 cm (1.4") in width. Both front shoulder belt systems were sewn in a rectangular pattern with an X-pattern within the rectangle. There was no separation of the driver's stitch pattern.

The lap belt for the driver's position was attached to the rear frame of the motorized wheelchair. The lap belt was manufactured by Q'Straint and was identified by Part Number S5-6323 with a Date of Manufacturer of 11/01. The lap belt was labeled as meeting applicable FMVSS/CMVSS regulations and SAE J2249.

The lap belt was equipped with a cinching latch plate that was positioned on the inboard (right) aspect of the wheelchair. The length of this webbing was 84 cm (33") with a TRW buckle stamped with the nomenclature RCF-67 TE639.



Figure 15. Routed positions of the manual safety belts.



Figure 16. Wear mark of the shoulder belt webbing from chest stabilizer.

The outboard positioned buckle was sewn to a length of webbing that was 34 cm (13.5”) in length. The webbing was routed through the buckle loop and folded back 21 cm (8.25”) and sewn in a zigzag stitch pattern containing 18 lateral stitch runs across the full width of the webbing.

The second row of the Ford van was equipped with a Q’-Straint shoulder belt webbing with a cinching latch plate. This belt was identified by Part No. Q5-6410 with a Date of Manufacturer of 9/98. The upper attachment point of this safety belt was at the left roof side rail at the C-pillar. Located in the drop floor forward of the third row seat were two Q’Straint floor anchors positioned on 36 cm (14.25”) centers. Two additional floor anchors were located at the left B-pillar location mounted on 53 cm (21”) centers. This belt system was a wheelchair tie-down system. There was no belt system at the second row right position due to the installation of the wheelchair platform lift.

The three-passenger third row seat was a carryover from the conversion van. This bench seat folded forward to form a bed. The outboard positions were equipped with 3-point lap and shoulder belts with cinching latch plates and ELR retractors. The center rear position was equipped with a lap belt with a cinching latch plate. All three buckles for this seat were found lying on the floor under the seat cushion.

Frontal Air Bag System

The 1998 Ford E-150 van was equipped with a redesigned frontal air bag system for the driver and front right occupant positions. The air bag system was not altered for this vehicle. Due to the low severity frontal impact, the system did not deploy during the crash. In addition to the frontal air bags, the front row safety belt buckles were equipped with buckle pretensioners.

Occupant Demographics

Driver – 1998 Ford E-150 Van

Age/Sex: 72-year old/Male
 Height: 173 cm (68”)
 Weight: 86 kg (190 lb)
 Seat Track Position: Seated in motorized wheelchair locked into a fixed EZ-Lock restraint device
 Manual Restraint Use: Separate lap and shoulder belt safety systems
 Usage Source: Vehicle inspection, observations of first responders
 Eyewear: Eyeglasses
 Type of Medical Treatment: Transported by ambulance to a local hospital where he was evaluated and released.

Driver Injuries

| Injury | Injury Severity (AIS/90/Update 98) | Injury Source |
|-------------------------|---|---|
| Contusion to right hand | Minor (790402.1,1) | Steering wheel rim |
| Contusion to left hand | Minor (790402.1,2) | Adaptive hand controls for accelerating/braking |

Source: Medical records.

Driver Kinematics

The 72-year old male driver was seated in an upright posture and restrained within his motorized wheelchair. He was restrained by the manual lap belt system that was attached to the wheelchair and a separate B-pillar mounted shoulder belt that buckled across the driver to the floor mounted buckle. The wheelchair was secured by the EZ-Lock device. Post-crash, the right side of the leading edge of the wheelchair seat was positioned 22 cm (8.5") aft of the top of the knee bolster and the left side was positioned 29 cm (11.25") aft of the bolster.



Figure 17. Wheelchair footrests inadvertently positioned behind and under the brake pedal.

The driver stated that as he attempted to apply the brakes with his left hand, the brakes failed to slow the vehicle. The power-adjustable foot-rests of the wheelchair were inadvertently adjusted by the driver during his trip which positioned the leading edge of the foot rests under and forward of the brake pedal (**Figure 17**).

As the vehicle exited the roadway and impacted the guardrail the driver was probably slightly displaced in a forward direction but remained in his upright posture due to the restraint systems. During the subsequent rollover, the driver's hands probably contacted the adaptive hand controls resulting in contusions to both hands. The driver was suspended upside-down inside the vehicle by the manual safety belt systems when emergency personnel arrived on the scene. The driver was removed from the wheelchair and placed on a backboard and transported to local hospital where he was evaluated for injury and released.

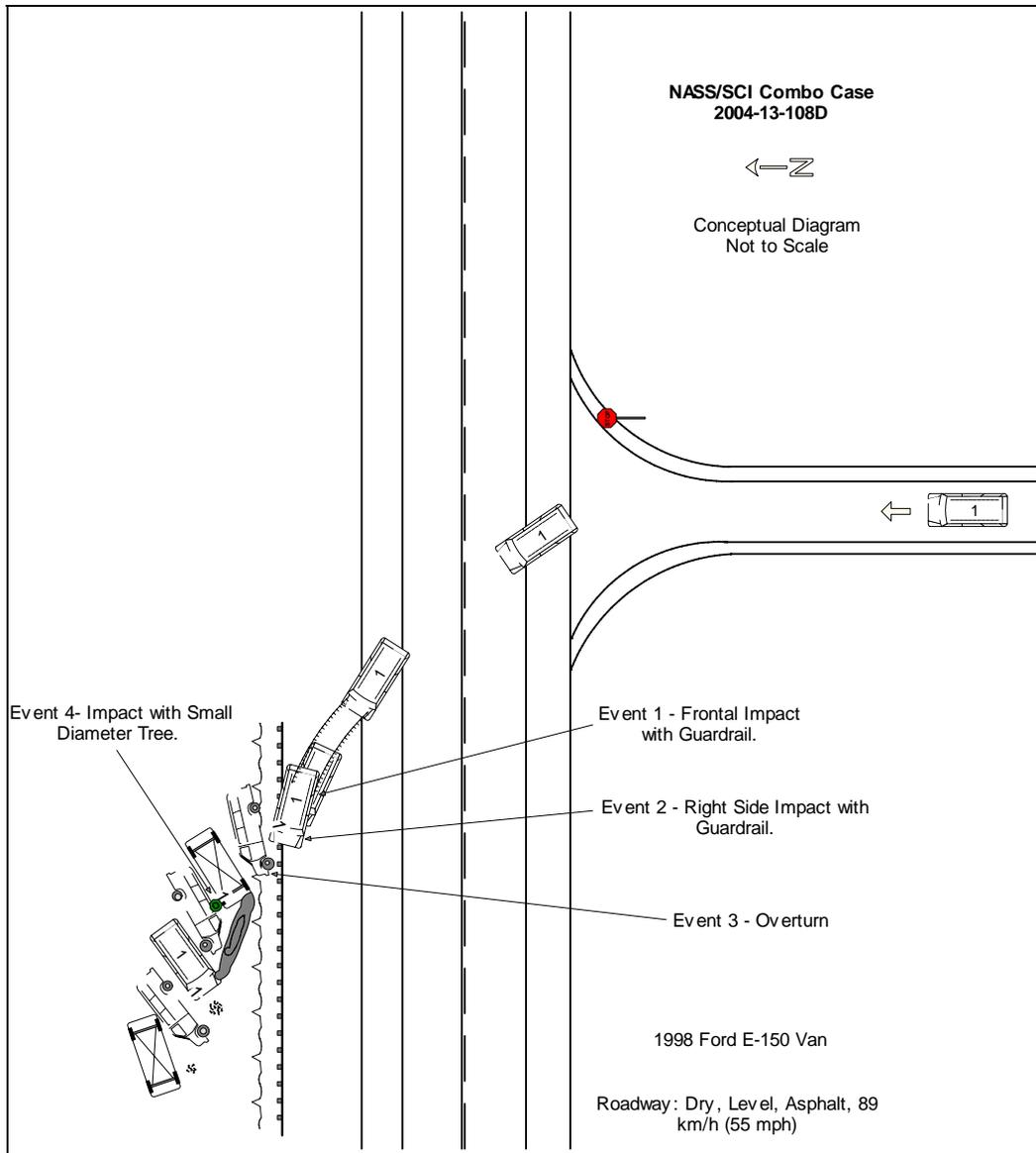


Figure 18. SCI Revised Scene Schematic