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VERIDIAN LIMITED ON-SITE SIDE IMPACT AIR BAG DEPLOYMENT INVESTIGATION VERIDIAN CASE NO. CA01-019 VEHICLE: 1998 INFINITY I30 LOCATION: NEW JERSEY CRASH DATE: NOVEMBER 2000

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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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BACKGROUND

This remote investigation focused on the performance of a side impact air bag in a 1998 Infinity I30. The Infinity was struck on the left side by a 1988 Ford Econoline E250 van as the 28 year old male driver of the Infinity initiated a left turn across the path of the Ford. The impact resulted in moderate severity damage to the Infinity **(Figure 1)** and deployed the redesigned frontal air bags and the left front seat back mounted side impact air bag. The driver of the Infinity sustained a contusion and abrasion of the left posterior parietal scalp, an abrasion of the left hand, and a contusion of the left lower leg from contact with the interior components of the vehicle. The deployed side impact air bag provided the driver with additional crash protection, thus mitigating potential injury of the abdomen and torso. He was transported to the emergency room of a local hospital where he was treated for his injuries and released.

Figure 1. Left side damage to the Infinity I30.

Personnel from the NASS PSU-04 identified the side impact air bag deployment crash during the inspection of another vehicle for the CDS. The team personnel provided notification to the Veridian Special Crash Investigation team. The crash details were forwarded to NHTSA and a remote investigation was assigned to the Veridian team on January 31, 2001. The NASS PSU personnel documented the vehicles that were involved in this crash.

SUMMARY

Crash Site

The crash occurred within the boundaries of a three-leg T-intersection. The 1998 Infinity was traveling in a westerly direction on a two-lane road on an approach to the T-intersection. A stop sign regulated westbound traffic flow from entering the four-lane north/southbound roadway. Traffic flow on the north/southbound roadway was not regulated by traffic control devices, however, the asphalt surface was marked with broken white lane lines and double yellow centerlines. Both edges of the four-lane roadway were bordered by paved shoulders. At the time of the daylight cash, the asphalt road surfaces were dry and the weather was clear. The posted speed limit was 64 km/h (45 mph).

Crash Sequence

Pre-Crash

The driver of the 1998 Infinity was traveling in a westerly direction on the two-lane road and was decelerating as he approached the three-leg T-intersection. The driver stopped for the regulatory stop sign and checked for approaching north/southbound traffic flow. Although the driver of the Infinity stated that he failed to detect the approaching 1988 Ford Econoline van, he may have attempted to "beat" the vehicle through the intersection as he initiated a left turn across the Ford's path of travel.

The driver of the Ford van was traveling in a northerly direction on the inboard travel lane at an estimated speed of 64 km/h (45 mph). The driver observed the Infinity as it initiated a left turn. The driver of the Ford steered to the left and braked in an attempt to avoid the impending collision.

Crash

The full frontal area of the Ford Econoline van impacted the left side area of the left turning Infinity I30. The impact involved the left front fender and left doors of the Infinity. The resultant directions of force were within the 1 o'clock sector for the Ford van and 10 o'clock for the struck Infinity. The damage algorithm of the WinSMASH program computed total velocity changes of 25.0 km/h (15.5 mph) for the I30 and 17.2 km/h (10.7 mph) for the Ford Econoline. The specific longitudinal and lateral components for the Infinity were -8.6 km/h (-5.3 mph) and 23.5 km/h (14.6 mph) respectively. As a result of the side impact sequence, the Infinity's frontal air bag system and the left front seat-back mounted side impact air bag deployed.

The impact deflected both vehicles across the southbound travel lanes. The vehicles came to rest off-road beyond the west shoulder. At rest, both vehicle's were facing in a westerly direction with the left side of the Infinity nearly parallel to the right side of the Ford Econoline. The driver of the Infinity unbuckle his manual restraint system and exited the vehicle unassisted from the right front door. He was observed walking at the crash scene prior to ambulance transport to a local hospital where he was treated for his minor severity injuries and released. The driver of the Ford van stated to the investigating officer that he was properly restrained by the manual belt system. He was not injured and refused medical treatment. Both vehicles sustained disabling damage and were towed from the scene of the crash.

Vehicle Data - 1998 Infinity I30

The 1998 Infinity I30 was a four-door sedan that was equipped with a 3.0 liter V-6 engine and an electronically controlled automatic transmission with a console mounted selector lever. The braking system consisted of four-wheel disc brakes with anti-lock (ABS). The steering was engine-speed sensitive power-assisted rack-and-pinion. The Infinity was identified by vehicle identification number JNKCA21AXWT (production number deleted).

The interior was configured with front leather trimmed bucket seats with 8-way power adjustments and adjustable head restraints. The rear seat was a three-passenger seat with a 60/40 fold down seat back support. The four outboard seated positions were equipped with continuous loop three-point lap and

shoulder belt systems. The front belt systems incorporated adjustable D-rings, pre-tensioners, and load limiter retractors. It should be noted that the driver reported to the investigating officer that he was restrained, however, the belt webbing was stowed and captured between the intruding B-pillar and the seat back support.

In addition to the manual belt systems, the Infinity was equipped with redesigned frontal air bags for the driver and front right passenger positions. The front seated positions were also equipped with side impact air bags that were mounted in the outboard aspects of the front seat back supports. Both the frontal and left side impact air bag deployed as a result of the left side impact with the Ford Econoline van.

Vehicle Damage

Exterior - 1998 Infinity I30

The Infinity sustained moderate severity damage to the left side as a result of the intersection-type crash with the Ford Econoline. Maximum crush was 31.0 cm (12.2") located at the mid door level of the vehicle at the left A-pillar area. The direct contact damage began 9.0 cm (3.5") forward of the left front axle position and extended 243.0 cm (95.7") rearward, terminating forward of the left C-pillar **(Figure 2)**. The combined induced and direct contact damage began 48.0 cm (18.9") forward of the left front axle and extended 284.0 cm (111.8") rearward to the left C-pillar. A crush profile was documented by the NASS researcher at the level of the mid door. The profile was as follows: C1 = 0 cm, C2 = 21.0 cm (8.3"), C3 = 25.0 cm (9.8"), C4 = 31.0 cm (12.2"), C5 = 6.0 cm(2.4"), C6 = 0 cm. Maximum crush was 31.0 cm (12.2") located at the C4 location. The Collision Deformation Classification (CDC) for this impact was 10-LYAW-3.

Figure 2. Exterior damage to the Infinity I30.

Interior

The interior of the Infinity I30 sustained moderate damage that was associated with exterior deformation, deployment of the frontal and side impact air bags, and driver contact points. The driver's compartment and the left rear (unoccupied) seated position were reduced in size by intrusion of the left doors and the left B-pillar. Maximum intrusion involved 15.0 cm (5.9") of lateral displacement of the left B-pillar and approximately 7.0 cm (2.8") of door intrusion at both left outboard seated positions. There was also intrusion of the left lower A-pillar and the left side kick panel. These was not measured by the NASS researcher.

The frontal air bags deployed as designed from the respective module assemblies. The left front seat- back side impact air bag deployed as designed. The left B-pillar intruded into the outboard aspect of the left front seat back support in the area of the air bag module assembly. The side air bag probably deployed prior to intrusion, therefore the performance and deployment path of the side air bag was not impeded or restricted.

The driver's left hip loaded the intruding left door armrest. The contact deformed the armrest in an outboard direction **(Figure 3)**. The leather/vinyl fabric was torn in the area of the contact point, however, it was unknown if this was crash related or resulted from post-crash activity within the vehicle. The driver's left knee contacted the lower aspect of the knee bolster and a support bracket for the steering column. This bracket is depicted in **Figure 4** .

Figure 3. Driver's left hip loading to the left door armrest.

Figure 4. Driver's left knee contact to the support bracket.

Exterior - 1988 Ford Econoline

The full frontal area engaged the left side of the Infinity resulting in a direct contact damage length of 188.0 cm (74.0") that extended from bumper corner to bumper corner. Maximum crush was 18.0 cm (7.1") located at the left corner of the bumper. A crush profile was documented at the level of the bumper and was as follows: C1 = 18.0 cm (7.1"), C2 = 5.0 cm (2.0"), C3 = 4.0 cm (1.6"), C4 = 3.0 cm (1.2"), C5 = 2.0 cm (0.8"), C6 = 5.0 cm (2.0"). The CDC for this damage pattern was 01-FDEW-2. The damage profile for the Ford Econoline is documented in Figures 5 and 6.

Figure 5. Frontal damage to the Ford Econoline.

Figure 6. Profile view documenting the extent of frontal crush.

Air Bag System - 1998 Infinity I30

The 1998 Infinity I30 was equipped with redesigned frontal air bags and seat mounted side impact air bags for the driver and right passenger positions. The frontal air bags **(Figure 7)** and the driver's side impact air bag deployed during the left side impact with the Ford Econoline. The frontal air bag system consisted of a driver air bag module that was mounted within the steering wheel rim, a top mount passenger air bag in the right instrument panel, and a single point sensing system and diagnostic module that was located in the rear aspect of the center console.

Figure 7. Deployed frontal air bags.

The side impact air bags were mounted in the upper outboard aspects of the front seat back supports and concealed by a single cover flap that opened to the rear of the vehicle **(Figure 8)**. Side impact crash sensing was achieved by sensors located in the lower aspect of the B-pillars.

Figure 8. Side air bag cover flap opening to rear of vehicle

The frontal driver air bag deployed from symmetrical H-configuration module cover flaps. The horizontal tear seam was 15.0 cm (5.9") in width while the upper and lower flaps were 6.0 and 7.0 cm (2.4 and 2.8") in height respectively. The bag was tethered by two internal straps affixed to the face of the membrane. The bag was directly vented into the passenger compartment by two ports located on the back side of the bag at the 10 and 2 o'clock sectors. In its deflated state, the driver air bag measured 68.0 cm (26.7") in diameter. There was no damage or contact evidence to the deployed frontal driver air bag. The horizontal distance between the maximum excursion of the driver air bag and the seat back was documented at 55.0 cm (21.7").

The front right passenger air bag deployed from H-configuration module cover flaps from the right upper instrument panel. The width of the flaps was 24.0 cm (9.4") at the horizontal tear seam and the vertical measurements were 3.0 and 7.0 cm (1.2 and 2.8"), for the upper and lower flaps respectively. The air bag membrane was not tethered. The overall dimensions of the front right air bag was 64.0 cm (25.2") vertically and 36.0 cm (14.2") horizontally. The bag was vented by two lateral ports located at the 3 and 9 o'clock sectors. There was no damage or driver contact to the front right passenger air bag.

The driver side impact air bag was contained in the outboard aspect of the seat back support and concealed by a single cover flap that was formed in a L-configuration that conformed to the side and rear aspects of the seat back support. The flap was documented by the researcher as 21.0 cm (8.3") in height with the sides measuring 9.0 and 10.0 cm (3.5 and 3.9"), from front to back. The side bag deployed in a forward direction from the seat back support **(Figure 9)**. The NASS researcher documented the overall dimensions of the side impact air bag at 42.0 cm (16.5") horizontally and 26.0 cm (10.2") vertically. The

bag extended 22.0 cm (8.7") forward of the seat back support and extended 28.0-54.0 cm (11.0-21.3") above the seat cushion. There was no damage to the air bag, however, the cover flap extended rearward of the seat back support due to the lateral intrusion of the left B-pillar **(Figure 10)**.

Figure 9. Deployed driver side impact air bag.

Figure 10. Intrusion of the left B-pillar against the side air bag module and cover flap.

Driver Demographics - 1998 Infinity

Age/Sex:	28 year old male
Height:	Unknown
Weight:	Unknown
Manual Restraint Usage:	None, 3-point lap and shoulder belt system was available
Usage Source:	Vehicle inspection
Mode of Transport From Scene:	Ambulance transport
Type of Medical Treatment:	Treated at a local hospital and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Small abrasion left posterior parietal area	Minor (190202.1,2)	Intruding left upper B-pillar
Left scalp contusion	Minor (190402.1,2)	Intruding left upper B-pillar
Abrasions of the left hand	Minor (790202.1,2)	Flying glass
Contusion of the left lower leg	Minor (890402.1,2)	Knee bolster

** Source - Hospital emergency room records*

Driver Kinematics

The driver of the Infinity I30 was seated in a presumed upright driving posture with his seat adjusted to a mid-to-rear position. The seat back support was slightly reclined and the head restraint was positioned approximately 3.8 cm (1.5") above the seat back support. Although the driver stated that he was restrained by the manual belt system, the belt was in a stowed position against the left B-pillar and captured between the seat back support and the intruding pillar. Based on the position of the belt, it was determined that the driver was not restrained by the manual system.

At impact, the frontal air bags and the left side seat mounted side impact air bag deployed. The unrestrained driver initiated a lateral and slightly forward trajectory **(Figure 11)** to his left in response to the 10 o'clock direction of force. His left knee/lower leg contacted the left aspect of the plastic knee bolster panel. The contact cracked the component and resulted in a superficial contusion of the left lower leg. His left hip area contacted the intruding left front door armrest. The padded and plastic component was cracked and deflected in an outward direction. The driver was not injured by the armrest contact.

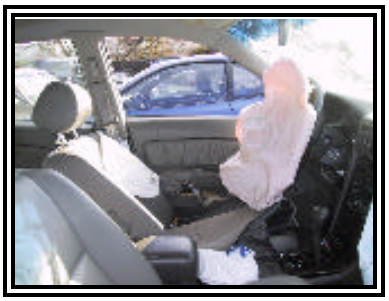

Figure 11. Trajectory and driver's contact points.

His left upper anterior abdominal, chest, and upper arm loaded the deployed side impact air bag. The air bag prevented direct contact against the intruding door panel and mitigated potential injury. The driver's head impacted the intruding left upper B-pillar. Although there was no contact evidence on the pillar covering, the driver sustained a small abrasion of the left posterior/parietal area of the scalp and a left scalp contusion. In addition, the driver sustained abrasions of the left hand that probably resulted from flying glass. There was no contact evidence on the deployed frontal air bag for the driver's position and no related injury from bag involvement. The combination of front and side impact air bags offered adequate protection to the unbelted driver.

Medical Treatment

The driver exited the vehicle unassisted post-crash and was walking at the scene complaining of lower left leg pain. He was transported by ambulance to a local hospital where he was treated for his minor severity injuries and released.