Remote, Redesigned Air Bag Special Study

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Dynamic Science, Inc., Case Number (1998-49-165G)

1998 Ford Escort/EXP

Texas

October/1998

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16. Abstract

This remote investigation was focused on the redesigned air bag system deployment of a 1998 Ford Escort/EXP four-door sedan. This was a single vehicle crash that occurred during the early morning hours of a weekend in October, 1998. The weather was clear and the concrete roadway surface was dry. This single vehicle crash occurred in the center median area of the southbound travel lanes. There are three southbound travel lanes and three northbound travel lanes. The center grass median is bordered by curbs and the roadway is curved to the right (pre-crash) with a negative 5% grade. The roadway was lighted by overhead luminaires and the posted speed limit is 64 km/h (40 mph). Vehicle 1, a 1998 Ford Escort/EXP four-door sedan was driven by a fully restrained 16 year-old male (157 cm/62 in., 59 kg/130 lbs.) who was traveling in lane two (center travel lane) at a driver estimated speed of 89 km/h (55 mph). An unknown, noncontact vehicle changed lanes from lane one into lane two. Due to the lane encroachment, the driver of the Ford Escort applied an evasive left steering input. Driver 1's vehicle traversed lane three as the case vehicle mounted the curb that borders the center median. The front right tire impacted the curb which resulted in an air-out and rim damage (12FRWN3 / Event #1). As Vehicle 1 continued in its forward trajectory, the right rear tire also impacted the curb with sufficient force to cause an air-out and wheel rim damage (12FRWN9 / Event #2). The front left bumper corner (12FLEE2 / Event #3) impacted a non-breakaway overhead luminaire pole located in the center of the median. The impacted pole was damaged and was replaced with a new one. It is unknown whether the impacted metal pole was just bent or totally separated from its concrete base. The pole impact was of sufficient force to deploy the driver and passenger air bags. The corner impact nearly bypassed the stiff front bumper structure and settled into the softer upper left corner structure (i.e., hood, left fender and upper radiator support). In addition, the impacted pole was either totally separated or yielded which further complicated the proper application of energy deceleration calculations. The 12 o'clock left corner impact initiated a rapid counterclockwise rotation of the case vehicle. The case vehicle came to rest facing in an easterly direction reportedly in full contact with the damaged pole. The driver of Vehicle 1 sustained an abrasion (AIS-1) to the left side of his neck due to shoulder belt contact. The driver also reported that he sustained a right shoulder dislocation/glenohumeral joint (AIS-2) which was attributed to the deploying driver's air bag.

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Summary

This remote investigation was focused on the redesigned air bag system deployment of a 1998 Ford Escort/EXP four-door sedan. This was a single vehicle crash that occurred during the early morning hours of a weekend in October, 1998. The weather was clear and the concrete roadway surface was dry. This single vehicle crash occurred in the center median area of the southbound travel lanes. There are three southbound travel lanes and three northbound travel lanes. The center grass median is bordered by curbs and the roadway is curved to the right (pre-crash) with a negative 5% grade. The roadway was lighted by overhead luminaires and the posted speed limit is 64 km/h (40 mph).

Vehicle 1, a 1998 Ford Escort/EXP four-door sedan was driven by a fully restrained 16 year-old-male (157 cm/62 in., 59 kg/130 lbs.) who was traveling in lane two (center travel lane) at a driver estimated speed of 89 km/h (55 mph). An unknown, non-contact vehicle changed lanes from lane one into lane two. Due to the lane encroachment, the driver of the Ford Escort applied an evasive left steering input. Driver 1's vehicle traversed lane three as the case vehicle mounted the curb that borders the center median. The front right tire impacted the curb which resulted in an air-out and rim damage (12FRWN3 / Event #1). As Vehicle 1 continued in its forward trajectory, the right rear tire also impacted the curb with sufficient force to cause an air-out and wheel rim damage (12FRWN9 / Event #2). The front left bumper corner (12FLEE2 / Event #3) impacted a non-breakaway overhead luminaire pole located in the center median. The impacted pole was damaged and replaced with a new pole. It is unknown whether the impacted metal pole was just bent or totally separated from its concrete base.

The pole impact was of sufficient force to deploy the driver and passenger air bags. The corner impact nearly bypassed the stiff front bumper structure and settled into the softer upper left corner structure (i.e., hood, left fender and upper radiator support). In addition, the impacted pole was either totally separated or yielded which further complicated the proper application of energy deceleration calculations. The 12 o'clock left corner impact initiated a rapid counterclockwise rotation of the case vehicle. The case vehicle came to rest facing in an easterly direction reportedly in full contact with the damaged pole. The driver of Vehicle 1 sustained an abrasion (AIS-1) to the left side of his neck due to shoulder belt contact. The driver also reported that he sustained a right shoulder dislocation/glenohumeral joint (AIS-2) which was attributed to the deploying driver's air bag.

Figure 1. Vehicle 1 impacts curb (Events 1 & 2) with right side tires

Figure 2. Pole impact (Event #3) and final rest location

Figure 3. Vehicle 1/Frontal damage

Exterior of Case Vehicle

Table 1. Vehicle Information

Model year, make and model	1998 Ford Escort/EXP
VIN	1FAFP10P9WW
CDC	12FLEE2

Table 2. Crush Measurements

Plane of Impact	Field L cm/in.	C1 cm/in.	C2 cm/in.	C3 cm/in.	C4 cm/in.	C5 cm/in.	C6 cm/in.
Front Bumper	140	5	5	1	0	0	0
	55.1	2	2	0.4	0	0	0

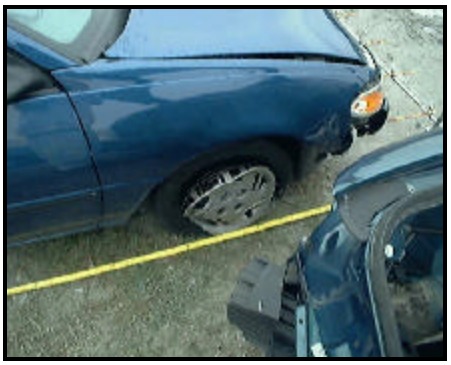


Figure 6. Front, right tire damage (curb impact / Event #1)

Figure 7. Right, rear tire damage (curb impact / Event #2)

Figure 8. Primary impact to left corner (pole impact / Event #3)

Interior of Case Vehicle

Figure 9. Front, Left view showing interior of case vehicle

Figure 10. Front, right view showing interior of case vehicle

The interior of the Ford Escort maintained its integrity with minor intrusion which was isolated to 4cm (1.6 in.) of longitudinal displacement of the toe pan located at the left, front seated position. There was a small scuff mark located at the upper left A-pillar and lower left knee/bolster. There was a small contact mark noted to the lower right quadrant of the drivers air bag. The passenger air bag module cover flap broke the laminated windshield glazing upon air bag deployment.

This vehicle is equipped with front bucket seats with the seatback angle adjustment feature. The driver's seat was adjusted at the middle track position. The front seats are equipped with adjustable head restraints which were not damaged during the crash.

Table 3. Intrusions

Intruded Component	Location of Intrusion	Intruded Value cm/in.		Dominant Crush Direction
Toe Pan	Front, Left	4	1.6	Longitudinal

Case Vehicle Occupant Protection Systems

The 1998 Ford Escort was equipped with redesigned air bag systems which consisted of a single, centrally located (fire wall mounted) electric crash sensor (ECS)[1]. Among other functions, the ECS signals the inflators to deploy in the event of a deployable crash. An air bag warning lamp is located in the front, left instrument panel area[2]. There is an air bag module located in the front, left steering wheel hub
and front right instrument panel (mid mount).

The drivers air bag is housed in the steering wheel hub and encases the nylon air bag, inflator unit, mounting plate,

[1] Refer to attached Supplemental Air Bag System Mapping Views for the 1998 Escort

[2] Refer to Mapping Views of the Instrument Panel Cluster

retainer ring and the air bag sliding contact. These components are concealed by the steering wheel trim cover which is equipped with standard horizontal tear seams. The circular air bag was tethered by two straps and two exhaust vent ports are present.

The lower instrument panel is equipped with a rigid plastic knee bolster. A scuff mark was documented to the lower left area of the knee bolster panel. There was a small scuff contact noted to the lower right quadrant of the air bag nylon fabric.

The front, right passenger air bag was located on the instrument panel (mid-mount type). The module deployment door is rectangular in shape and equipped with a tear seam that is designed to allow the door to hinge outward during deployment. The nylon air bag is inflated with nitrogen after the chemical reaction of sodium azide and copper oxide combusts. The inflator unit is supported by a metal reaction housing unit. There was no residual damage to the air bag and the module cover deployment door opened at the designated tear point. The deployment door cover opened with enough force to break the laminated windshield.

Figure 11. Occupant contact to drivers air bag

Figure 12. View showing deployed passenger (front, right) air bag

Case Vehicle Occupant Demographics

	Occupant 1
Age/Sex:	16/Male
Seated Position:	Front Left
Seat Type:	Bucket
Height (cm/in:):	157 61.81
Weight (kg/lbs).:	59 130.1
Pre-existing Medical Condition:	None Reported
Body Posture:	Unknown
Hand Position:	Unknown, At least one hand on steering wheel rim, position is unknown
Foot Position:	Right foot on brake pedal and left foot on floor panel
Restraint Usage:	Active, three-point lap and shoulder belt applied in a normal and proper fashion.
Air bag:	Driver air bag deployed as a result of the frontal impact.

Occupant Injuries

Table 4. Injuries

Injury	Injury Severity (AIS)	Injury Mechanism
Neck abrasion (left side aspect)	1	Shoulder belt webbing
Right shoulder dislocation (glenohumeral joint)	2	Driver's air bag

Occupant Kinematics

The 16 year-old-male driver of the 1998 Ford Escort was fully restrained and situated in the front left seated position. It was reported that he was in a normal posture and was presumably upright and facing forward. The shoulder belt height adjuster was at the full down position. The shoulder belt webbing was still positioned high, touching his neck due to his short stature (157 cm/ 61in.).

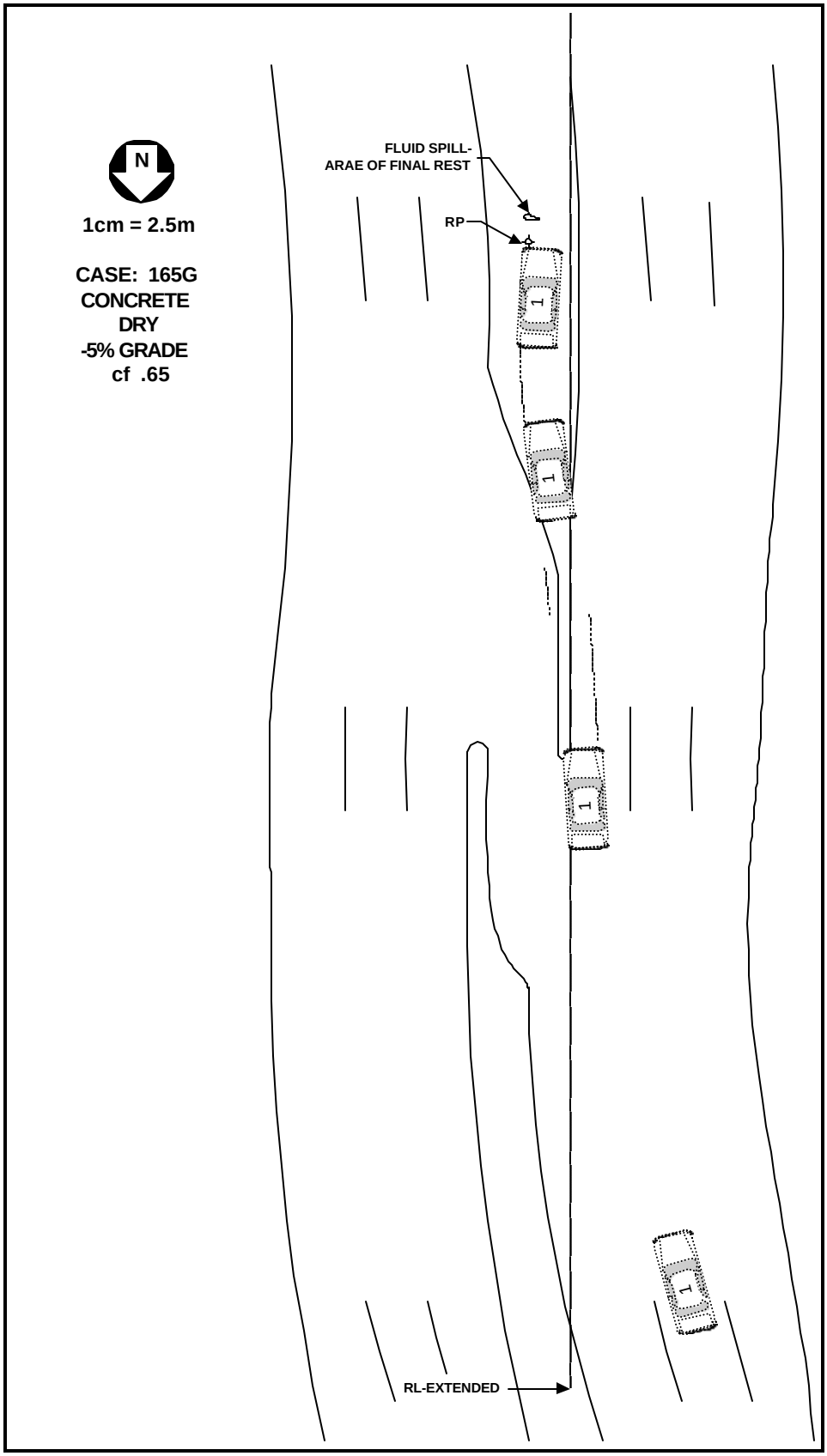
The initial right side tire impacts did not significantly displace him from his seated position. He responded to the 12 o'clock primary impact with the light pole by moving directly forward. The shoulder belt webbing restricted extended forward motion of his upper torso, however, he sustained a left side neck abrasion (AIS-1) from the shoulder belt webbing. As the vehicle rotated in a rapid counterclockwise direction, the right side of his face and shoulder dipped and pitched downward. His right shoulder (glenohumeral joint) was reportedly dislocated (AIS-2) due to his

interaction with the deploying driver's air bag[3]. His left knee contacted the knee bolster which resulted in a scuff mark to the rigid plastic cover, but did not result in injury. The air bag deployment caused his left hand to flail upward making contact with the upper left A-pillar molding. This contact did not result in injury. The case occupant rebounded into the seatback support, where he came to rest and remained in his respective seated position.

It should be noted that the reported glenohumeral joint dislocation was reported by the driver and could not be substantiated due to missing official medical data.

[3] Refer to Figures 11 & 12

Scene Diagram



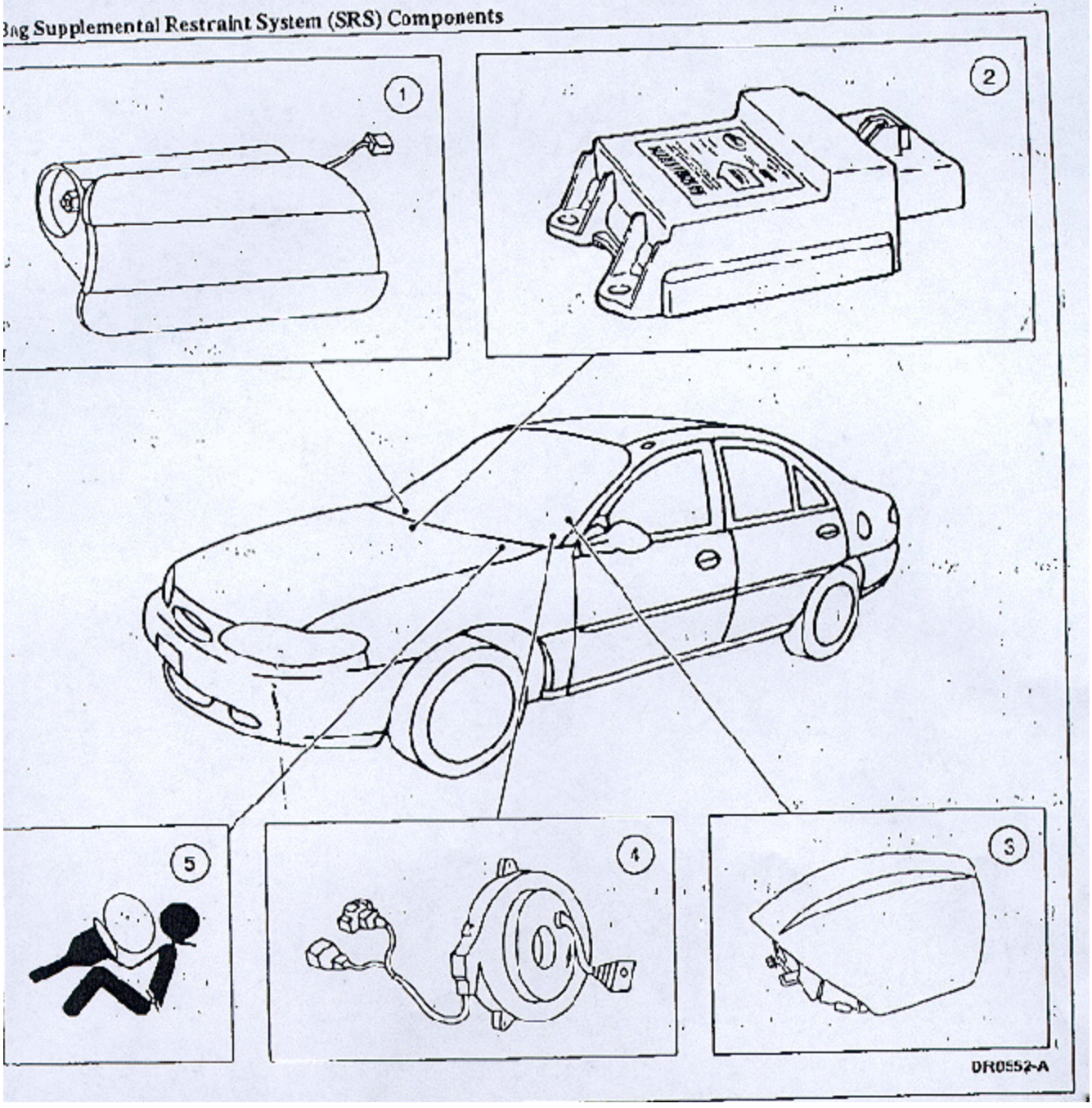
SCRIPTION AND OPERATION

Bag Supplemental Restraint tem (SRS)

ir bag supplemental restraint system (SRS) is ned to provide increasedcollision protection for seat occupants in addition to that provided by the -point safety belt system. Safety belt use is ssary to obtain the best occupant protection and to ve the full advantages ofthe SRS.

The air bag supplemental restraint system (SRS) components are shown in the following illustration.

Bag Supplemental Restraint System (SRS) Components



DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	044A74	Passenger Air Bag Module
2	14B321	Air Bag Electronic Crash Sensor (ECS) Module
3	043B13	Driver Air Bag Module
4	14A664	Air Bag Sliding Contact
5	—	Air Bag Indicator (Part of 10849)

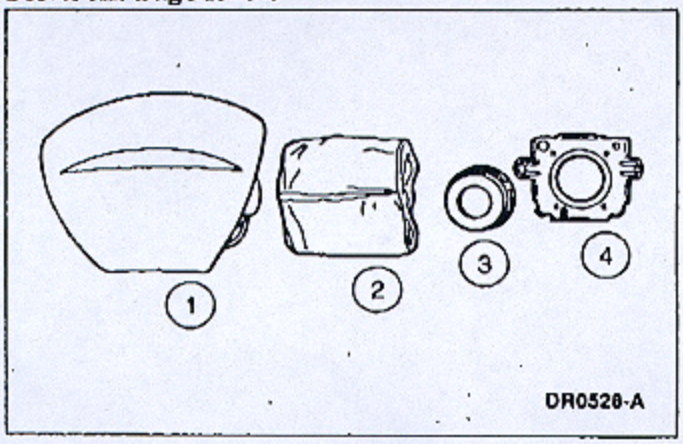
(Continued)

Air Bag Module — Driver

The driver air bag module:

- is replaced as an assembly.
- is mounted in the center of the steering wheel (3600)

Driver Air Bag Module



Item	Part Number	Description
1	—	Steering Wheel Trim Cover (Part of 043B13)
2	—	Air Bag (Part of 043B13)
3	—	Inflator (Part of 043B13)
4	—	Mounting Plate and Retainer Ring (Part of 043B13)

Air Bag

The air bag:

- is constructed of nylon.
- is a component of the driver air bag module an not replaced separately.

Inflator

The inflator:

- receives electrical energy when the air bag sen closes.
- contains an igniter that converts the electrical s to thermal energy (heat), causing the ignition o inflator gas generant.
- inflates the air bag with nitrogen gas after the s azide/copper oxide combustion occurs.
- is a component of the driver air bag module an not replaced separately.

Mounting Plate and Retainer Ring

The mounting plate and retainer ring:

- attach and seal the air bag to the inflator.
- attach the trim cover.
- mount the entire driver air bag module to the st wheel .
- are components of the driver air bag module an not replaced separately.

ESCRIPTION AND OPERATION (Continued)

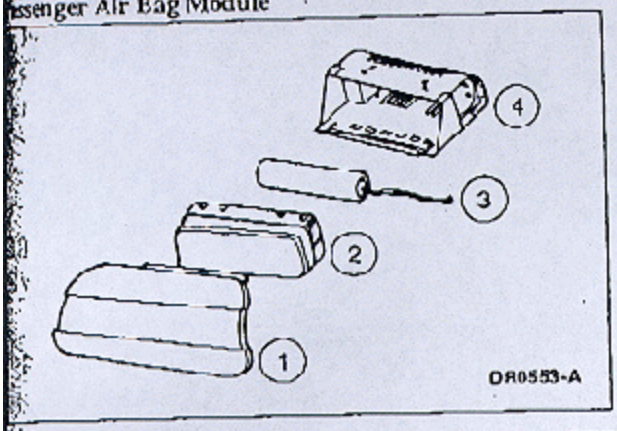
Bag Module — Passenger

passenger air bag module:

replaced as an assembly.

mounted in the RH side of the instrument panel (04320).

ssenger Air Bag Module



Item	Part Number	Description
1	—	Deployment Door (Part of 044A74)
2	—	Air Bag (Part of 044A74)
3	—	Inflator (Part of 044A74)
4	—	Reaction Housing (Part of 044A74)

Deployment Door

The deployment door:

- is textured and painted to match the surface of the instrument panel.
- has a tear seam that separates when the air bag inflates, and hinges out of the way during deployment.
- retains the air bag in the reaction housing until deployment.
- must not be repainted for any reason.
- is a component of the passenger air bag module and is not replaced separately.

Air Bag

The air bag:

- is constructed of nylon.
- is a component of the passenger air bag module and is not replaced separately.

Inflator

The inflator:

- receives electrical energy when the air bag sensor closes.
- contains an igniter that converts the electrical signal to thermal energy (heat), causing the ignition of the inflator gas generant.
- inflates the air bag with nitrogen after the chemical reaction takes place.
- is a component of the passenger air bag module and is not replaced separately.

Reaction Housing

The reaction housing:

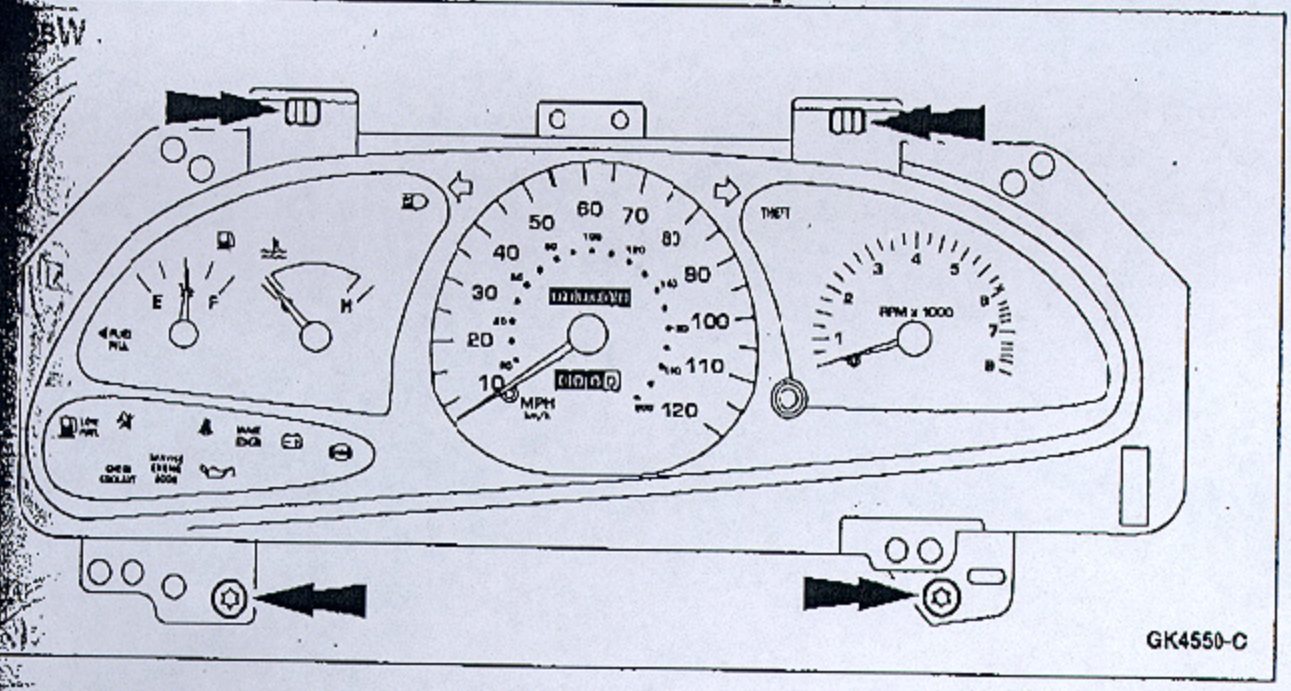
- provides support for the inflator.
- provides a reaction surface for the passenger air bag module.
- is used to attach the deployment door.
- contains mounting brackets that attach the passenger air bag module to the instrument panel.
- is a component of the passenger air bag module and is not replaced separately.

Air Bag Electronic Crash Sensor (ECS)

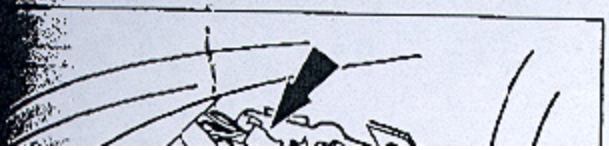
The air bag electronic crash sensor (ECS) module performs the following functions:

- discriminates between an event that warrants frontal air bag deployment and an event that does not.
- signals the inflators to deploy the air bags in the event of a deployable crash.
- monitors the air bag supplemental restraint system (SRS) for faults.
- illuminates the air bag indicator if a fault is detected.
- flashes the air bag indicator to indicate the lamp fault code (LFC) detected.
- communicates through the data link connector (DLC) the current and historical DTCs.
- activates a chime if the air bag indicator is not available.

VAL AND INSTALLATION (Continued)



8. Remove the four screws and position the instrument cluster (10849).



9. Disconnect the three electrical connectors and remove the instrument cluster.