CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

SCI CASE NO: CA08048

VEHICLE: 2005 ACURA TL

LOCATION: TEXAS

CRASH DATE: AUGUST 2008

Contract No. DTNH22-07-C-00043

Prepared for:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety system.

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OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION
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BACKGROUND

This investigation focused on the inflatable side impact protection system that deployed in a 2005 Acura TL 4-door sedan (**Figure 1**) during its intersection crash with a 2003 Ford F250 pickup truck. The Acura was equipped with side impact Inflatable Curtain (IC) air bags, front row seatback-mounted side impact air bags, Certified Advanced 208-Compliant (CAC) frontal air bags and front row safety belt pretensioners. The manufacturer of this vehicle has certified that the Acura is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard No. 208. The crash occurred when the southbound Acura was impacted on the left side by the front of the westbound Ford as both vehicles entered a 4-leg intersection. The driver's seatback-mounted side impact air bag and the left IC air bag deployed in the Acura. The Acura was driven by a 61-year-old restrained male. He sustained multiple injuries of the head, chest, pelvis and extremities and was transported to by helicopter to a regional trauma center where he was admitted for nine days for treatment of his injuries. The Ford was driven by a 47-year-old restrained male. The police report indicated that the Ford's frontal air bags did not deploy. The driver sustained possible injuries, but refused on-scene medical attention.

Figure 1: Left front oblique view of the Acura TL.

This crash was identified by the National Highway Traffic Safety Administration (NHTSA) through a review of Police Crash Reports (PAR). The PAR was forwarded to the Calspan Special Crash Investigation (SCI) team for an on-site investigation on September 19, 2008. The insurance company was contacted by the SCI team and cooperation was established to inspect the Acura that was located at a salvage facility; however, permission to remove the Electronic Data Recorder (EDR) was denied by the insurance company due to pending litigation. The on-site investigation took place on October 8, 2008 and involved the inspection and documentation of the Acura, the crash site and the acquisition of the driver's medical records. The Ford F250 was repaired prior to the assignment of this case and was not inspected.

SUMMARY

Crash Site

This crash occurred during the daylight hours at a controlled 4-leg intersection during clear and dry conditions. The Acura was exiting a residential community from a divided four-lane north/south residential street onto a seven-lane divided east/west roadway. The seven-lane roadway consisted of three lanes in each direction with opposing designated left turn lanes. The Ford was exiting a left curve onto a straight segment of road prior to the intersection. Both roadways were boarded by a concrete curbs. The posted speed limit was 64 km/h (40 mph) for the east/west roadway and 48 km/h (30 mph) for the north/south intersecting street. **Figure 2** is a westbound view of the intersection which depicts the pre-crash trajectory of the Ford. A schematic of the crash is included at the end of this report as **Figure 11**.

Figure 2: Overall view of the intersection in the westbound direction of travel.

Vehicle Data - 2005 Acura TL

The 2005 Acura TL 4-door sedan was manufactured in November 2004 and was identified by Vehicle Identification Number (VIN): 19UUA66205A (production sequence deleted). The odometer reading at the time of the crash was unknown. The powertrain consisted of a 3.2-liter, 6-cylinder engine linked to a 5-speed automatic transmission with front-wheel drive. The Acura was equipped with a 4-wheel ABS, disc brake system, which included break assist and electronic brakeforce distribution. Additional safety features included electronic stability control and traction control systems. The vehicle manufacturer recommended tire size was P235/45R17 with front and rear cold tire pressures 221 kPa (32 PSI). At the time of the crash, the Acura was equipped with OEM 5-spoke alloy wheels with Kumho ECSTA ASX, P235/45R17 tires. The specific tire data at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	Tire Flat	5 mm (6/32 in)	Yes	Outer face of alloy wheel abraded
LR	193 kPa (28 PSI)	7 mm (9/32 in)	No	None
RF	Tire Flat	5 mm (6/32 in)	No	Outer bead of alloy wheel abraded
RR	193 kPa (28 PSI)	6 mm (8/32 in)	No	Outer bead of alloy wheel abraded

The interior of the Acura was configured for five passenger seating and consisted of leather-surfaced front bucket seats and a rear bench with a split, forward-folding seat back. Both front seats were power adjustable. The adjustable head restraints were positioned 3 cm (1 in) above the seatbacks on both sides. The outboard positions of the rear seat were equipped with adjustable head restraints that were in the full-down positions. The manual restraint system consisted of 3-point lap and shoulder safety belts in all five seat positions.

The interior safety systems consisted of the CAC frontal air bags; front seatback-mounted side impact air bags and the IC air bags that provided coverage to the four outboard seating positions. The safety belt systems consisted of continuous loop lap and shoulder belts for the five seating positions. All of the belt systems utilized sliding latch plates. The front row safety belts were equipped with retractor mounted pretensioners.

2003 Ford F250

The 2003 Ford F250 pickup truck was identified by VIN: 1FTNW21F83E (production sequence deleted). Based on VIN sourced information, the vehicle was a 4-door, Super Duty crew cab. The powertrain consisted of a 7.3-liter, 8-cylinder engine linked to a 5-speed automatic transmission with four-wheel drive. The braking system was a 4-wheel ABS with electronic brakeforce distribution, disc brake system. This vehicle was repaired prior to case assignment and was not inspected for this investigation.

Crash Sequence

Pre-Crash

The Acura was southbound, driven by the 61-year-old restrained male as it approached the 4-leg intersection. The driver was traveling on the inboard lane and entered the intersection on a green signal phase. As he entered the intersection, the driver initiated a left turn to travel in an easterly direction. The Ford was westbound, driven by the 47-year-old restrained male as it approached the intersection in the second travel lane from the north curb line. As the Acura entered the intersection and initiated the left turn, the Ford continued along a straight travel path into the intersection. The traffic light for the Ford was on the red signal phase. There was no pre-crash evidence at the crash site indicative of evasive actions at the time of the SCI scene inspection.

Crash

The full frontal area of the Ford impacted the forward aspect of the Acura's left side. The direction of force was in the 12 o'clock sector for the Ford and in the 10 o'clock sector for the Acura. The Missing Vehicle Damage Algorithm of the WinSMASH program was used to calculate the delta-Vs for this event. The total delta-V of the Acura was 63 km/h (39.1 mph). The longitudinal and lateral delta-V components were -32 km/h (-19.9 mph) and 55 km/h (34.2 mph), respectively. The Ford's total delta-V was 37 km/h (23 mph)

with longitudinal and lateral components of -36 km/h (-22.4 mph) and -6 km/h (-3.7 mph), respectively. These results were considered a borderline reconstruction as the delta Vs appeared to be overstated based on SCI experience. This primary impact resulted in the actuation of the Acura's driver safety belt pretensioners and the deployment of the driver seatback-mounted side impact air bag and the left IC air bag. The Ford's frontal air bag system did not deploy in this crash.

The force and direction of this impact, forward of the Acura's center of gravity, caused the vehicle to rotate clockwise (CW) approximately 95 degrees from its initial point of impact to its final rest position. The investigating officer documented a post-crash travel distance of 38 m (125 ft) for the Acura. At rest, the Acura was straddling the inboard westbound travel lane, facing a southwesterly direction. The Ford rotated approximately 15 degrees counterclockwise (CCW) from initial impact and traveled approximately the same distance as the Acura to final rest. At rest, the Ford was in the outboard eastbound lane, facing in a westerly direction.

Post-Crash

Police and ambulance personnel responded to the crash site. The driver of the Acura was unconscious and was extricated from the vehicle. The firefighters used rescue tools to pry open the jammed left front door. Following his extrication, the driver of the Acura was transported by air ambulance to a local trauma center where he was admitted for treatment. The Acura sustained disabling damage and was towed from the crash site by the city's duty wrecker service. The driver of the Ford suffered police reported possible injuries, but refused on-scene medical attention. The Ford also sustained disabling damage and was towed from the crash site by a private tow service.

Vehicle Damage – 2005 Acura TL

The Acura sustained severe left side damage from the vehicle-to-vehicle crash with the Ford pickup truck. The damage involved the front bumper fascia, the left front fender and inner side structure, hood, the left front tire and wheel, left front suspension and driveline, the left A-pillar and windshield, the left front door, sill and left B-pillar. **Figure 3** is a view of the left side damage to the Acura. The direct contact damage began 112 cm (44 in) forward of the left rear axle and extended 186 cm (72.25 in) forward to the left front corner of the bumper fascia. The combined induced and direct contact damage began at the left C-pillar and extended 323 cm (127.25 in) forward to the front

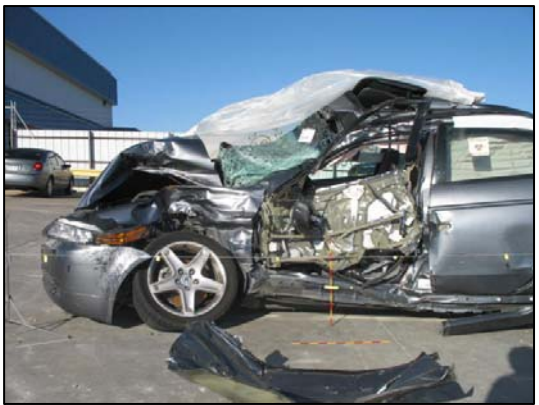

Figure 3: View of the Acura's left side impact damage.

corner. The maximum crush was 74 cm (29.1 in) located on the left front door beam 65 cm (25.5 in) forward of the B-pillar and 60 cm (23.5 in) above the ground. The crush profile was measured along the lower door level with the following results: C1 = 6 cm (2.4 in), C2 = 14 cm (5.5 in), C3 = 37 cm (14.6 in), C4 = 48 cm (18.9 in), C5 = 74 cm (29.1 in), C6 = 28 cm (11 in). The Acura's left wheelbase was reduced by 9 cm (3.5 in) when compared to exemplar measurements. The Collision Deformation Classification (CDC) for this direct damage pattern was 10LYAW5.

The left front door was jammed closed by the impact. The resulting body deformation jammed the both rear doors in the closed positions. The right front door remained closed during the crash and was operational post-crash. Rescue personnel pried the left front door open to extricate the driver from the vehicle. The windshield was 100 percent cracked with a partial bond separation at the upper left corner and a small perforation in the lower left quadrant from a fractured section of the upper instrument panel. The left front door glazing was disintegrated from impact forces. All other glazing remained intact.

Interior Damage – 2005 Acura TL

The interior damage to the Acura consisted of the deployment of the vehicle's side impact air bag systems, actuation of the front row pretensioner systems, occupant contact points and occupant compartment intrusions. Descriptions of the Acura's measured intrusions, when compared to exemplar measurements, are listed in the following table:

Position	**Component**	**Intrusion**	**Direction**
Front row, left	A-pillar (upper portion)	43 cm (17 in)	Lateral
	B-pillar (by striker plate)	39 cm (15.4 in)	Lateral
	Steering wheel	37 cm (14.6 in)	Lateral
	Door panel (forward upper quadrant)	36 cm (14.2 in)	Lateral
	Door armrest (rear lower quadrant)	36 cm (14.2 in)	Lateral
	Roof side rail	36 cm (14.2 in)	Lateral
	Roof headliner	29 cm (11.4 in)	Vertical
	Kick panel (forward of A-pillar)	15 cm (5.9 in)	Lateral
	Seatback	5 cm (2 in)	Lateral
Second row, left	Roof side rail	19 cm (7.5 in)	Lateral

Position	Component	Intrusion	Direction
	Door panel (forward lower quadrant)	12 cm (4.7 in)	Lateral

Interior damage exhibiting characteristics of occupant contact was identified to eleven separate areas within and adjacent to the driver's position. The first area of damage was located in the forward lower quadrant of the interior driver door panel (**Figure 4**), which consisted of deformation associated with occupant loading of this component by the driver's left lower leg. Multiple scuff marks and deformation were identified on the door armrest and the upper rear door quadrant that were attributed to contact with the driver's left hip and left flank areas, respectively. The fourth damaged component was identified as the intruded portion of the front left roof headliner, which exhibited scuff marks potentially created by contact with the top of the driver's head. The center console (**Figure 5**) was distorted and fractured from the driver's hip area as he was compressed between the console and the intruding left side structure. The left aspect of the front row right seatback and head restraint exhibited frictional abrasions and compression with body fluid transfers from contact from the driver's face, head, and right shoulder regions. The left aspect of the anterior portion of the driver's seatback, extending from 11 cm (4.3 in) to 19 cm (7.5 in) above the seat bight, was deformed by lateral intrusion and contact with the driver's left hip area. The area immediately forward of the left side seatback deformity contained the deployed seat-mounted air bag, which also exhibited loading evidence consistent with the same body region. Multiple scuff marks and deformation were identified on the left side kick panel located under the instrument panel, forward of the A-pillar, that were attributed to contact with the driver's left lower leg area. The left IC airbag exhibited frictional abrasions and compression type bodily fluid transfer marks to the inboard surface of the air bag created by contact with the left side of the driver's head and face.

Figure 4: Depicts occupant contact damage to the left front door panel and armrest.

Figure 5: Depicts occupant contact damage to the center console.

Manual Restraint System – 2005 Acura TL

The driver's safety belt system consisted of continuous loop webbing, a sliding latch plate, a rigid stalk buckle, an adjustable D-ring, and an Emergency Locking Retractor (ELR) with a pretensioner. The D-ring was adjusted to the full-up position. The safety belt webbing was found in an extended position, measuring 137 cm (54 in) in length and locked in place by the actuated retractor pretensioner. Further inspection of the safety belt webbing revealed two extrication tool cuts. The shoulder portion of webbing was cut 5 cm (2 in) below the D-ring. The lap belt webbing was cut at a 45 degree angle, 58 cm (23 in) above the outboard seat frame anchor point. Frictional abrasions were identified on the outboard aspect of the lower webbing section from 15 cm to 29 cm (6 in to 11.5 in) above the lower anchor point. These abrasions were the direct result of intrusion contact with the B-pillar trim panel. Based upon the post-crash condition and position of the safety belt system, SCI determined that the driver was restrained at the time of the crash.

Frontal Air Bag System – 2005 Acura TL

The Acura was equipped with a CAC frontal air bag system for the driver and front right passenger positions. The driver's CAC air bag was located in the center hub of the steering wheel rim. The front right air bag was mounted in the top aspect of the right instrument panel. The manufacturer of this vehicle certified that the Acura was compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard No. 208. The CAC air bag system did not deploy in this side impact crash. The system was controlled by a center tunnel-mounted air bag control module that had Event Data Recording (EDR) capabilities. The insurance company refused to allow the SCI team to remove the EDR for imaging by Honda due to pending litigation.

Side Impact Air bag System – 2005 Acura TL

The Acura was equipped with a side impact air bag system that consisted of front seatback-mounted side impact air bags and roof side rail-mounted IC air bags. The left seatback-mounted air bag and the left IC air bag deployed in this side impact crash. The seatback air bag deployed from the forward stitch seam of the seat back that measured 22 cm (8.7 in) in height. The deployed air bag, in its deflated state, measured 30 cm x 25 cm (12 in x 9.75 in) height x width. The air bag was vented by a 1 cm (.25 in) vent port located

Figure 6: Depicts the inboard aspect of the deployed seat-mounted side impact air bag.

6 cm (2.4 in) forward of the tear seam on the inboard aspect of the air bag. There was no occupant contact evidence or damage to the deployed seatback air bag. **Figure 7** is a view of the deployed air bag.

Figure 7: Depicts the front row aspect of the left IC airbag after the removed section was reattached.

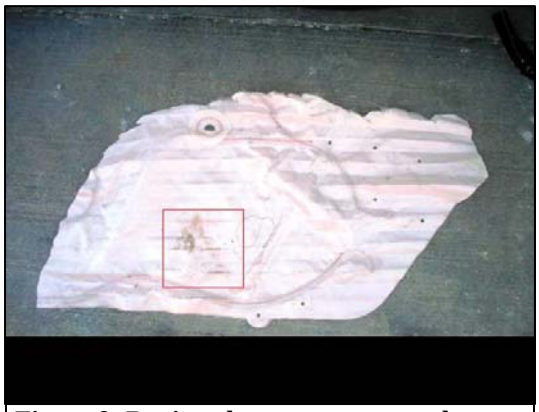

Figure 8: Depicts the on-scene cut and removed section of the front row portion of the left IC air bag.

The IC air bags were mounted within both roof side rails. The IC air bag system provided coverage for the outer seating positions of both rows. The left side IC air bag deployed as a result of the impact with the Ford. The IC measured 132 cm x 41 cm (52 in x 16 in) length x height in overall dimensions and provided coverage from the upper aspect of the A-pillar to the C-pillar area. A section from the forward most aspect of this air bag (**Figure 8**), measuring 57 cm x 35 cm (22.5 in x 13.75 in) length x height, was cut from the vehicle during the extrication of the driver. This section was realigned with the IC air bag's core section (**Figure 9**). A 30 cm (12 in) void in coverage was measured between the beltline region of the A-pillar and the forward edge of the IC. The deployed IC did not contain a sail panel or tethers within its construction. The vertical coverage of the IC extended 13 cm (5 in) below the beltline for both seating rows. Frictional abrasions and body fluids are highlighted within the red bordered areas of **Figure 8 and 9**, were recognized on the inboard surface of this air bag 28 cm (11 in) longitudinally rearward of the lower front corner and 12 cm (4.7 in) above the bottom edge of the curtain.

Driver Demographics/Data

2005 Acura TL

Age/Sex:	61-year-old/male
Height:	188 cm (74 in)
Weight:	87.4 kg (193 lbs)
Seat Track Position:	3 cm (1 in) forward of full-rear
Safety Belt Usage:	3-point lap and shoulder
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Extricated by rescue personnel
Type of Medical Treatment:	Transported by air ambulance to a local trauma center where he was admitted for nine days

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Bilateral pulmonary contusion	Severe (441410.4,3)	Left front door (rearward upper quadrant)
Left tibia fracture, proximal shaft (comminuted w/1 cm lateral displacement)	Serious (853422.3,2)	Left front door (forward lower quadrant, speaker and metal housing)
Brief loss of consciousness (< 30 min.)	Moderate (160202.2,0)	Exterior of other vehicle loaded through IC air bag
Left fibula neck fracture (non-displaced and comminuted)	Moderate (851606.2,2)	Left front door (forward lower quadrant, speaker and metal housing)
Bilateral (superior and inferior) pubic rami fracture	Moderate (852602.2,5)	Left B-pillar
Left sacral ala fracture (non-displaced) and left acetabular lip fracture	Moderate (852602.2,2)	Left B-pillar
Right rib fractures 1, 2 and 3 (rib 1 proximal fracture)	Moderate (450220.2,1)	Rebound into the front right seatback (left aspect)
Left clavicle fracture (non-operative)	Moderate (752200.2,1)	Left front door (rearward upper quadrant)
Right clavicle fracture	Moderate (752200.2,2)	Rebound into the front right seatback (left aspect)

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Sternum fracture (including the manubrium w/retrosternal hematoma)	Moderate (450804.2,4)	Left front door (rearward upper quadrant)
Nasal bridge laceration (2 cm)	Minor (290602.1,4)	Left IC air bag and eyewear
Left tibia/fibula contusion	Minor (890402.1,2)	Driver door (forward lower quadrant)
Right tibia/fibula contusion	Minor (890402.1,1)	Left knee bolster
Abdominal wall contusion	Minor (590402.1,9)	Safety belt webbing
Left clavicle contusion	Minor (790402.1,2)	Left front door (rearward upper quadrant)
Right clavicle contusion	Minor (790402.1,1)	Front right seatback (left aspect)
Right chest contusion	Minor (490402.1,1)	Safety belt webbing
Right upper extremity abrasion	Minor (790202.1,1)	Front right seatback (left aspect)

Source of Injury Data: Medical Records

Driver Kinematics

The 61-year-old male driver of the Acura was seated in a mid-to-rear track position and was restrained with the 3-point safety belt system. At impact, the ELR safety belt retractor locked, the retractor mounted pretensioner actuated, and the left seatback-mounted side impact air bag and the left IC air bag deployed.

The driver responded to the 10 o'clock direction of force by initiating a slightly forward and predominately left trajectory as he loaded the belt restraint system, the deployed side impact air bags systems and the intruding left side interior components with his left shoulder, chest and pelvis and lower extremities. The left kick panel, A-pillar, B-pillar, door panel, sill and roof side rail intruded laterally. A vertical reduction of the occupant compartment, from the induced movement of the left roof headliner and floor pan, also occurred to a lesser degree.

The driver contacted the deployed IC curtain with the left side of his face and head as evidenced by the documented scuff marks and compression-type body fluid transfer

marks to the air bag. This contact, coupled with the driver's corrective eyewear, caused a 2 cm (0.8 in) nasal bridge laceration. The driver's head loaded through the deployed IC air bag and engaged the front of the Ford pickup truck. This contact resulted in a brief loss of consciousness associated with head trauma as the front end of the Ford loaded through the IC air bag.

The left front door panel and adjacent B-pillar intruded against the left aspect of the front left seatback and the driver's left flank. He sustained multiple left side injuries including a non-displaced left sacral ala fracture and a left acetabular hip fracture. The driver also sustained a left tibia fracture of the proximal shaft, a non-displaced and comminuted left fibula neck fracture and a contusion over the left tibia and fibula area, associated to the forward lower quadrant of the left front door that housed a 17 cm (6.5 in) diameter speaker and metal speaker housing, identified within the red bordered areas of **Figure 9**. The driver's right lower leg contacted the knee bolster causing a contusion over the right tibia and fibula area without producing any contact point evidence.

Figure 9: Depicts the speaker and metal speaker housing located in the forward lower door quadrant

During maximum engagement, the driver was compressed between the left side intruding components and the center console and the right seatback. Force of this compression caused bilateral pulmonary contusions, bilateral (superior and inferior) pubic rami fractures, a sternum fracture of the manubrium with a retrosternal hematoma, bilateral clavicle fractures and bilateral clavicle contusions consistent with crushing type injuries. The driver also sustained a non-evidentiary abdominal wall contusion associated with loading of the lap portion of the restraining safety belt webbing.

The left side intruding components, reinforced by the Ford's forward momentum, displaced the driver laterally rightward and forced his right flank against the right aspect of his seatback, center console and the left aspect of the front row right seatback and head restraint. **Figure 10** identifies the driver loading evidence consisting of frictional abrasions and compression type bodily fluid transfer marks to the left aspect of the front row right seatback and headrest. This occurrence caused three rib fractures to the top

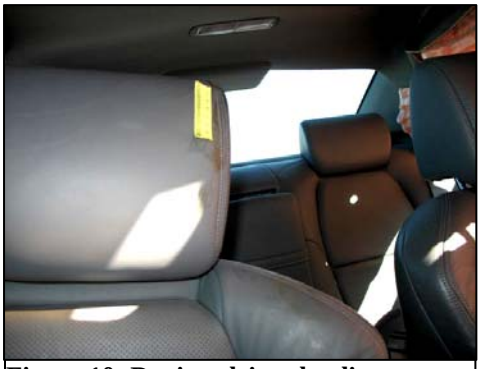

Figure 10: Depicts driver loading evidence to the left aspect of the front right seatback and headrest.

aspect of the driver's right rib cage, a right chest contusion and an abrasion of the right upper extremities.

The driver came to final rest within his seating position in an unconsciousness state. During the extrication efforts, several unsuccessful attempts were made to remove the intruded driver door. The Acura's driver was ultimately extricated through the right front door opening.

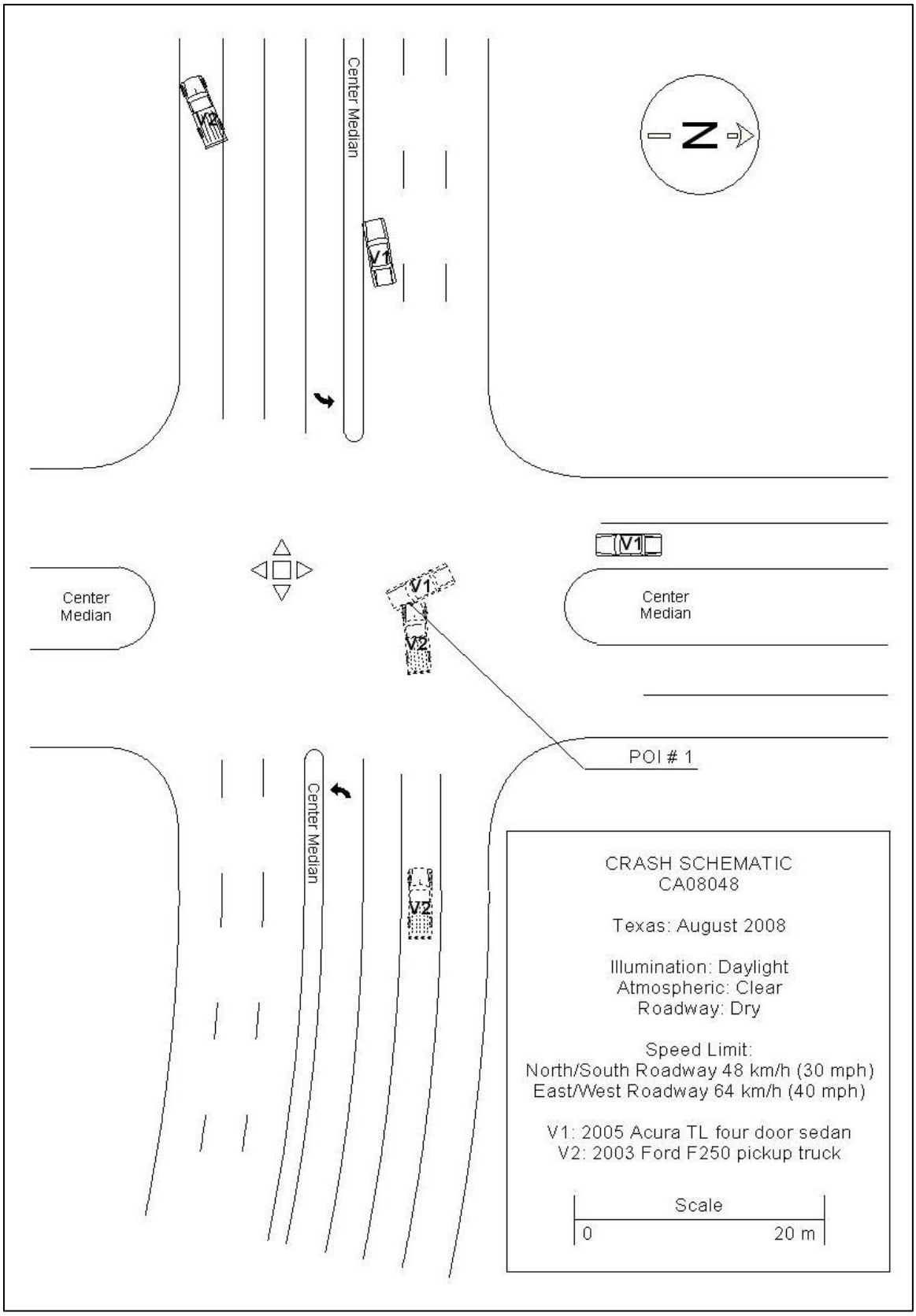

Figure 11. Crash Schematic