**TRANSPORTATION SCIENCES**
**CRASH DATA RESEARCH CENTER**

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# VERIDIAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION
# SCI TECHNICAL SUMMARY REPORT

**CASE NO. CA02-048**

**VEHICLE – 2001 SAAB 9-5**

**LOCATION - STATE OF PENNSYLVANIA**

**CRASH DATE – OCTOBER 2002**

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

# TECHNICAL REPORT STANDARD TITLE PAGE

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| *16. Abstract*<br>This on-site investigation focused on the performance of the head/torso side impact air bag system that was present in a 2001 Saab 9-5. The Saab was also equipped with an Advanced Occupant Protection System (AOPS), which included dual-stage frontal air bags and seat belt retractor pretensioners. The Saab 9-5 was involved in a minor severity intersection collision with a 2002 Ford F-150 pickup truck that resulted in the deployment of the driver's side impact air bag system in the Saab. A 45-year-old female driver of the Saab was restrained by the manual 3-point lap and shoulder belt. The driver's side impact air bag deployed and she initiated a lateral trajectory in response to the left side crash force. The driver loaded the seat belt and contacted the deployed driver's side impact air bag. The driver did not sustain injury and was not transported to any medical facility. Both vehicles were driven from the scene. | | | |
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**CRASH DATE - OCTOBER 2002**

## BACKGROUND

This on-site investigation focused on the performance of the head/torso side impact air bag system that was present in a 2001 Saab 9-5. The Saab was also equipped with an Advanced Occupant Protection System (AOPS), which included dual-stage frontal air bags and seat belt retractor pretensioners. The Saab 9-5 (Figure 1) was involved in a minor severity intersection collision with a 2002 Ford F-150 pickup truck that resulted in the deployment of the driver's side impact air bag system in the Saab. A 45-year-old female driver of the Saab was restrained by the manual 3-point lap and shoulder belt. The driver's side impact air bag deployed and she initiated a lateral trajectory in response to the left side crash force. The driver loaded the seat belt and contacted the deployed driver's side impact air bag. The driver did not sustain injury and was not transported to any medical facility. Both vehicles were driven from the scene.

**Figure 1. Damaged 2001 Saab 9-5**

The investigating officer notified NHTSA of the crash and the notification was forwarded to the Veridian SCI team on Wednesday, October 23, 2002 and assigned as an on-site investigative effort. Cooperation was established with the driver, insurance company, and the auto body repair facility to inspect the vehicle in its damaged state.

## SUMMARY

### *Crash Site*

This two-vehicle crash occurred at a T-intersection of two local roadways during the daylight hours of October 2002. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The north/south roadway was straight with an approximate 3 percent positive northbound grade. It configured with one travel lane in each direction separated by a double-yellow centerline and bordered by asphalt shoulders. The east/west roadway was curved and had an approximate 3 percent positive eastbound grade at the mouth of the intersection. The east/west roadway was configured with one travel lane in each direction separated by a double-yellow centerline and bordered by asphalt shoulders. Traffic flow into the intersection from the west leg was controlled by a stop sign that was located on the east roadside across from the west leg of the T-intersection. A white painted stop line was present at the mouth of the intersection on the eastbound lane. The scene schematic is included as **Figure 12** at the end of this report.

***Pre-Crash***

The 45-year-old female driver of the Saab 9-5 was operating the vehicle in a northbound direction on the two-lane roadway on approach to the T-intersection **(Figure 2)**. The driver applied the brakes and brought the Saab to a complete stop in the intersection and waited for southbound traffic to clear prior to attempting a left turn on to the east/west roadway. The male driver of the Ford F-150 pickup truck was traveling eastbound on approach to the intersection **(Figure 3)**. He applied the brakes and brought the vehicle to a complete stop at the stop line. Due to the positive grade at the intersection and limited sight distance, the driver of the pickup truck slowly traveled into the intersection to attempt to make a left turn when the north/south traffic cleared. As the southbound traffic cleared the intersection, the driver of the Saab 9-5 initiated a left turn across the path of the pickup truck. The driver of the pickup truck also initiated a left turn into the path of the Saab.

**Figure 2. Northbound approach for the Saab 9-5**

**Figure 3. Eastbound approach for the Ford F-150**

***Crash***

The front of the 2001 Ford F-150 pickup truck impacted the left side passenger area of the Saab 9-5. The direction of force was in the 10 o'clock sector for the Saab and in the 12 o'clock sector for the F-150. The impact resulted in minor damage to both vehicles and the deployment of the driver's side impact air bag in the Saab 9-5. The damage algorithm of the WinSMASH program computed a total delta-V of 11.0 km/h (6.8 mph) for the Saab 9-5 and a total delta-V of 9.0 km/h (5.6 mph) for the Ford F-150. The longitudinal and lateral components were -7.1 km/h (-4.4 mph) and 8.4 km/h (5.2 mph), respectively for the Saab. The longitudinal and lateral components were -8.9 km/h (-5.5 mph) and -1.6 km/h (-1.0 mph), respectively for the F-150. The Saab was displaced in a lateral direction and came to rest in the intersection at an approximate 45 degree angle relative to the roadside, facing northwest. The F-150 pickup truck also came to rest in the intersection facing east.

***Post-Crash***

The drivers of both vehicles drove the vehicles from their final rest positions onto the roadside. The Saab was equipped with the OnStar system, which activated as a result of the crash. The driver stated that the system activated immediately and that she was speaking with emergency dispatchers within seconds of the vehicle coming to rest. Both drivers exited the vehicles under their own power. The drivers did not sustain injuries and were not transported to any medical facility. Both vehicles were driven from the scene following the on-scene police investigation.

**VEHICLE DATA – 2001 Saab 9-5**

The 2001 Saab 9-5 was identified by the Vehicle Identification Number (VIN): YS3ED55E213 (production sequence omitted). At the time of the vehicle inspection, the odometer read 41,213 km (25,609 miles). The vehicle was a five-door wagon that was equipped with a 2.3 liter, turbo-charged, 4-cylinder engine, five-speed manual transmission, four-wheel disc brakes with anti-lock, tilt and telescoping steering wheel, power steering, power windows, power sunroof, power locks, heated seats, and General Motors' OnStar security and communications system. The Saab 9-5 was configured with Michelin MXV4 215/55R16 tires. The recommended tire pressures were 32 psi for 1 – 3 passengers and 39 psi for 4 – 5 passengers. The specific tire data is as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|---|---|---|---|---|
| LF | 193.1 kpa (28.0 psi) | 5.6 mm (7/32”) | No | None |
| LR | 199.9 kpa (29.0 psi) | 6.4 mm (8/32”) | No | None |
| RF | 199.9 kpa (29.0 psi) | 5.6 mm (7/32”) | No | None |
| RR | 196.5 kpa (28.5 psi) | 5.6 mm (7/32”) | No | None |

The front seating positions in the Saab 9-5 were configured with 8-way power adjustable, leather-trimmed bucket seats with four-way adjustable head restraints. The driver’s seat was equipped with memory settings for three seat configurations. Each front seat back was configured with a manual circular crank on the outboard aspect to adjust the lumbar support. At the time of the vehicle inspection, the driver’s seat track was positioned 8.9 cm (3.5”) rear of the full forward position and 11.4 cm (4.5”) forward of full rear position. The front right passenger’s seat track was positioned at the full-rear position with a total seat track travel of 20.3 cm (8.0”).

The rear seating positions were configured with a leather-trimmed 60/40 split bench seat with forward-pivoting cushions and a 60/40 split folding back. Each rear seat position was configured with a four-way adjustable head restraint.

The cargo area was configured with a rubber floor mat. A retractable cover was present in the rear seat back that extended rearward over the cargo area.

**VEHICLE DAMAGE**

**Exterior Damage – 2001 Saab 9-5**

The Saab 9-5 sustained minor left side damage as a result of the impact with the Ford F-150. The direct contact damage began 1.3 cm (0.5”) aft of the forward aspect of the left front door and extended 121.9 cm (48.0”) rearward along the left side **(Figure 4)**. Paint transfers and abrasions were present on the left front and left rear door panels. The outline of the Ford F-150’s front bumper could be seen above the left door trim. The maximum crush was located 56.0 cm (22.1”) aft of the leading edge of the left front door and

**Figure 4. Left side damage to the 2001 Saab 9-5**

measured 9.5 cm (3.8”). The combined direct and induced damage began at the leading edge of the left front door and extended 219.7 cm (86.5”) rearward along the left front and left rear doors. The left rear door was displaced slightly rearward. Six crush measurements were taken along the left side plane at the mid-door level and were as follows: C1 = 0.0 cm, C2 = 0.6 cm (0.3”), C3 = 3.2 cm (1.3”), C4 = 7.6 cm (3.0”), C5 = 8.9 cm (3.5”), C6 = 0.0 cm. The Collision Deformation Classification (CDC) for the impact with the Ford F-150 was 10-LPEW-2.

**Interior Damage – *2001 Saab 9-5***

Interior damage to the Saab 9-5 was minimal. There was no passenger compartment intrusion or occupant contact. Both left side doors were minimally displaced but were operational. The windshield laminate and vehicle glazing did not sustain damage. The right aspect of the driver’s sun visor mirror was fractured, although, there was no contact evidence to suggest it was a result of occupant contact.

**Exterior Damage – *2002 Ford F-150***

The 2002 Ford F-150 sustained minor frontal damage as a result of the impact with the Saab 9-5. The damage to the F-150 was based on police photographs **(Figure 5)**, as an on-site inspection could not be obtained from the owner. The direct damage began approximately 8 cm (3”) from the left front corner and extended laterally approximately 122 cm (48”) across the front bumper. The damage consisted of paint transfers from the Saab and minor abrasions on the bumper. There was no measurable crush to the bumper. The CDC for the impact with the Saab was 12-FDEW-1.

**Figure 5. Police photograph of damaged Ford F-150**

**MANUAL RESTRAINT SYSTEMS – 2001 Saab 9-5**

The 2001 Saab 9-5 was equipped with manual 3-point lap and shoulder belts with switchable/locking latch plates and emergency locking retractors (ELR’s) for both front seating positions and each rear seat position. The driver’s and front right passenger’s positions were configured with automatic height adjusters for the shoulder belts that were located on the respective upper B-pillars. The front seat belts were configured with retractor pretensioners, although it could not be confirmed if they fired in this crash. The driver’s seat belt webbing exhibited minor stretching that began 51.4 cm (20.3”) above the lower anchor and extended 35.6 cm (14.0”) on the lap and shoulder belt webbing. Two faint lateral linear transfers spaced 7.6 cm (3.0”) apart were present on the outboard front aspect of the shoulder belt webbing. The transfers measured 2.5 cm (1.0”) in length and were located 69.0 cm (27.1”) above the lower anchor. The driver’s seat belt is shown in **Figure 6**.

**Figure 6. View of driver's seat belt**

The driver's plastic latch plate exhibited a minor abrasion from the seat belt webbing from occupant loading. The abrasion measured 1.0 cm (0.4") in width and was located on the upper forward corner of the plastic latch plate in the buckled position. The latch plate also exhibited a small gouge that was located 7.6 cm (3.0") above the bottom aspect of the latch plate on the left aspect of the plastic housing. The gouge measured 1.3 cm (0.5") in length and 0.6 cm (0.3") in depth.

The left B-pillar exhibited a faint, curved, linear abrasion forward of the slot for the automatic height adjuster. The abrasion measured 3.8 cm (1.5") in length and was located 1.9 cm (0.8") above the bottom aspect of the height adjuster slot. The forward aspect of the plastic slot exhibited a small, faint abrasion/gouge at the center aspect.

The front right shoulder belt was equipped with an after-market padded sleeve that measured 26.7 cm (10.5") in length and 6.4 cm (2.5") in width.

**FRONTAL AIR BAG SYSTEM – 2001 Saab 9-5**

The 2001 Saab 9-5 was equipped with dual-stage frontal air bags for the driver and front right passenger positions. The driver's air bag was housed in the center of the steering wheel hub with symmetrical H-configuration flaps. The front right passenger's air bag module was housed in the top aspect of the right instrument panel, with no discernable tear seam. "SRS Airbag" was embossed on the vinyl cover flaps of the steering wheel and on the top right instrument panel. The frontal air bag system did not deploy in this crash.

**SIDE IMPACT AIR BAG SYSTEM – 2001 Saab 9-5**

The 2001 Saab 9-5 was equipped with side impact air bags that were located in the front seat backs. The owner's manual stated that the side impact air bag sensors were located in the front side doors. The side impact air bag system illustration from the owner's manual is shown in **Figure 7**. The driver's side impact air bag deployed from the driver's seat back as a result of the impact with the Ford F-150 pickup truck. The Air Bag light on the instrument panel was continuously illuminated when the ignition was keyed at the time of the vehicle inspection. The tear seam along the front outboard aspect of the driver's seat back measured 70.0 cm (27.5") in length.

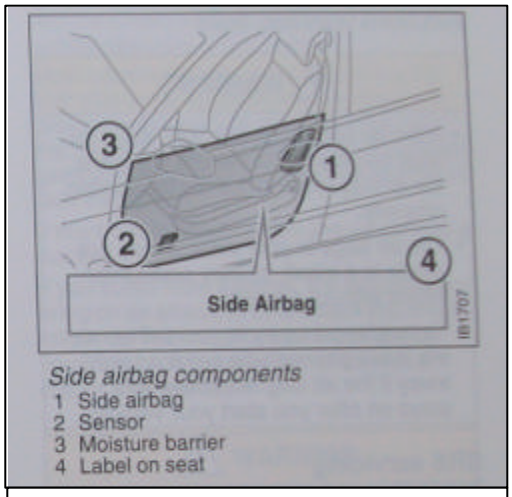


**Figure 7. Side air bag illustration from the owner's manual**

**Figure 8. View of inboard aspect of the driver's side impact air bag**

**Figure 9. View of outboard aspect of the driver's side impact air bag**

The side impact air bag was a single-chamber bag that provided protection for the head and torso of the occupant **(Figures 8 and 9)**. The air bag measured 76.2 cm (31.0”) in height, 30.5 cm (12.0”) in width at the bottom aspect, and 38.1 cm (15.0”) in width at the top aspect. The air bag was constructed of two separate fabric patterns for the upper and lower aspects, which were stitched together by a seam located 38.1 cm (15.0”) below the top aspect of the air bag. The top portion overlapped the bottom portion by 7.6 cm (3.0”). A vertical line of break-away stitching was present on the forward inboard aspect of the air bag that began 2.5 cm (1.0”) below the center seam and extended to the bottom aspect of the air bag **(Figure 10)**. The stitching appeared to have restricted the initial inflation of the torso portion of the air bag, which allowed the head portion of the air bag to inflate first. As the head portion of the air bag inflated, the stitching tore to allow the torso portion of the air bag to inflate completely.


**Figure 10. View of center seam and vertical break-away stitching**

The driver’s side impact air bag was vented by one external port that was located on the outboard aspect of the air bag 25.4 cm (10.0”) aft of the forward aspect of the air bag and 30.5 cm (12.0”) above the bottom aspect. The vent measured 1.9 cm (0.8”) in diameter.

The driver’s side impact air bag deployed to a depth of 35.6 cm (14.0”) from the top aspect of the driver’s seat back, 24.1 cm (9.5”) forward of the center aspect of the seat back, and 7.6 cm (3.0”) forward of the bottom aspect of the seat back. The top aspect of the air bag extended vertically to the left roof side rail.

The air bag was housed in the driver seat back in a plastic module behind the outboard aspect of the seat back fabric **(Figure 11)**. The module cover flap measured 26.7 cm (10.5") in height and 10.2 cm (4.0") in width. The module flap was configured with four plastic tabs on the forward aspect which separated from the inboard module housing as the air bag deployed.

Three minor linear scuff marks were present on the outboard aspect of the driver's seat 15.2 cm (6.0"), 24.1 cm (9.5"), and 25.4 cm (10.0") above the seat back that measured 5.1 cm (2.0"), 8.9 cm (3.5"), and 3.8 cm (1.5"), respectively. There was no corresponding evidence on the air bag fabric.

**Figure 11. View of plastic air bag module housing located behind the seat back tear seam**

**OCCUPANT DEMOGRAPHICS – 2001 Saab 9-5**

***Driver***

| | |
|---|---|
| Age/Sex: | 45-year-old female |
| Height: | 155 cm (61") |
| Weight: | 63.5 kg (140 lb) |
| Seat Track Position: | 8.9 cm (3.5") rear of full forward |
| Manual Restraint Use: | Manual 3-point lap and shoulder belt |
| Usage Source: | Vehicle inspection, interview |
| Eyewear: | Sunglasses |
| Type of Medical Treatment: | Did not receive medical treatment and was not transported to any medial facility |

***Driver Kinematics***

The 45-year-old female driver was seated in an upright posture with the seat adjusted to 8.9 cm (3.5") rear of full forward track position. She was restrained by the manual 3-point lap and shoulder belt. The shoulder belt height was controlled by the automatic height adjuster on the upper left B-pillar. The driver stated that after securing the latch plate into the buckle, she regularly tugged the shoulder belt to ensure that the slack was taken out of the seat belt webbing. She stated that her hands were located at the 9 and 3 o'clock positions on the steering wheel rim prior to the crash.

At impact with the Ford F-150, the driver's side impact air bag deployed and the 45-year-old female driver initiated a lateral trajectory in response to the left side impact. She loaded the manual restraint and contacted the deployed side impact air bag which mitigated contact with the left side glazing and interior components. She rebounded to the right and came to rest upright in the driver's seat. She did not sustain injury. The driver stated that immediately following the crash the Saab's OnStar system activated and she was speaking with an emergency services dispatcher within approximately 20 seconds after the impact. The driver had difficulty opening the driver's door from the inside, and exited the vehicle through the right front door. She later opened the driver's door from the exterior to retrieve items from the vehicle. The driver of the Saab did not receive medical treatment and was not transported to any medical facility.

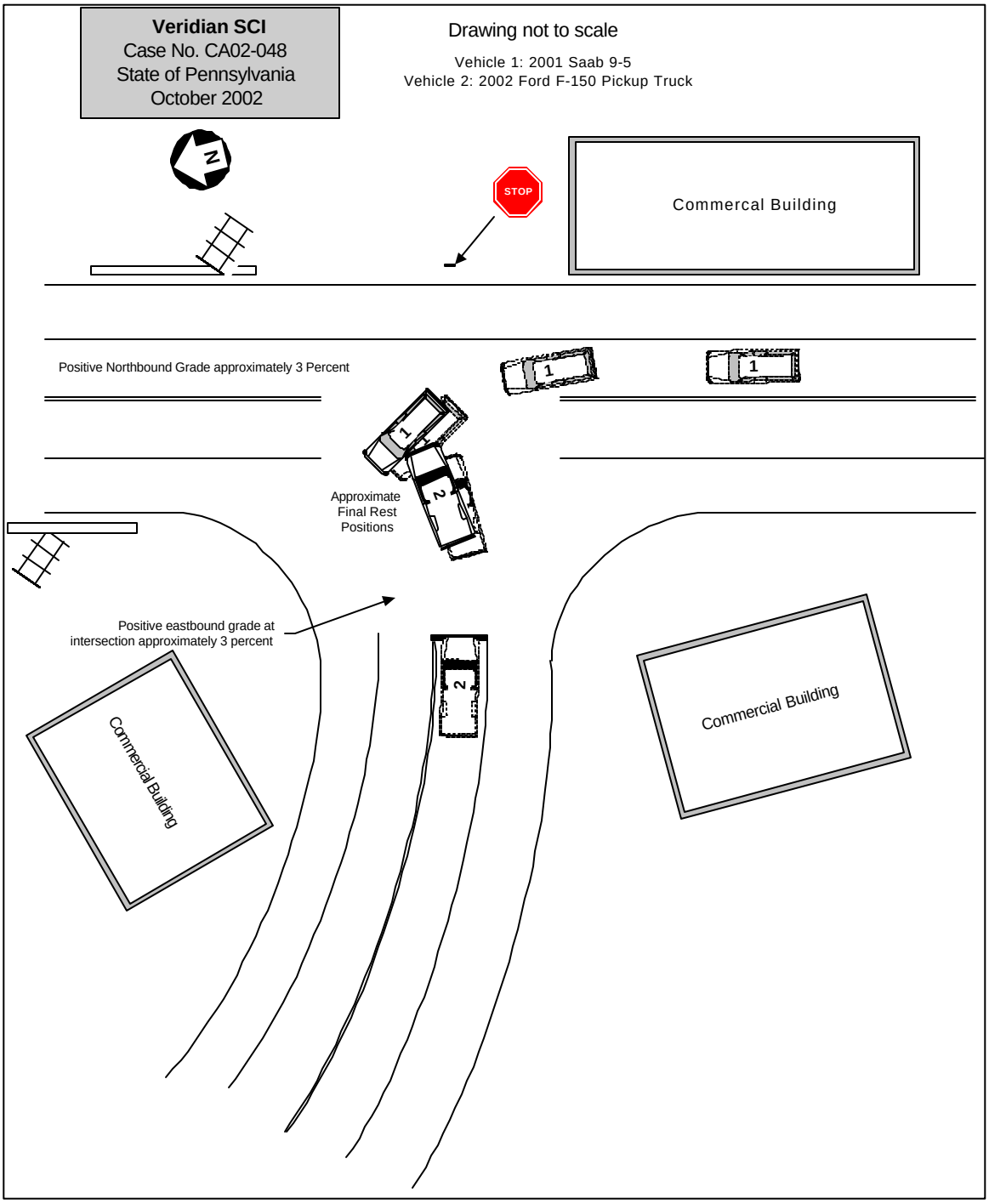


**Figure 12. Scene schematic**