

CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE AIR BAG DEPLOYMENT INVESTIGATION

SCI CASE NUMBER: CA08044

VEHICLE: 2007 SUZUKI SX4

LOCATION: NEW YORK

INCIDENT DATE: SEPTEMBER 2008

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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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16. Abstract This on-site investigation focused on the severity of the crash and deployment of the side air bag system of a 2007 Suzuki SX4. This vehicle was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system, front seatback-mounted side impact air bags, and Inflatable Curtain (IC) air bags for the four outboard seating positions. The Suzuki was struck on the left side by a 1996 Ford F150 pickup truck, at an intersection with a driveway. The left side impact and IC air bags of the Suzuki, and the driver's air bag system of the Ford, deployed as a result of the collision. The 23-year-old male driver of the Suzuki denied that he was injured and refused medical treatment at the scene. The 53-year-old male driver of the Ford was transported by ground ambulance for treatment of minor severity injuries.					
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CALSPAN ON-SITE SIDE AIR BAG DEPLOYMENT INVESTIGATION

SCI CASE NUMBER: CA08044

VEHICLE: 2007 SUZUKI SX4

LOCATION: NEW YORK

INCIDENT DATE: SEPTEMBER 2008

BACKGROUND

This on-site investigation focused on the severity of the crash and deployment of the side air bag system of a 2007 Suzuki SX4 (**Figure 1**). This vehicle was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system, front seatback-mounted side impact air bags, and Inflatable Curtain (IC) air bags for the four outboard seating positions. The Suzuki was struck on the left



Figure 1: Left side view of the Suzuki at final rest.

side by a 1996 Ford F150 pickup truck, at an intersection with a driveway. The left side impact and IC air bags of the Suzuki, and the driver's air bag system of the Ford, deployed as a result of the collision. The 23-year-old male driver of the Suzuki denied that he was injured and refused medical treatment at the scene. The 53-year-old male driver of the Ford was transported by ground ambulance for treatment of minor severity injuries.

The Calspan Special Crash Investigations (SCI) team was notified of the crash by the investigating police officer. The notification was forwarded to NHTSA's Crash Investigation Division and assigned for on-site investigation on the day of its occurrence. The investigating officer retained the vehicles under a police hold for this SCI investigation. The investigation involved the inspection and documentation of the vehicles and crash site, and interviews with the driver of the Suzuki. The on-site portion of this investigation took place on Friday, September 12, 2008.

SUMMARY

Crash Site

This collision occurred at the intersection of a two lane roadway with a building complex driveway with a raised median (**Figure 2**). The Suzuki was attempting a left turn from the 3.8 m (12.5 ft) wide left turn lane of the 7.4 m (24.3 ft) wide exit driveway out of the complex. This was accompanied by a solid white stop line and a regulatory stop sign off of the right side of the driveway. Adjacent to the left turn lane and separating the exit driveway from the entrance driveway was a 2.9 m (9.5 ft) wide raised median. This median was encompassed by a concrete curb, and had a tree centered at its south end. The crash schematic is attached as **Figure 13**.



Figure 2: Westbound view of the crash site.

At the time of the crash, the weather was clear and sunny. The straight and level bituminous two-lane roadway had 3.5 m (11.5 ft) wide travel lanes supported by a 1.3 m (4.3 ft) bituminous shoulder. A 1.5 m (4.9 ft) wide sidewalk extended parallel to the roadway, separated from the shoulder by a 1.2 m (3.9 ft) wide section of gravel on either side of the intersection. The posted speed limit was 56 km/h (35 mph).

Vehicle Data

2007 Suzuki SX4

The 2007 Suzuki SX4 was manufactured in Japan and was identified by the Vehicle Identification Number (VIN): JS2YB413675 (production sequence deleted). The exact odometer reading at the time of SCI inspection could not be obtained due to vehicle damage. This hatchback style vehicle had a 250 cm (98.5 in) wheelbase with all-wheel drive capabilities (**Figure 3**). Power came from a 2.0-liter transverse 4-cylinder gasoline engine linked to a 5-speed manual transmission. The associated gearshift was mounted in the center console. The service brakes included four-wheel power-assisted discs with anti-lock. The vehicle was also equipped with power steering, power windows, and power locks. A roof rack was integrated onto the roof of the vehicle, but lacked lateral crossbars. The Gross Vehicle Weight Rating (GVWR) was 1,197 kg (2,640 lb).



Figure 3: Left front oblique view of the Suzuki.

The manufacturer's recommended tire size was P205/60R16 front and rear. All tires were Bridgestone Turanza EL400 of the recommended size, mounted on OEM 5-spoke alloy wheels. Specific tire data at the time of SCI inspection was as follows:

<i>POSITION</i>	<i>TIN NUMBER</i>	<i>PRESSURE</i>	<i>TREAD DEPTH</i>	<i>DAMAGE</i>
LF	EL20 JFL4 806	Flat	6 mm (8/32 in)	Cut in outer sidewall with abrasions
RF	EL20 JFL4 806	210 kPa (30.5 PSI)	6 mm (8/32 in)	None
LR	EL20 JFL4 806	210 kPa (30.5 PSI)	4 mm (5/32 in)	None
RR	EL20 JFL4 806	262 kPa (38 PSI)	4 mm (5/32 in)	None

The interior of the Suzuki was configured for the seating of five occupants. The front was equipped with bucket seats with manual track adjustment and seatbacks with manual angular adjustment. At the time of SCI inspection, both seats were adjusted 7.6 cm (3 in) forward of the full-rear track positions. The left and right seatback angles were 22 degrees and 25 degrees from vertical, respectively, with both head restraints adjusted 7.6 cm (3 in) above the seatbacks.

The rear three passenger bench seat was split 60/40 from left to right. All three seat positions incorporated manual adjustable head restraints. These were positioned full-down at the time of SCI inspection. All five seating positions were equipped with 3-point lap and shoulder safety belts. For the two front seats, the shoulder D-ring was manually adjustable at the B-pillar.

1996 Ford F150

The 1996 Ford F150 (**Figure 4**) was manufactured in April 1996 and identified by the VIN: 1FTEF15Y9TL (production sequence deleted). The exact odometer reading at the time of SCI inspection was unknown. This two-door regular cab pickup truck had a 297 cm (117 in) wheelbase with rear wheel drive. Power was provided by a 6-cylinder gasoline engine linked to an automatic transmission. The service brakes were four-wheel power-assisted discs with anti-lock.



Figure 4: Overall view of the Ford

The manufacturer's recommended tire size was P235/75R/15 front and rear, with cold tire pressures of 241 kPa (35 PSI) and 283 kPa (41 PSI), respectively. All tires were mounted on OEM steel wheels. All tires were undamaged at the time of SCI inspection, with the following specific data:

POSITION	MAKE/MODEL	TIN	PRESSURE	TREAD DEPTH
LF	Uniroyal Laredo	ANHK FDUU	238 kPa (34.5 PSI)	5.5 mm (7/32 in)
RF	Uniroyal Laredo	ANHK FDUU	279 kPa (40.5 PSI)	5 mm (6/32 in)
LR	Firestone Wilderness AT	Unknown	296 kPa (43 PSI)	8 mm (10/32 in)
RR	Firestone Wilderness AT	VDHK AW2 1401	197 kPa (28.5 PSI)	7 mm (9/32 in)

The Gross Vehicle Weight Rating (GVWR) was 2,835 kg (6,250 lb). This pickup truck was equipped with a folding tailgate ramp. At the time of the incident the pickup was transporting a garden tractor and other miscellaneous lawn care tools in the payload bed, with a weight of approximately 680 kg (1,500 lbs). **Figure 5** shows the pickup's bed and cargo, as found on scene by police.



Figure 5: Cargo within the bed area of the Ford.

The interior of the Ford was configured with a bench seat with seating for three occupants. It was equipped with a driver frontal air bag. This seat had 3-point lap and shoulder safety belts with integrated head restraints for the outboard positions. A lap belt was available for the center occupant.

Crash Sequence

Pre-Crash

The 23-year-old male was restrained by the 3-point safety belt in the driver's seat of the Suzuki. He had just left an apartment and was on his way to class, having stowed his backpack on the front passenger seat. He maneuvered the vehicle into the left turn lane of the exit driveway of the building complex. The driver experienced difficulty in looking to the left due to glare from the sun. The Ford was westbound on the two lane roadway, approaching the building complex's driveway. The Suzuki continued out of the exit driveway and initiated its left turn, entering directly into the path of the Ford. There was no physical evidence at the scene of any avoidance action by either vehicle.

Crash

The front of the Ford struck the front left side of the Suzuki. This impact immediately transitioned the Suzuki into a right lateral translation and simultaneously rotated the vehicle clockwise (CW), perpendicular to the frontal plane of the pickup truck. As the vehicles engaged the left side structure of the Suzuki was crushed and displaced laterally. The greater kinetic energy of the pickup truck translated the Suzuki laterally 6 m (19.7 ft) to the west of the impact position. Both vehicles came to rest in the roadway, as depicted in **Figure 6**.



Figure 6: Vehicles at final rest.

The Damage Algorithm of the WinSMASH model was used to calculate the severity (delta-V) of the crash. The total calculated delta-V of the Suzuki was 32 km/h (20 mph). The longitudinal and lateral components of the delta-V were -16 km/h (-10 mph) and 27.7 km/h (17.2 mph), respectively. The total calculated delta-V of the Ford was 17 km/h (10.6 mph), with longitudinal and lateral components of -16.7 km/h (-10.4 mph) and -3 km/h (-1.9 mph), respectively.

Post-Crash

Emergency response to the incident scene included the local police department, fire and rescue personnel, and Emergency Medical Services (EMS). The driver of the Suzuki was able to exit the vehicle unassisted and refused EMS. The driver of the Ford was transported by EMS ambulance to a local hospital for treatment of minor severity injuries. Both vehicles were towed from scene due to damage.

Vehicle Damage – 2007 Suzuki SX4 Exterior

The Suzuki sustained moderate left side damage from the collision. Damage on this plane included all components from the roof to the wheels forward of the aft edge of the rear passenger door. The left mirror was fractured from its mounts. Both the driver and rear passenger doors had damage to the exterior skins consisting of abrasions and lateral crush, but remained operational and in their closed positions. The front fender was crushed and displaced right laterally, coinciding with similar crush and displacement of the left edge of the hood. The left headlight assembly was fractured and hanging



Figure 7: Exterior crush to the left front door of the Suzuki.

from its front mounts. The left front wheel was damaged at the axle, resulting in inward rotational displacement of the top of the wheel. There was no damage on the right or rear. Damage to the vehicle glazing included the disintegration of the small triangular window between the A- and B-pillars and the driver's door window between the B- and C-pillars. The windshield and all other glazing were intact and undamaged.

The direct and induced damage began at the left front corner and extended 264 cm (104 in) toward the rear, ending 33 cm (13 in) forward of the left rear axle. The accompanying crush profile was measured at mid-door level, minus free space, with the following results: C1 = 0 cm (0 in), C2 = 3 cm (1.2 in), C3 = 9 cm (3.5 in), C4 = 7 cm (3 in), C5 = 15 cm (5.75 in), C6 = 0 cm (0 in). Maximum crush was located at C5. The Door/Sill Differential (DSD) measured 7 cm (2.6 in), located 46 cm (18 in) aft of the left A-pillar (**Figure 7**). The Collision Deformation Classification (CDC) for the damage pattern was 10LYAW2.

2007 Suzuki SX4 Interior

Interior intrusion associated with the collision was limited to the left front door panel. A 2.5 cm (1 in) inward buckling of the interior panel of the driver's door was found immediately aft of the speaker. The door panel armrest was also deflected inward, and an area of buckling was evidenced by stress discoloration in the polymer door skin above the speaker (**Figure 8**). The gearshift between the front seats was fractured from its linkage and displaced from the console. This was attributed to being struck during the crash sequence by the book bag that had been placed on the right front passenger seat. No occupant contact points were located.



Figure 8: Interior door panel intrusion of the Suzuki.

1996 Ford F150

The Ford sustained moderate frontal damage from the collision. Damage in this plane included all components from the hood to the frame forward of the front axle, biased to the left side. The front aspect of both the left and right front fenders were crushed and displaced rearward. The width of direct and induced damage extended 178 cm (70 in) from bumper corner to bumper corner (**Figure 9**). The corresponding crush profile was as follows: C1 = 16 cm (6.3 in), C2 = 24 cm (9.5 in), C3 = 27 cm (10.6 in), C4 = 29 cm (11.4 in), C5 = 20 cm (7.9 in), and C6 = 9 cm (3.5 in). Maximum crush was 29 cm (11.4 in), located at C4. The CDC associated with this damage pattern was 12FDEW2.



Figure 9: Left front oblique damage view of the Ford.

Damage to the front of the pickup bed and rear of the cab was caused by the cargo shifting during the collision. The front of the bed was bowed forward in the center, which contacted the rear of the cab below the rear window glazing and bowed the rear of the cab inward. This caused slight buckling of the exterior metal body panels at the mid-glazing level on the aft of the B-pillars (**Figure 10**).

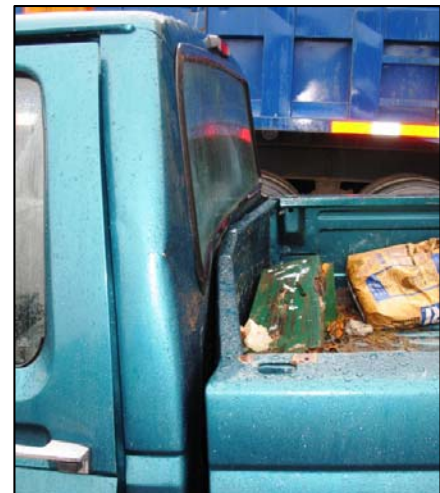


Figure 10: Cargo area damage of the Ford.

Manual Safety Belt System - 2007 Suzuki SX4

All five seating positions were equipped with 3-point lap and shoulder safety belts utilizing continuous loop webbing with sliding latch plates. For the two front seats, the D-ring was manually adjustable at the B-pillar. The front left safety belt was equipped with an Emergency Locking Retractor (ELR) with a retractor pretensioner. The right front seating position had an ELR and Automatic Locking Retractor (ALR) with pretensioner. The driver reported that he was restrained by the 3-point lap and shoulder safety belt at the time of the crash. At the time of SCI inspection, the left D-ring was adjusted full-up, while the right was full-down. There was also historical wear on the latch plate, though no loading evidence was present on the webbing. None of the pretensioners had actuated.

Frontal Air Bag System - 2007 Suzuki SX4

The Suzuki was equipped with the CAC frontal air bag system. The manufacturer of the Suzuki has certified that this vehicle is compliant to the advanced air bag requirements of Federal Motor Vehicle Safety Standard No. 208. This system consisted of a steering wheel hub-mounted driver air bag and instrument panel-mounted front right passenger air bag. The frontal air bag system did not deploy.

Side Impact Air Bag System - 2007 Suzuki SX4

The Suzuki was equipped with seatback-mounted side impact air bags and IC air bags. Forces from the collision triggered the deployment of this side air bag system on the left side. Both air bags were constructed of Automotive Safety Components International (ASCI) recognized PA 6.6+UMQ nylon material. No direct occupant contact evidence was found on either air bag.



Figure 11: Left side inflatable curtain air bag.

The IC air bag was identified by the manufacturer's number 898409942201 (**Figure 11**). This rectangular shaped air bag was 48 cm (19 in) tall by 157 cm (62 in) long. A 17 cm (6.5 in) long tether held the bag in place at the forward edge. There was no rear tether. This resulted in a 25 cm (10 in) tall by 6 cm (2.5 in) wide trapezoidal void at the rear, immediately to the aft of the left rear passenger head restraint. This air bag had deployed through the edge of the headliner.



Figure 12: Left front seatback-mounted air bag.

The seatback-mounted air bag was identified by the manufacturer's number 870409583901. This rectangular shaped air bag was 20 cm (8 in) wide by 30 cm (12 in) tall. The air bag had deployed through the stitching on the outboard edge of the seatback at thoracic to lumbar level (**Figure 12**).

Occupant Data - 2007 Suzuki SX4

Driver Demographics

Age/Sex:	23-year-old / Male
Height:	175 cm (69 in)
Weight:	84 kg (185 lb)
Seat Track Position:	8 cm (3 in) forward of full-rear
Safety Belt Usage:	Restrained by 3-point lap and shoulder safety belt
Usage Source:	Driver statements
Egress from Vehicle:	Exited unassisted
Type of Medical Treatment:	None

Driver Injuries

The driver denied that he was injured when interviewed by the SCI team. He stated that he was sore, but denied medical treatment or transport at scene and did not seek follow-up medical treatment.

Driver Kinematics

The driver of the Suzuki was seated in a rear third track position with the seat back reclined aft of vertical. The driver stated that he was wearing the manual safety belt system. There was no loading evidence on the belt system and the retractor pretensioner did not actuate as a result of the crash.

The driver responded to the side impact by initiating a left lateral trajectory. His left flank and head loaded the deployed seatback-mounted and IC air bags, respectively, as the vehicle was translated laterally by the Ford. These contacts did not result in injury. He then rebounded right laterally against the safety belt and seat as the vehicle came to rest. Following the crash, the driver exited the vehicle unassisted. He refused medical treatment or transport at scene, and did not seek medical treatment at a later date.

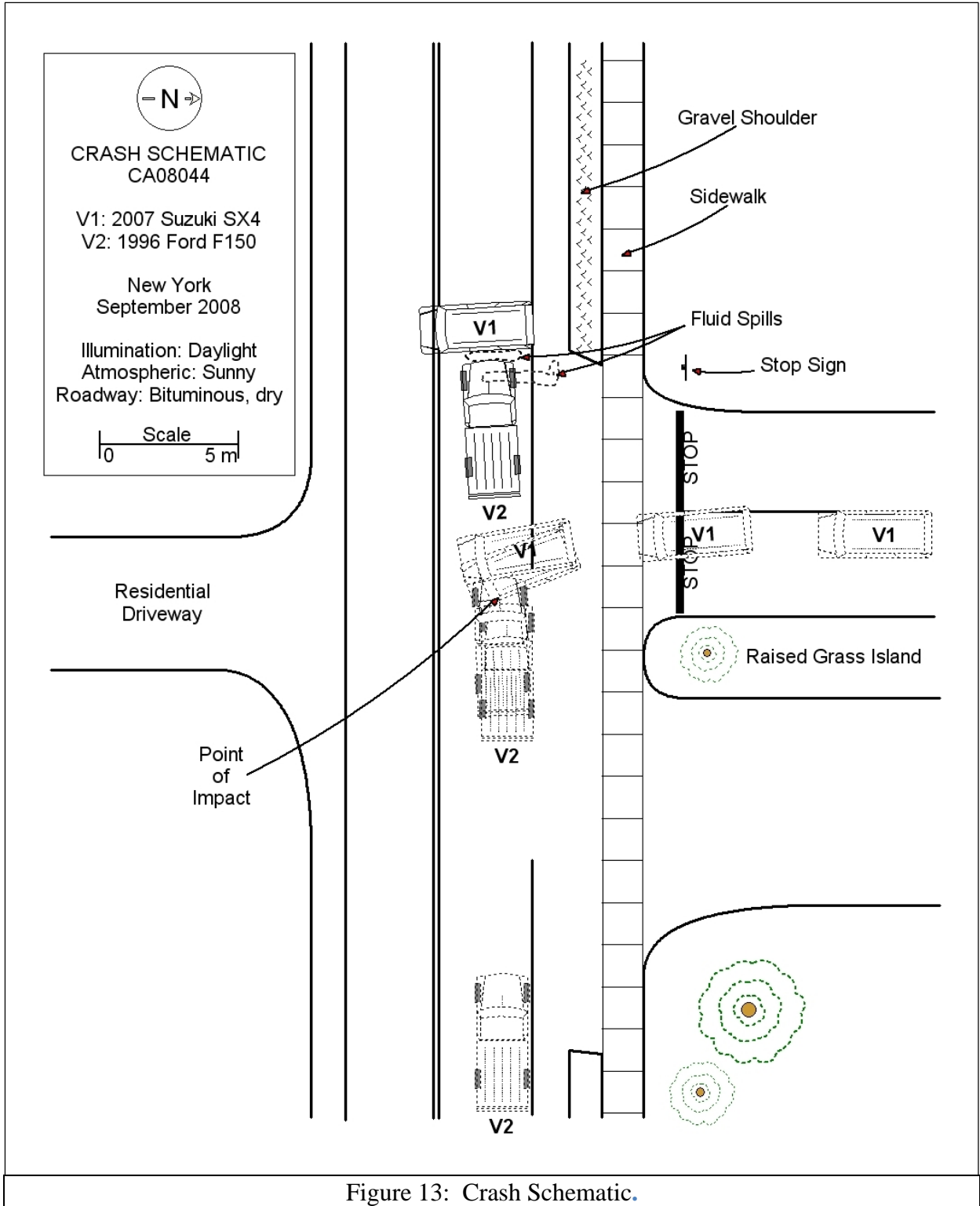


Figure 13: Crash Schematic.