



**Survival Factors and Biomechanics Factual
In support of the General Aviation Airbag Study**

April 29, 2009

Location: Fullerton, CA
Aircraft Type: Cessna 172S
Accident Date: 9/30/08
Accident Time: 1837 PDT
Accident Number: LAX08FA301
Airbag Equipped:

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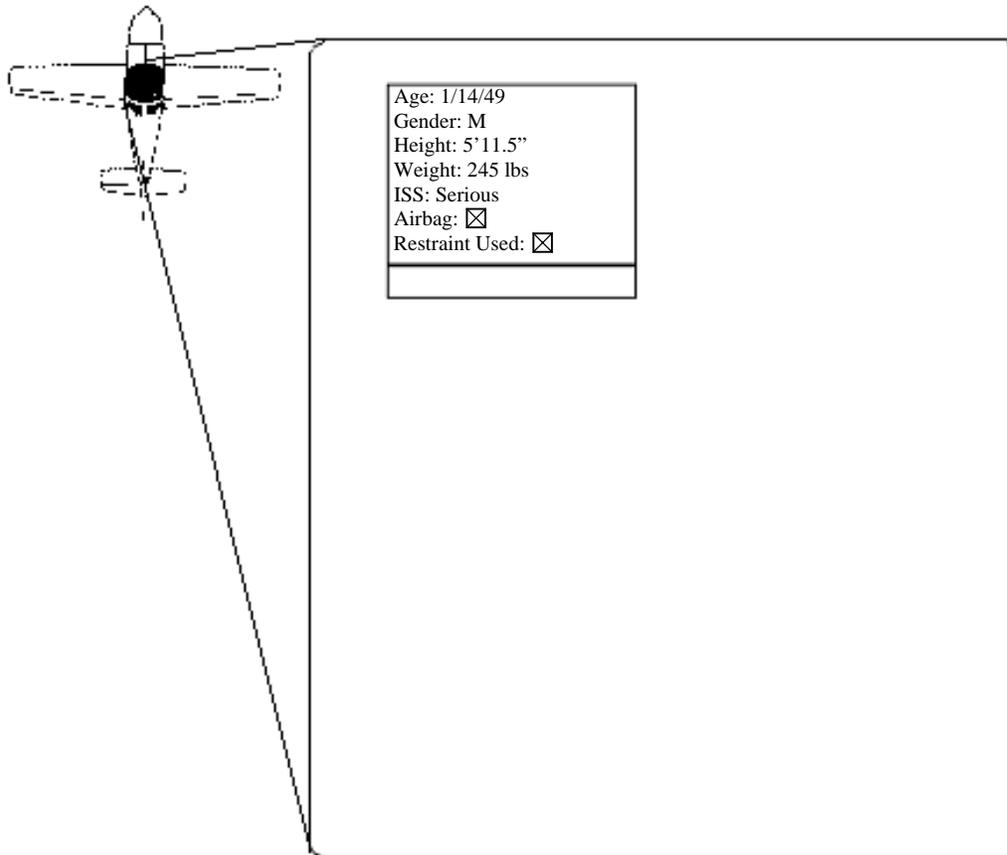
Accident Summary:

On September 30, 2008, about 1835 Pacific daylight time, a Cessna 172S, N2190W, impacted terrain following a loss of control on takeoff from runway 24 at Fullerton Municipal Airport, Fullerton, California. The student pilot, the sole occupant, sustained serious injuries. The airplane sustained substantial damage. Visual meteorological conditions prevailed for the local solo instructional flight, and no flight plan was filed. The pilot was operating the airplane under 14 Code of Federal Regulations Part 91. The flight was originating when the accident occurred.

Federal Aviation Administration inspectors examined the accident site and reported that the wreckage path began with fiberglass fragments and scarring consistent with the airplane's tail tie down ring/skid contacting the runway. The airplane then departed the left side of the runway, impacted a runway/taxiway sign, became airborne, and impacted another runway/taxiway sign. Approximately 1,000 feet down the runway from the second sign impact, fragments of the right wingtip and gouges in the asphalt were found consistent with the airplane colliding with the runway in a nose down, right wing low attitude. The airplane came to rest inverted on the right side of the runway with its longitudinal axis aligned near perpendicular to the runway.

Abstract:

The survival factors documentation focused on damage to the aircraft fuselage, damage to the cockpit, and the condition of the seats, restraints and the airbags that may have affected the pilot's motion or his level of injury. Hospital records were reviewed to document the level and extent of occupant injury. The aircraft was equipped with lap/shoulder (3-point) belts at all four seating positions. The lap portion of the front two seats was also equipped with an inflatable restraint system (airbag). Aircraft damage patterns indicate that there was impact from the front, right side of the aircraft. The instrument panel, control yokes, other control surfaces, the lower center pedestal and the foot wells were displaced aft and toward the left side. Possible load marks were noted on the restraint webbing and loading of the airbag was noted through squaring of the vent hole. The pilot suffered serious bilateral lower extremity injuries, a right upper extremity fracture, a possible rib fracture, facial lacerations, and chest abrasions and contusions.

Seating Chart:**Aircraft Documentation:**

The primary impact to the airplane was on the right wingtip and on the nose of the aircraft. The engine was displaced aft toward the left and up. The primary impact direction was from the front right. The nose gear was still attached and displaced slightly aft. The rear spar carry-through was separated, except at the passenger door frame. The aircraft came to rest upside down. After the crash, the pilot released his restraint and exited through the left door. Photographs showing the final rest position of the aircraft are shown in Figure 1, Figure 2 and Figure 3. Damage to the aircraft can further be seen once the wings were removed and the aircraft was placed in an upright position, Figure 4.



Figure 1: The aircraft's final rest position relative to the runway.



Figure 2: A photograph showing the aircraft in its final rest position. (The photo is looking toward the pilot's seat.)



Figure 3: A photograph showing the aircraft in its final rest position showing the damage to the nose and the right wing tip. (The photo is looking toward the front, right seat.)



Figure 4: A photograph showing the damage to the aircraft. (The wings were removed.)

Blood transfer was noted on the left edge of the pilot's head restraint and on the head-liner, both on the ceiling and on the under side near the left door. Blood splatter was noted on the door seal, and on the left forward side wall side molding forward of the door. The pilot's yoke was off-set to the left. (Figure 5) Both yokes were also displaced upwards. (Figure 6) Scraping was noted on the bottom edge of the pilot's yoke. (Figure 7) (The yoke was inverted during the examination.) The thumb controls for the microphone were broken. In the engine control area of the instrument panel, the radio was off-set so that it was now centered on the pilot's seat. Damage was noted to the region of the alt static air pull-on. (Figure 8) Blood transfer was noted in this area as well. The wing flap knob was deformed to the right. (Figure 9) The throttle and mixture knobs were displaced to the right. (Figure 10) The lower center pedestal was displaced to the left and both control yokes were displaced upwards. The glare shield was broken, but no occupant impact marks were noted. A small semi-circular crack was noted on the right side center of the multi function display unit (MFD). (Figure 11) Note that the MFD unit is the right side display while the primary flight display (PFD) unit is on the left. Deformation to the foot well was noted due to the displacement of the lower center pedestal.



Figure 5: Measurements showing the left lateral shift of the instrument panel relative to the A-pillar.



Figure 6: A photograph showing damage to the instrument panel and the displacement of both yokes.



Figure 7: Scrape marks on the underside of the pilot's yoke.



Figure 8: Damage in the region of the alt static air pull-on knob.



Figure 9: The wing flap knob was deformed to the right.



Figure 10: The throttle and mixture knobs were displaced to the right.



Figure 11: A small semi-circular crack was noted on the right side center of the multi function display unit.



Figure 12: Deformation to the pilot's foot well was noted due to the displacement of the lower center pedestal.

In order to document the intrusion into the pilot region, the post-accident location of various points along the instrument panel relative to the seatback at 19" up from the seat bite were measured parallel to the longitudinal axis of the plane.¹ (Table 1) The deformation to the pilot's foot well was also documented. (Table 2)

Table 1: Measurements documenting the intrusion into the pilot's region. All measurements are taken from a point 19" vertically above the seat bite and parallel to the longitudinal axis of the plane.

Instrument Panel Measurements	Distance (in)
Left edge of pilot's yoke	13
Right edge of pilot's yoke	9.5
Left corner of MFD	14.5
Instrument panel at the altimeter	19.5
Glare shield	23

¹ The seat bite refers to the location where the seat cushion and the seat back meet.

Table 2: Measurements documenting the intrusion into the pilot's region at the floor.

Floor Measurements	Distance (in)
Lateral distance from center console to left side wall	14.5
Lateral distance from center console to left side wall at maximum deformation	8
Longitudinal distance from the front edge of the seat track to the right rudder pedal	21
Longitudinal distance from the front edge of the seat track to the left rudder pedal	22

Seats

The pilot's seat was found in the 3rd pin back from full forward. Minor deformation was noted to the pilot's seat track (Figure 13) matching the damage to the bottom of the aircraft (Figure 14). The passenger seat was in the 11th pin back from full forward. There were 13 total seat track positions for each seat. The pilot's seat did not appear to be vertically compressed although the front right corner of the seat pan appeared slightly lower. The seat did move forward but did not move aft due to the deformation of the seat track. All seat position adjustments were functional once the seat was removed from the airplane. The dimensions of the pilot's seat are shown on a generic general aviation seat in Figure 15. The seats are assembled by Cessna and are not specifically marked with any tracking numbers. These seats were not equipped with an energy absorbing seat pan structure as seen in some other investigations.² Instead, there was a foam cushion in between the surface of the seat pan and the underlying structure of the seat itself. (Figure 16) No noticeable deformation of the seat pan structure was found. In addition, there was no indication of vertical loading to the seat structure. There was a slight displacement of the seat frame to the right.

² Indianapolis, IN, General Aviation Airbag Study.



Figure 13: The pilot's seat track showed a slight deformation, or curvature upward, matching the damage to the aircraft under this seat position.



Figure 14: Damage to the underside of the aircraft under the pilot's seat position.



Figure 15: Dimensions of the pilot's seat.



Figure 16: Photographs showing the foam cushion and the seat pan structure of the pilot's seat.

Restraints:

All four seating positions were equipped with lap/shoulder (3-point) belts. The restraint identification numbers are shown in Figure 18. The front two seats were also equipped with an inflatable restraint (airbag) in the lap portion of the belt. A photograph showing an exemplar lap/shoulder belt equipped seat with the airbag stowed in the lap portion of the belt is shown in Figure 17. For both the pilot's seat and the front passenger seat, the attachment points for the lap and shoulder portions of the belt are on the inboard side of the seat while the seat belt buckle is on the outboard side of the seat. (The position of the buckle for the pilot's seat can be seen in Figure 13.)

Both the pilot and front passenger restraint inertia reels were working correctly, post-accident. With respect to the pilot's seatbelt restraint, the load bar (latch connector), in the position found upon examination, was located 36.5" from the seatbelt anchor bolt. The distance from the edge of the airbag cover to the load bar, along the seatbelt, was 12.5". (In Figure 17, the distance from the edge of the airbag cover to the load bar is almost negligible since the latch connector appears to touch the airbag cover.) There were no load marks where the load bar was found, but faint marks were found at 15" from the airbag cover. (Note that this was a large radius load bar.) Blood transfer was noted on the shoulder harness. Measuring from the load marks, the blood transfer marks extended from 20" to 25" on the inside (facing the pilot) surface. More blood transfer marks were noted 9-10" above the load marks. We also measured the girth measurement (i.e., how long from the load marks at 15" to the seatbelt anchor bolt, represented by the yellow dimension line in Figure 17) and found it was 38".



Figure 17: A photograph showing a general aviation seat equipped with a lap/shoulder belt and an inflatable restraint system (airbag) in the lap portion of the belt.³

³ AmSafe Aviation, <http://www.amsafe.com/products/detail.php?id=68&type=categories> on February 2, 2009.

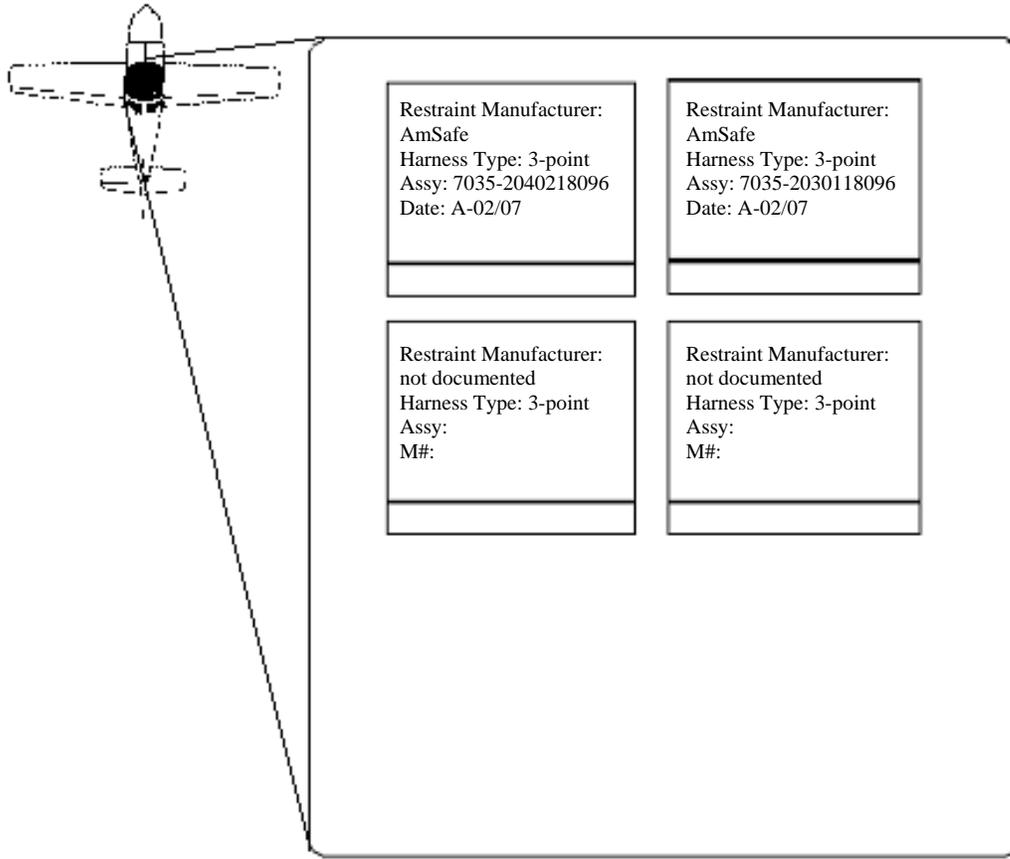


Figure 18: Restraint identification numbers.

Airbags:

The Cessna aircraft was equipped with lap/shoulder (3-point) belts and the inflatable restraint system or airbag was contained within the lap portion of the restraint for the two first row seats. This airbag system has a latch sensor, which is activated when the seatbelt is connected.

The inflator number for the pilot seat airbag is PN508794-401, lot number 10090032, expiration 01 October, 2013. The electronic module assembly (EMA) numbers were PN 508358-421, LN (lot number) 3509770, expiration date: 01 February 2014, manufacture date February 2007.

The passenger side airbag did not deploy during the crash. The system was manually disabled by the AmSafe representative prior to examination of the aircraft interior.

The general dimensions of the pilot side airbag were 30" long, 17" wide at the top of the airbag, and 14" wide at the bottom of the airbag. (Figure 20) On the instrument panel side of the airbag (i.e., surface that strikes the instrument panel), transverse or side-

to-side scuff marks were found 14" up from the bottom of the airbag. A black vertical scuff mark was noted 3" from the left seam, extending from 4" from the bottom of the airbag to 7". Round scuff marks were noted 5" from the left seam and 7" from the bottom of the airbag with a 1.5" diameter. (Figure 21) (The emblem on the control yoke has a similar diameter on the short axis.) The black vertical scuff mark appeared to correspond in position to scuff-marks found on the right lower portion of the left yoke. (Figure 22) A final set of scuff marks were noted in the center of the airbag on the bottom, extending vertically upward to 4".

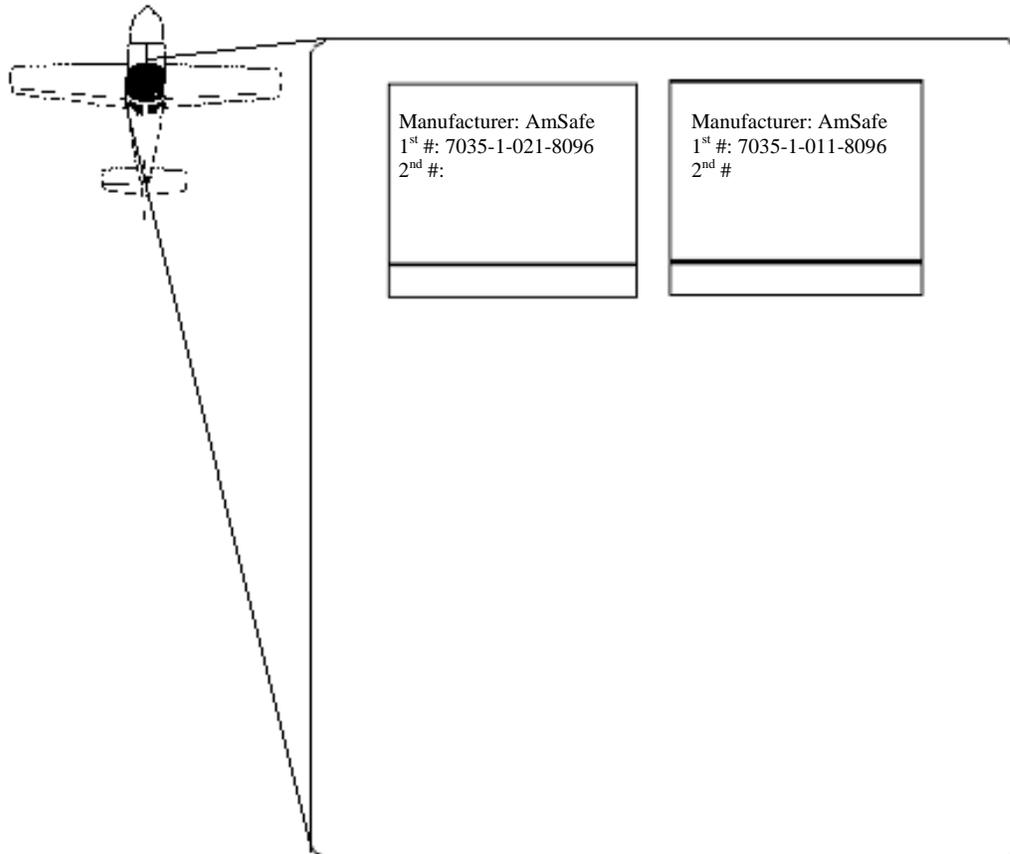


Figure 19: Airbag labels.



Figure 20: A photograph showing the pilot's airbag on the side facing the instrument panel. The top of the airbag is toward the right of the photograph.

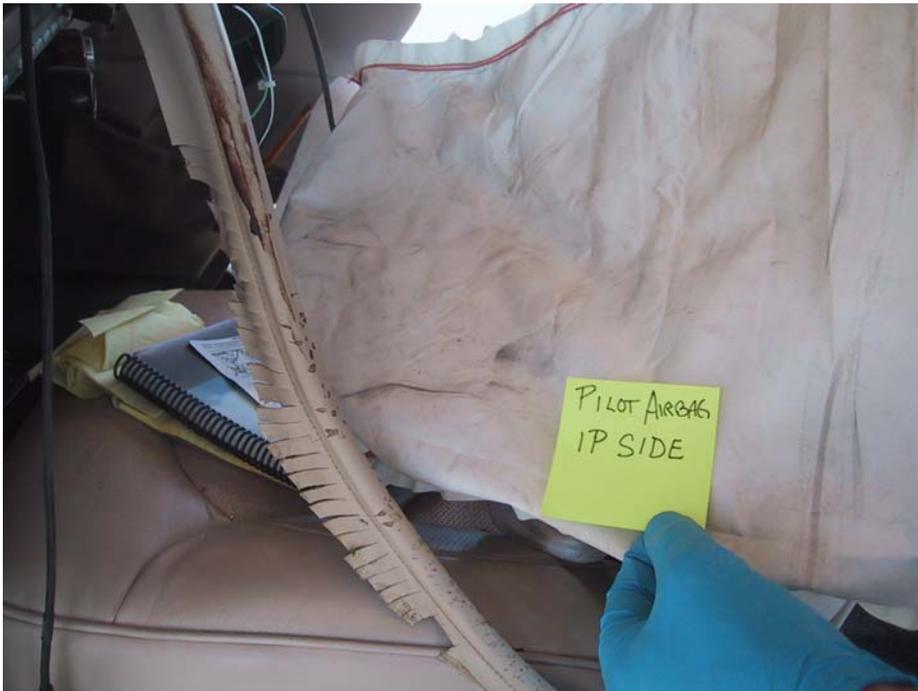


Figure 21: Scuff marks on the instrument panel side of the pilot's airbag.

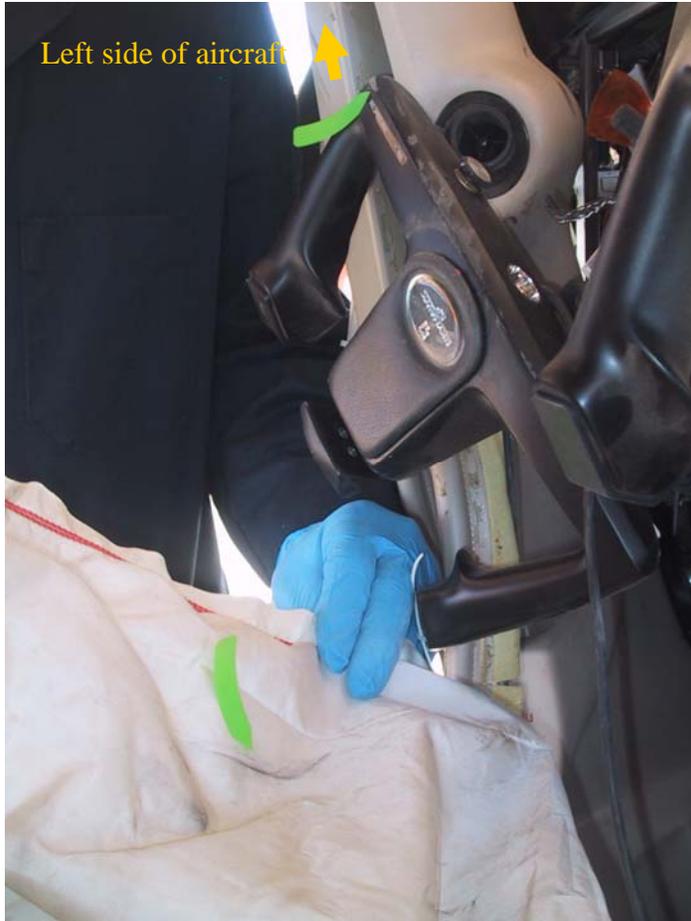


Figure 22: Scuff marks corresponding to marks on the pilot's yoke.

The airbag is equipped with a single vent hole that exhibited squaring to six strands. (Figure 23) Generally, the airbag was in good condition, showing no tears or cuts, and a small normal separation at the belt. On the pilot's side of the airbag (i.e., the surface that strikes the pilot, Figure 24), two blood spots were found in the upper right corner, 2" from the right seam and 3" down from the top. There were small scattered blood spots on the upper left quadrant of the bag. The belt was also in good condition and the airbag cover appeared to split normally.

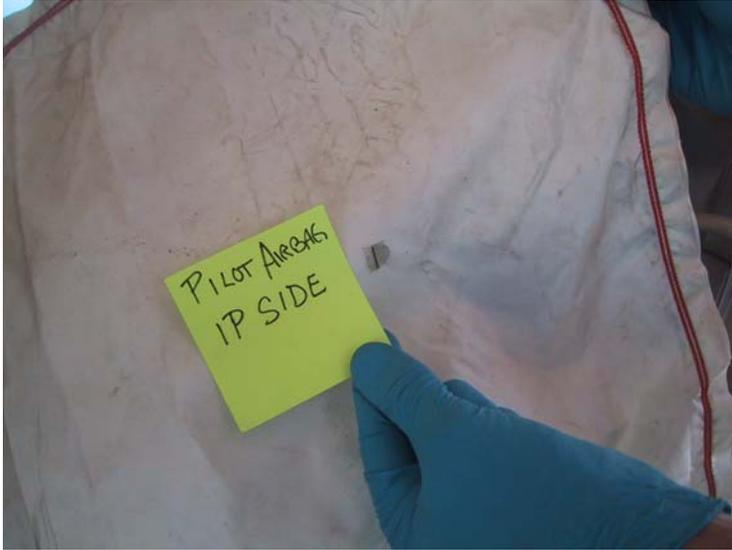


Figure 23: The single vent hole on the pilot's airbag.



Figure 24: A photograph showing the pilot's airbag on the occupant's side. The top of the airbag is at the bottom of this photograph.

Medical/Autopsy Information:

The male occupant, the pilot, in the 1st row on the left side was brought by ambulance to the University of California, Irvine Medical Center (101 The City Drive Orange, CA 92868, 877-824-3627) on September 30, 2008 at 7:25 pm. The occupant

seating location, gender, age, height, weight and injuries are listed in Table 3 below. Figure 25 is a diagram showing the injury locations on a body image.

Table 3: A table of the occupant injury description and classification.

Occupant Location	Gender	Age	Height	Weight	Description Of Injuries	Injury Classification
1 st Row, Left	M	1/14/49	5' 11.5"	245 lbs	Right proximal femoral shaft fracture; left tibial plateau fracture; right distal nondisplaced femoral shaft fracture; right open ulnar fracture; right anterior pulmonary contusion; nasal bone fracture; stellate laceration across bridge of nose (6 cm); right eyebrow laceration (3 cm); abrasion, hematoma on left chest; abrasions across right upper and lower quadrant	Serious

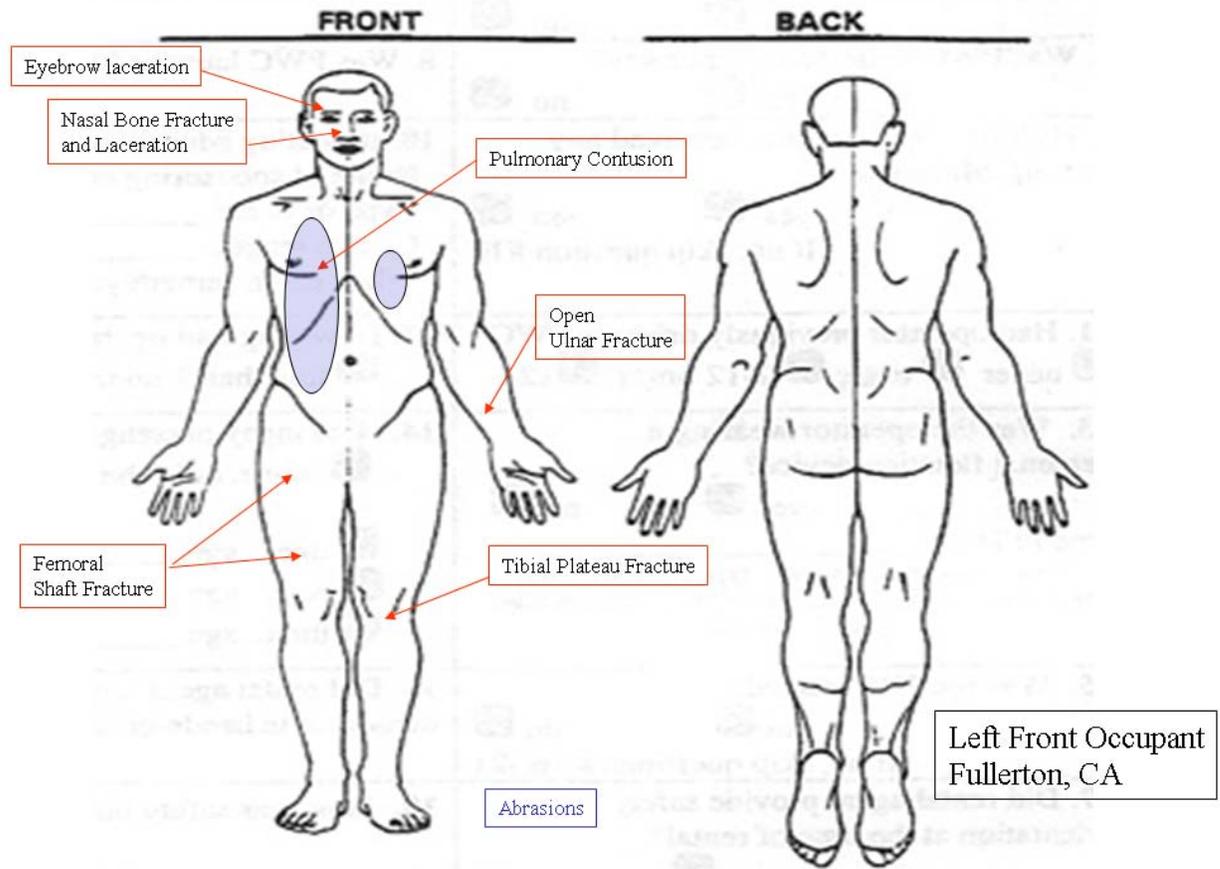


Figure 25: A diagram showing the injury locations.