CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

NASS/SCI COMBO CASE NO.: 2007-45-174A

VEHICLE: 2007 VOLVO S80

LOCATION: TENNESSEE

CRASH DATE: OCTOBER 2007

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 systems.

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LOCATION: TENNESSEE
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BACKGROUND


Figure 1. 2007 Volvo S80.

This on-site investigation focused on the crash dynamics and the deployment of the side impact air bag system in a 2007 Volvo S80. The Volvo was equipped with roof side rail mounted Inflatable Curtain (IC) air bags for the four outboard seats, seat back mounted air bags for the front seats, retractor pretensioners for all five seating positions, and a Certified Advanced 208-Complaint frontal air bag system. Additionally, the Volvo was equipped with an Air Bag Control Module (ACM) that had some Event Data Recording (EDR) capabilities. A representative from Volvo downloaded the crash data from the ACM and provided a brief summary of the crash events. The Volvo was involved in a run-off road collision with a signpost, a parked vehicle, a large tree, and a mailbox. As a result of the crash, the left IC and driver's seat back mounted air bags deployed. The frontal and right side impact air bags did not deploy. An unrestrained 33-year-old male driver, a restrained 24-year-old female front right passenger, and an unrestrained 21-year-old male left rear passenger occupied the vehicle. During the pre-crash rotation, the driver was positioned against the left front door; therefore, at impact with the tree the IC air bag deployed inboard of the driver's head. The driver suffered a near total decapitation at the angle of the mandible with massive skull fractures and an avulsion of the majority of the brain from the cranium. These injuries are a result of the driver's head striking the tree. The driver was pronounced deceased at the scene and was transferred to the county medical examiner's office. The front right and left rear passengers sustained minor injuries and were transported to a regional trauma center where they were treated and released.

This crash was initially selected for research within the National Automotive Sampling System (NASS). The NASS researcher forwarded the crash information to the Zone Center and the Calspan Special Crash Investigation (SCI) team due to the deployment of the side air bags and the fatal injuries to the driver. The crash notification was then forwarded by the Calspan SCI team to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA). Subsequently, this crash was assigned on December 18, 2007 as an on-site SCI investigation. The on-site investigation took place on January 23, 2008 and included the inspection of the vehicle and scene. A

technical representative from Volvo was present at the time of the SCI inspection and downloaded the EDR at that time with proprietary software. Thereafter, the ACM was removed from the vehicle and forwarded to Volvo by NHTSA. Volvo provided NHTSA with a brief summary of the crash events to assist in the completion of this report.

SUMMARY

Vehicle Data – 2007 Volvo S80

The 2007 Volvo S80 was designed as a four-door sedan and identified by the Vehicle Identification Number (VIN): YV1AS982471 (production number omitted). The vehicle's mileage at the time of the crash was 1,500 km (3,307 miles). The vehicle was equipped with a 3.2-liter, 6-cylinder engine linked to an automatic transmission. The braking system consisted of 4-wheel disc brakes with anti-lock (ABS), and a Brake Assist system. The Brake Assist system was designed to increase braking pressure in an emergency situation. The Volvo was also equipped with Electronic Stability Control (ESC), which detects and helps correct the loss of lateral traction during cornering. The system automatically reduces the throttle and applies braking to counter the effects of the control loss. The vehicle was also configured with a direct Tire Pressure Monitoring System (TPMS), which detects improperly inflated tires and alerts the operator. The Volvo was also designed with a Side Impact Protection System (SIPS), which reduces the risk of serious injury in a side impact due to a body structure that distributes the crash forces across a large part of the vehicle's body.

The Volvo's total Gross Vehicle Weight Rating (GVWR) was 2,068 kg (4,559 lb) with 1,220 kg (2,690 lb) distributed to the front axle and 848 kg (1,869 lb) to the rear. The vehicle was equipped with Michelin MXM4 P225/50R17 tires. The manufacturer's recommended cold tire pressure was 262 kPa (38 PSI). The specific tire information at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire Flat	7 mm (9/32")	No	Debeaded
LR	Tire Flat	7 mm (9/32")	No	Debeaded
RF	Tire Flat	7 mm (9/32")	No	Debeaded
RR	Tire Flat	7 mm (9/32")	No	Debeaded

The seating in the Volvo S80 was configured with leather-trimmed bucket seats for the driver and front right passenger positions. The front seats were configured with adjustable and active head restraints, both of which were in the full down position at the time of the inspection. The active head restraints are part of the Whiplash Protection System (WHIPS) that was integrated into the front seating positions. The system was designed to utilize the seatback and head restraint to cradle the spine and neck in a controlled manner. The system was designed primarily for rear impacts. The driver's seat had a total track travel of 24 cm (9.5") and was positioned 9 cm (3.5") forward of the full-rear track position; the front right seat was positioned 10 cm (4") forward of the full-rear track position.

The rear seating positions were configured with a leather trimmed driver-side wide split bench seat with adjustable head restraints. All three head restraints were in the full down position.

Vehicle Data – 1987 Honda CRX

The 1987 Honda Civic was parked in a driveway at the scene of the crash and impacted by the Volvo while unoccupied. The vehicle was not available for either a NASS or an SCI inspection; however, on-scene images of the vehicle were obtained from the investigating police agency. The VIN was not reported. The front-wheel drive vehicle was designed as a 3-door hatchback and was powered by a 1.5-liter, 4-cylinder engine. The specific tire information was not reported.

Crash Site

This single vehicle crash occurred during the early morning hours of October 2007 in the state of Tennessee. At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. The crash occurred on the east roadside of a two-lane, north/south roadway that intersected with a two-lane, east/west roadway. The north/south roadway was curved slightly to the right as it approached the four-leg intersection. Both roadways were configured with one lane in each direction and were delineated by double-yellow painted centerlines. The southbound approach of the north/south roadway ascended to a hillcrest located 67 m (220 ft) south of the intersection and experienced a slope of -10 percent leading to the intersection. The intersection was controlled in all four directions by stop signs on the corners. The roadway environment consisted of residential properties and natural growth. Two driveways leading to private homes were present on the east roadside south of the intersection. The driveways were located 41 m (135 ft) and 48 m (158 ft) south of the intersection, respectively. The 1987 Honda CRX was parked back end first in the first driveway. The posted speed limit for the north/south roadway was 48 km/h (30 mph). The NASS Crash Schematic is attached as **Figure 16** at the end of this narrative report.

Crash Sequence

Pre-Crash

The 33-year old male driver of the Volvo was operating the vehicle in a southbound direction and was approaching the hillcrest at a high rate of speed **(Figure 2),** as reported by the left rear passenger. The driver and the 24-year old front right female passenger were reportedly engaged in an argument. As the Volvo crested the hill, it became airborne and landed in the southbound lane 7 m (23 ft) beyond the crest. This was evidenced by two 1 m (3 ft) gouge marks in the asphalt roadway from the front tires. The operator of the Volvo then lost directional control and the vehicle began to rotate counterclockwise (CCW) toward the southeast quadrant of the intersection. As the vehicle rotated, the right front and rear tires left yaw marks of 19 m (62 ft) and 22 m (72 ft), respectively. Both yaw marks continued onto the roadside leading to the point of impact with the stop sign. **Figure 3** is a look back from the Volvo's southbound approach.

Figure 2 - Southbound approach of the Volvo.

Figure 3 - Look back at the southbound approach of the Volvo.

Crash

The right fender of the Volvo impacted a stop sign post **(Event 1)** that was mounted 5 m (16 ft) south of the intersection on the southeast corner **(Figure 4)**. At impact with the signpost, the Volvo had rotated CCW approximately 110 degrees from its original heading. The signpost sheared at the ground level, wrapped around the hood, and became attached to the front right aspect of the vehicle. This impact did not alter the vehicle's trajectory as it continued its southeast trajectory while in the CCW rotation.

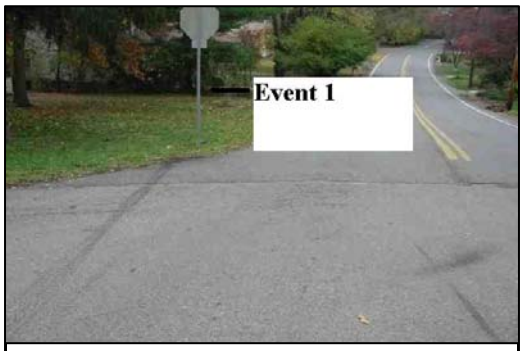

Figure 4 - Event 1 - stop sign.

The vehicle continued its CCW rotation for approximately 28 meters (92 feet) where the left rear plane impacted the right side of a Honda Civic that was parked in the residential driveway, **(Event 2)**. At impact with the Honda, the Volvo had rotated approximately 250 degrees from its original heading. The direction of force for the impact with the Honda was in the 8 o'clock sector. A Collision Deformation Classification (CDC)-only damage algorithm of the WinSMASH program computed a total delta-V of 11 km/h (4.3 mph) for the Volvo and 25 km/h (9.8 mph) for the Honda. The respective longitudinal and lateral velocity changes were 7 km/h (2.8 mph) and 9 km/h (3 mph) for the Volvo and -16 km/h (-6.3 mph) and -19 km/h (-7.4 mph) for the Honda. The Honda was displaced approximately 15 m (50 ft) in the southeast direction from the point of impact and came to rest against the private home facing the northwest **(Figure 5)**.

Figure 5 - Final rest position of the Honda.

The rotation of the Volvo was further amplified by the impact with the Honda. The Volvo continued approximately 6 meters (20 feet) and rotated CCW an additional 30 degrees where it struck a 63 cm (25") tree with the left front door and B-pillar areas, **(Event 3)**. The direction of force for this impact was in the 10 o'clock sector. The damage algorithm of the WinSMASH program computed a total delta-V of 25 km/h (15.5 mph). The specific longitudinal and lateral velocity changes were -9 km/h (-5.6 mph) and 24 km/h (15 mph), respectively. Due to the removal of the left side doors and B-pillar, the sill level crush measurements resulted in the delta-V being computed too low for this event. It is therefore not representative of the severity of this impact. The impact was sufficient to deploy the right side IC and seatback mounted air bags. **Figure 6** illustrates the locations of the second and third crash events.

Figure 6 - Events 2 and 3.

The vehicle rebounded from the tree impact and traveled an additional 16 meters (52 feet) while rotating CCW. Prior to coming to final rest on the east roadside, the rear of the Volvo struck a mailbox, **(Event 4)**.

Post-Crash

The front right and second row left passengers exited the vehicle under their own power and awaited the arrival of emergency personnel. The driver sustained fatal injuries. Emergency personnel arrived on-scene and pronounced the driver deceased. The passengers were transported by ambulance to a regional trauma center where they were treated and released. The driver was extricated from the vehicle and transported to the county medical examiner's office. The vehicle was towed from the scene and declared a total loss by the insurance company.

Vehicle Damage

Exterior Damage – 2007 Volvo S80

The 2007 Volvo S80 sustained severe damage as a result of the multiple impacts within this crash sequence. The impact with the stop sign post caused only minor damage to the right fender **(Figure 7)**. The direct contact damage began 8 cm (3") aft of the front right axle and extended rearward 12 cm (4.7"). The maximum crush was 2 cm (1") in depth and was located at 14 cm (5.5") aft of the axle. The CDC for this impact was 03-RFEN-1.


Figure 7 - Damage to right side of Volvo from signpost.

The impact with the parked 1987 Honda CRX resulted in moderate damage to the left quarter panel of the Volvo **(Figure 8)**. The direct contact damage began 10 cm (4") aft of the left rear axle and extended 74 cm (29") rearward. The combined direct and induced damage began at the left rear axle and extended rearward 84 cm (33"). The maximum crush was located 69 cm (27") aft of the left rear axle and was 30 cm (11.8") in depth. Six equidistant crush measurements were taken along the mid-door level of the vehicle and were as follows: C1 = 6 cm (2.4"), C2 = 30 cm (11.8"), C3 = 21 cm (8.3"), C4 = 13 cm (5"), C5 = 0 cm, C6 = 0 cm. The CDC for the impact with the Honda CRX was 08-LBEW-3.

Figure 8 - Damage to left quarter panel from Honda CRX.

The third impact with the 63 cm (25") diameter tree resulted in severe damage to the Volvo's left side **(Figure 9)**. The direct contact damage extended above the beltline to the A- and B-pillars and the roof side rail. The roof deformed laterally and was creased along the header at its midline. The roof damage resulted in a 40 cm (16") vertical x 85 cm (34") horizontal hole in the windshield. The glazing in the roof and left side windows disintegrated. Emergency personnel removed both left side doors and the B-pillar. Therefore, the crush profile was taken along the sill level and does not represent the severity of the damage. The direct contact damage began 102 cm (40") forward of the left rear axle and extended forward 115 cm (45.2"). The combined direct and induced damage began 28 cm (11") forward of the left rear axle and extended forward 270 cm (106"). The maximum crush was located 149 cm (58.6") forward of the left rear axle and measured 31 cm (12.2") in depth. Considering that direct damage was present on the roof side rail, it is probable that the dynamic crush exceeded the 31 cm (12.2") maximum crush before rebounding to its static post crash state. Six crush measurements were taken along the sill and were as follows: C1 = 1 cm (0.5"), C2 = 14 cm (5.5"), C3 = 19 cm (7.5"), C4 = 22 cm (8.7"), C5 = 8 cm (3.1"), C6 = 0 cm. The CDC for the impact with the tree was 09-LPAW-3.

Figure 9 - Damage to left side of Volvo from tree impact.

As the Volvo came to final rest, its back plane impacted and fractured the mailbox post. The CDC for this impact was 06-BLEN-1. The damage was minor and was masked by overlapping damage. The data contained within the Exterior Damage section was revised by the SCI investigator. The revised data is not consistent with the Electronic Data System (EDS) coding that was completed by the NASS team.

Exterior Damage – 1987 Honda CRX

The parked 1987 Honda CRX sustained moderate damage as a result of being struck on the right side by the Volvo **(Figure 10)**. The vehicle was removed from the scene and not available for an inspection by either the NASS or the SCI team. A review of the on-scene images revealed that the direct contact damage began at the right front corner of the vehicle and extended rearward to the forward aspect of the front right door. The front right door was deformed outboard from the vehicle and the right A-pillar was deflected upwards. The crush appeared to have extended into the second extent zone. The CDC derived from the on-scene images was 02-RYEW-2.

Figure 10 - Final rest position of the Honda CRX.

Interior Damage – 2007 Volvo S80

The 2007 Volvo S80 sustained moderate interior damage as a result of passenger compartment intrusion and occupant contact. The greatest intrusions were to the left A-pillar and the front left roof side rail, both of which intruded laterally 23 cm (9”). The intrusions are detailed by their respective magnitude in the following table:

Location	Component	Magnitude	Direction
Front left	A-pillar	23 cm (9”)	Lateral
Front left	Roof side rail	23 cm (9”)	Lateral
Front left	B-pillar	18 cm (7”)	Lateral
Front left	Floor panel	18 cm (7”)	Lateral
Front left	Door panel	15 – 30 cm (6 – 12”)	Lateral
Second row left	Door panel	15 – 30 cm (6 – 12”)	Lateral
Front left	Windshield header	14 cm (5.5”)	Vertical
Front left	Roof	14 cm (5.5”)	Vertical
Second row left	Roof side rail	13 cm (5”)	Lateral
Second row left	Floor panel	11 cm (4.3”)	Lateral
Front left	Side panel – forward of A-pillar	10 cm (4”)	Lateral

Multiple occupant contact points were identified during the NASS inspection. On the left side of the front row, scuffing was present on the left door panel above and below the armrest and on the lower left aspect of the instrument panel. These scuffs resulted as the driver loaded the door panel and instrument panel during the impact sequence. The center console was also deformed to the left and the transmission selector was scuffed as a result of front right passenger loading during the crash.

In the second row, two scuffs were identified on the driver’s seatback near the head restraint. During an in-person interview with the NASS team, the left rear passenger

recalled gripping that area during the impact as he attempted to negotiate the crash forces. The second row left armrest was also deformed from probable passenger loading.

Manual Restraint System – 2007 Volvo S80

The Volvo S80 was equipped with 3-point lap and shoulder belts with sliding latch plates for each seating position. All of the safety belts were configured with retractor pretensioners. The driver's belt webbing was cut 10 cm (4") below the stop button by emergency personnel. The remaining webbing was spooled and locked within the Emergency Locking Retractor (ELR) after being damaged by post-crash extrication measures **(Figure 11)**. At the position in which the belt webbing was found during the SCI inspection, stowed within the retractor, along with the absence of loading evidence to the latch plate and belt webbing, it was determined that the driver was not using the belt system. Analysis of the Volvo's EDR data confirmed that the driver was not belted during the crash sequence.

Figure 11 - Damaged B-pillar and retractor pretensioner.

The front right passenger's belt was configured with a switchable ELR/Automatic Locking Retractor (ALR) and a retractor pretensioner that actuated during the crash. The belt webbing's full excursion was 230 cm (90"). Loading evidence in the form of a fabric crease was identified on the belt webbing 69 cm (27") above the belt's anchor point. Based on the location of the crease, and combined with the size of the front right passenger, the crease in the webbing would be near the latch plate if the belt was in use. Additionally, heavy abrasions were identified on the latch plate plastic housing **(Figure 12)**. Based on the physical evidence, it was determined that the front right passenger was restrained by the belt system at the time of the crash. These conclusions were supported by the EDR data, which confirmed that the front right occupant was restrained.

Figure 12 - Loading evidence on RF latch plate housing.

The rear belt systems were configured with switchable ELR/ALR retractors. The belts were in the stowed position at the time of the SCI inspection and were devoid of any indications of usage. All three retractors remained fully operational.

The safety belt information in this report was revised by the SCI investigator; therefore the coding in the EDS will not be consistent with this report.

Certified Advanced 208-Compliant Air Bag System – 2007 Volvo S80

The Certified Advanced 208-Compliant (CAC) frontal air bag consisted of advanced dual stage air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switch sensors, a front right occupant detection sensor, and retractor mounted safety belt pretensioners. The manufacturer of the vehicle certified that the vehicle met the requirements of Federal Motor Vehicle Safety Standard (FMVSS) No.: 208. An indicator light was present on the rearview mirror indicating the active/suppressed status of the front right air bag. The system was controlled and monitored by the Air Bag Control Module (ACM) that had some Event Data Recording (EDR) capabilities. The ACM was located in the center console. The ACM was downloaded by representatives of Volvo and later removed for analysis. The ACM data is summarized in this report. With the absence of sufficient longitudinal forces associated with a frontal impact, the frontal air bags did not deploy.

Side Impact Air Bag System – 2007 Volvo S80

The Volvo S-80 was equipped with seatback mounted side impact air bags for the front left and right positions and IC air bags for the four outboard seating positions. As a result of the left side engagement with the tree, the left side IC and seatback mounted air bag deployed.

The IC deployed from the left roof side rail **(Figure 13)**. The IC provided coverage from the A- to C-pillars; however, the triangular area around the A-pillar tether resulted in an opening of 24 cm (9.4”) in width and 18 cm (7”) in height. The tear seam was 190 cm (75”) in length. The air bag membrane was rectangular in shape and measured 41 cm (16”) vertically from the roof side rail and 178 cm (70”) in length. The inboard aspect of the air bag was attached to the A-pillar by a 25 cm (10”) tether. During the NASS inspection, the researcher documented body fluid and hair transfers to the outboard aspect of the air bag and scuffing from the tree. During the SCI investigation, the air bag was weathered and the majority of the physical evidence on the air bag had eroded due to the elements. However, a 20 x 24 cm (7.8 x 9.4”) area of the air bag, 30 cm aft of the forward most aspect, revealed a tree bark/body fluid transfer **(Figure 14)**. It should be noted that no obstructions were noted within the path of the deployed air bag.

Figure 13 - Deployed IC air bag.

Figure 14 - Transfer evidence on outboard aspect of the IC air bag.

The following nomenclature was stamped on the inboard aspect of the IC air bag membrane:

Seq. PN01596
Auto LN
7PA 6.6 / S/L

The seat mounted side air bag deployed forward through a 50 cm (20”) tear seam in the seatback **(Figure 15)**. The tear seam began 16 cm (6.3”) below the top of the seatback and extended downward to the seat bight. The air bag membrane was a semi-circular shape and measured 50 cm (20”) in height and 22 cm (8.7”) in width. The bag was tethered by two 5 cm (2”) wide straps. Two 4 cm (1.5”) ports on the vertical seam and one 4 cm (1.5”) port along the horizontal seam vented the bag. The first vertical vent port was located 20 cm (7.8”) forward of the seatback and 11 cm (4.3”) below the top aspect of the air bag. The second was located 20 cm (7.8”) forward and 17 cm (6.7”) below the same. The horizontal port was located 17 cm (6.7”) forward of the seatback and along the horizontal seam. The air bag was saturated with blood from the driver and was weathered from the elements. The following nomenclature was stamped on the air bag:

Figure 15 - Deployed driver's seat mounted side air bag.

Seq. A/VA >PA6.6+VM0<
No. 8003LH (2880030D062721097)

Event Data Recorder – 2007 Volvo S80

The EDR was downloaded by a technical representative from Volvo using proprietary software at the time of the SCI inspection. The module was later removed from the vehicle’s center console by the SCI team and forwarded to Volvo for additional analysis. A text summary of events was provided by Volvo for inclusion into this report.

An analysis of the retrieved crash data showed that the vehicle was involved in a multiple crash event. Prior to the crash, the EDR indicated there were no fault codes present in the system. The control module detected that the driver was unrestrained and the front right passenger was restrained at the time of the crash. The first recordable event in the impact sequence was the impact with the parked vehicle. The module detected a rear end impact that exceeded the rear crash threshold level. During the SCI inspection, the direction of force for this impact was in the 8 o’clock sector and it is this event that the EDR detected. As a result of this impact, the front right pretensioner actuated. The unused driver pretensioner did not actuate.

Following the impact with the parked vehicle, the air bag sensor detected an impact to the left side of the vehicle. This impact resulted in a deployment of the left IC and seatback-mounted side air bags. The air bags deployed approximately 4 milliseconds after the left side impact. This event was attributed to the 63 cm (25") tree. The control module did not record the minor impacts to the signpost and mailbox post.

Occupant Demographics

Driver

Age/Sex:	33-year old/Male
Height:	180 cm (71")
Weight:	79 kg (175 lb)
Seat Track Position:	Mid-track: 9 cm (3.5") forward of full rear and 15 cm (5.9") rear of full forward
Manual Restraint Use:	None
Usage Source:	Vehicle inspection
Eyewear:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Near total decapitation at the angle of the mandible with massive skull fractures and an avulsion of the majority of the brain from the cranium	Maximum (311000.6,0)	Tree
Left lower leg abrasion	Minor (890202.1,2)	Left side door panel
Right knee abrasion	Minor (890202.1,1)	Left knee bolster

Source: Medical Examiner report

Driver Kinematics

According to the left rear passenger, the 33-year old male driver was seated in an upright posture at a mid-track position. He was not restrained by the 3-point lap and shoulder belt. Additionally, he stated that the driver was engaged in an argument with the front right passenger and was traveling at a high rate of speed. As the vehicle rotated CCW, the driver responded by moving slightly to the left. It is likely that he was attempting to regain control of the vehicle.

At impact with the Honda CRX, the driver responded to the 8 o'clock direction of force by loading the seatback and left door panel. As the Volvo displaced the Honda, the CCW rotation was amplified and the driver remained out of position left. The rapid CCW rotation placed the driver against the front left door. The vehicle then impacted a 63 cm (25") tree with a direction of force of 10 o'clock. The IC and seatback air bag deployed and the already out of position driver responded with a left and forward trajectory. The window disintegrated and the driver impacted the tree. The striking of the tree by the

driver resulted in the near total decapitation at the angle of the mandible with massive skull fractures and an avulsion of the majority of the brain from the cranium. The contact to the tree was evidenced by the presence of the tree bark/body fluid transfers on the outboard aspect of the air bag.

The driver came to rest within the front left driver's position seated in an upright posture. The on-scene images revealed a trail of body fluid that extended down the exterior of the left front door, pooling below the left sill. Additionally, the left IC was positioned on the driver's right shoulder at final rest. He was pronounced deceased at the scene and was removed from the vehicle for transport to the county medical examiner's office.

Front Right Passenger

Age/Sex:	24-year old/Female
Height:	170 cm (67")
Weight:	59 kg (130 lb)
Seat Track Position:	Mid-track: 10 cm (4") forward of full rear and 17 cm (6.5") rear of full forward
Manual Restraint Use:	3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a regional trauma center and released

Front Right Passenger Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Left forearm abrasion	Minor (790202.1,2)	Center console
Right forearm abrasion	Minor (790202.1,1)	Unknown

Source: Hospital records

Front Right Passenger Kinematics

The 24-year old female passenger was seated upright in the front right seating position and was restrained by the 3-point lap and shoulder belt. At impact with the Honda CRX, she was displaced left and her left forearm loaded the center console. This was evidenced by the deformation of the console and the abrasion to the passenger's left arm. She was further displaced left at impact with the tree; however, the lap belt prevented her from being displaced further. The lap belt loading was evidenced by the abraded latch plate and webbing.

Following the crash, the front right passenger exited the vehicle under her own power and awaited the arrival of emergency personnel. She was transported to a regional trauma center where she was treated and then released.

Second Row Left Passenger

Age/Sex:	21-year old/Male
Height:	178 cm (70”)
Weight:	109 kg (240 lb)
Seat Track Position:	Not adjustable
Manual Restraint Use:	None
Usage Source:	Vehicle inspection/interview
Eyewear:	Contact lenses
Type of Medical Treatment:	Transported by ambulance to a regional trauma center and released

Second Row Left Passenger Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Left foot sprain	Minor (850404.1,2)	Floor and driver’s seatback
Facial skin abrasions	Minor (290202.1,9)	Flying glass
Scalp abrasions and lacerations	Minor (190600.1,9) (190202.1,6)	Flying glass

Source: Hospital medical records

Second Row Left Passenger Kinematics

The 21-year old male passenger was seated in the second row left position and was unrestrained. He indicated during an in-person interview that he was concerned by the rate of speed of the vehicle and as the driver lost control, he braced himself by holding onto the driver’s seatback with both hands and by tucking his feet underneath the seat. As the vehicle impacted the Honda CRX, the left rear passenger initiated a trajectory to the left and the left rear window shattered, distributing glass into the second row. The left rear passenger sustained multiple abrasions and lacerations form the flying glass to his face and scalp.

As the vehicle impacted the tree, the IC deployed and the left rear passenger loaded the air bag. As he braced with his feet under the driver’s seat, he sustained a sprain to his left foot. The rear left passenger exited the vehicle under his own power. He was transported by ambulance to a regional trauma center where he was treated and released.

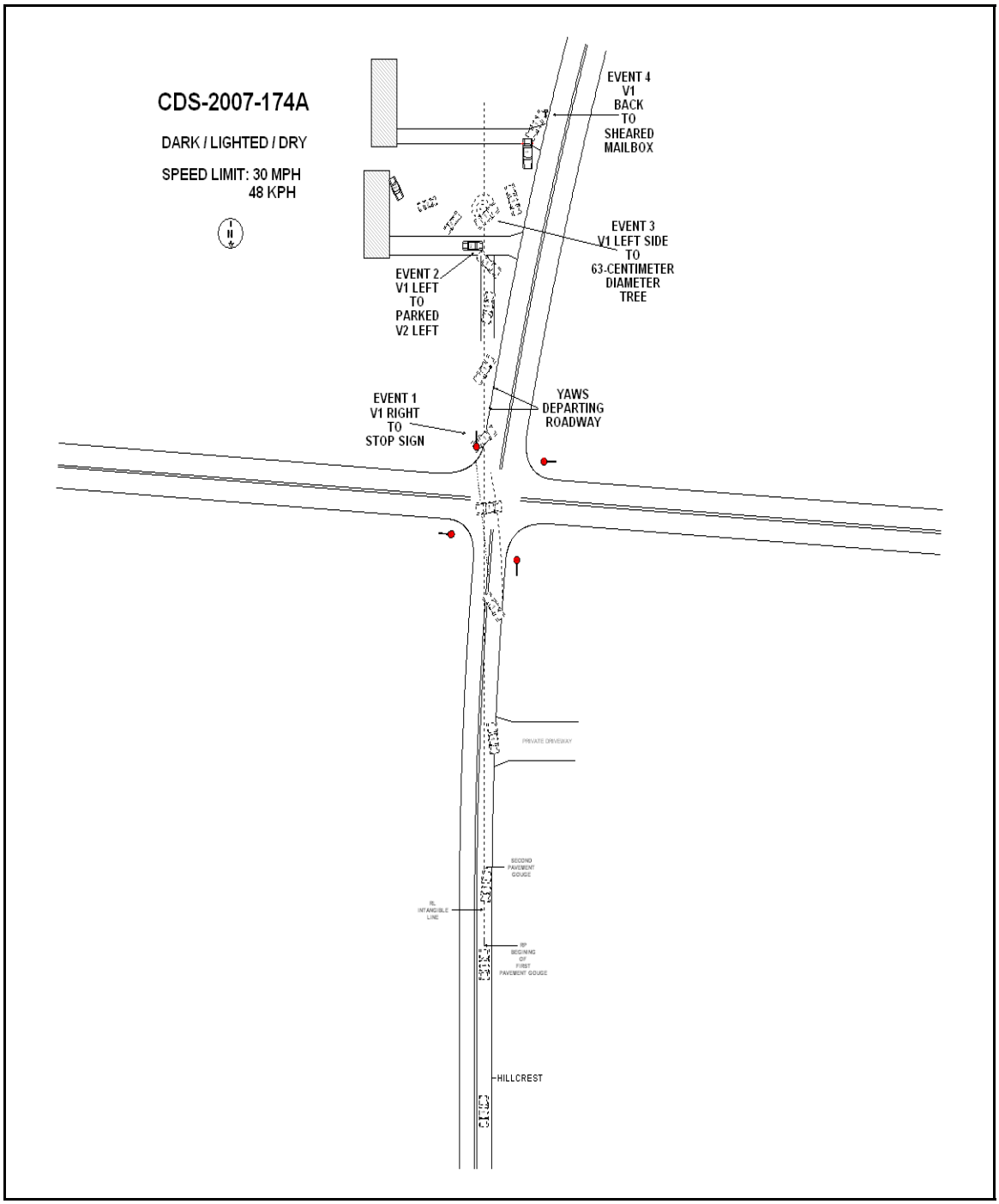

Figure 16 – NASS Crash Schematic