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ON-SITE CERTIFIED ADVANCED 208- COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-032
LOCATION - Texas
VEHICLE - 2004 FORD TAURUS
CRASH DATE - August 2004

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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 be 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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16. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 2004 Ford Taurus (case vehicle) and a 2003 Chrysler Sebring LX (other vehicle). This crash is of special interest because the case vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208 and was equipped with multiple Advanced Occupant Protection System (AOPS) features, an Event Data Recorder (EDR), and the case vehicle's driver (20-year-old, male), front right passenger (14-year-old, male) and back middle passenger [16-year-old, male] did not sustain a police reported injury as a result of the crash. The case vehicle was traveling northbound in the left middle lane of an Interstate highway. The Chrysler was in the same lane and was disabled due to a prior crash. The case vehicle's driver braked in an attempt to avoid the crash, and the front of the case vehicle impacted and underrode the back of the Chrysler causing a stage 1 deployment of the case vehicle driver's air bag. In addition, the driver's and front right passenger's safety belt buckle-mounted pretensioners activated. The front right air bag did not deploy. The EDR data indicated the weight sensor evaluated the front right passenger as "small" and suppressed deployment of the air bag. Following the impact, the case vehicle traveled an unknown distance north and came to rest in the left middle lane facing north. The Chrysler was accelerated forward and traveled to the left, impacted the concrete median barrier and came to rest against the median barrier facing north. The driver and front right passenger were restrained and the back middle passenger was not restrained. The impact caused the driver and front right passenger to continue forward and load their safety belts, and the driver's face and chest most likely impacted his deployed air bag. The unrestrained back middle seat passenger continued forward and loaded the backs of front seats and deformed them forward. He may have continued forward and impacted the instrument panel and rearview mirror. The rearview mirror was observed to be displaced during the vehicle inspection.					
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This investigation was brought to NHTSA's attention on or before September 17, 2004 by NASS CDS/GES sampling activities. This crash involved a 2004 Ford Taurus SE (case vehicle) and a 2003 Chrysler Sebring LX (other vehicle). The crash occurred in August 2004, at 4:15 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208 and was equipped with multiple Advanced Occupant Protection System (AOPS) features, an Event Data Recorder (EDR), and the case vehicle's driver [20-year-old, unknown race (Hispanic) male], front right passenger [14-year-old, unknown race (Hispanic) male] and back middle passenger [16-year-old, unknown race (Hispanic) male] did not sustain a police reported injury. This contractor inspected the case vehicle and harvested the Restraint Control Module (RCM), which contains the EDR, on October 6, 2004 and inspected the crash scene on October 11, 2004. This contractor was unable to locate the case vehicle's driver. The Chrysler had been sold at auction and could not be located. This report is based on the police crash report, scene and case vehicle inspections, occupant kinematic principles, an analysis of the EDR data provided by Ford and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northbound in the left middle lane of an Interstate highway. The Chrysler was in the same lane and was disabled due to a prior crash. The case vehicle's driver braked in an attempt to avoid the crash, and the front of the case vehicle impacted and underrode the back of the Chrysler causing a stage 1 deployment of the case vehicle driver's air bag. In addition, the driver's and front right passenger's buckle-mounted pretensioners activated. The front right air bag did not deploy. The EDR data showed that the weight sensor evaluated the front right passenger as "small" indicating the air bag deployment was suppressed (the occupants of the case vehicle could not be located and the weight of the front right passenger could not be determined). Following the impact, the case vehicle traveled an unknown distance north and came to rest in the left middle lane facing north. The Chrysler was accelerated forward, traveled to the left, impacted the concrete median barrier and came to rest against the median barrier facing north. The weather at the time of the crash was clear, the light condition was dark with street lights, the roadway was dry and the traffic density was light.

The CDC for the case vehicle was determined to be **12-FDEW1 (0 degrees)**. The WinSMASH program, missing vehicle algorithm calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs respectively as: 27.0 km.p.h. (16.8 m.p.h.), -27.0 km.p.h. (16.8 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The EDR data indicated that the case vehicle's Delta V was approximately -44 km.p.h. (-27 m.p.h.).

Immediately prior to the crash the case vehicle's driver was most likely seated in an upright driving posture. The driver had one of his feet on the brake and most likely had both hands on the steering wheel and was bracing for impact. The driver's seat track was adjusted to the middle track position, his seat back was most likely slightly reclined and the tilt steering wheel was

adjusted to its center position. The driver was restrained by his manual lap-and-shoulder safety belt.

Due to the pre-impact braking, the driver's seat belt retractor most likely locked and the driver continued forward into his safety belt. The case vehicle's impact with the Chrysler caused the driver to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. At the same time, the unrestrained back, middle passenger also moved forward and impacted the right portion of the driver's seat back, pushing the driver forward and deforming the seat back. The driver loaded his seat belt and his face and chest most likely contacted his deployed air bag. The driver's left knee also contacted the left knee bolster and slightly displaced the knee bolster panel. Following the impact, the driver most likely rebounded back into his seat. The driver remained in his seat as the case vehicle came to final rest. It is likely the driver was able to exit the case vehicle without assistance. The police crash report indicated that the driver was not injured in the crash.

Immediately prior to the crash, the case vehicle's front right passenger was seated in an unknown posture. His feet were likely on the floor, but the position of his hands and arms is not known. The front right seat track was adjusted to its rear-most position. The seat back was most likely slightly reclined, and the passenger was restrained by his manual lap-and-shoulder safety belt.

Due to the pre-impact braking, the front right passenger's safety belt retractor most likely locked and he continued forward into his safety belt. The case vehicle's impact with the Chrysler caused the front right passenger to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated, and he loaded his safety belt. At the same time, the unrestrained back middle passenger moved forward and impacted the left portion of the front right passenger's seat back, pushing the passenger forward and deforming the seat back. There was no evidence the front right passenger made contact with the instrument panel. Following the impact, the front right passenger rebounded back into his seat and remained in his seat as the case vehicle came to final rest. It is likely the passenger was able to exit the case vehicle without assistance. The police crash report indicated the front right passenger was not injured as a result of the crash.

Immediately prior to the crash the case vehicle's back middle passenger was seated in an unknown posture. The position of his feet are unknown. Due to the pre-crash braking, he may have been bracing with one hand on the back of each front seat back. The case vehicle's impact with the Chrysler caused the back middle passenger to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated, and he impacted the inside portion of each front seat back. The back middle passenger may have passed between the front seat backs and contacted the middle instrument panel and the rearview mirror. No occupant contact marks were found on the instrument panel, but the rearview mirror was displaced indicating it may have been contacted. The position of the back middle passenger following the crash is not known. It is likely he was able to exit the case vehicle without assistance. The police crash report indicated that the back middle passenger was not injured in the crash.

Crash Environment: The trafficway on which the case vehicle was traveling was an eight lane, divided, Interstate highway traversing in a north and south direction. The case vehicle's roadway was curved to the left and had four through lanes and one exit ramp lane. The Chrysler was on the same roadway and was disabled due to a prior crash. Each lane of the roadway was approximately 3.7 meters (12 feet) wide, and the trafficway was separated by a concrete median barrier. Roadway pavement markings consisted of a yellow median edge line, broken white lane lines and a solid white outside edge line. The approach of the case vehicle was uncontrolled, and the speed limit was 97 km.p.h. (60 m.p.h.). At the time of the crash the light condition was dark with street lights, the atmospheric condition was clear, and the roadway pavement was dry, travel polished bituminous with a slight negative grade. The estimated roadway coefficient of friction was 0.65. The traffic density was light, and the site of the crash was urban. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was northbound in the middle left lane, and the driver was intending to continue northbound (**Figure 1**). The Chrysler was in the same lane and was stopped facing northbound due to its involvement in a prior crash. The case vehicle's driver braked to avoid the crash. The crash occurred in the middle left lane.

Crash: The front of the case vehicle (**Figure 2** below) impacted the back of the Chrysler causing a stage 1 deployment of the case vehicle's driver air bag and activation of the driver's and front right passenger's safety belt buckle-mounted pretensioners. The case vehicle's front right air bag did not deploy. The case vehicle driver's pre-crash braking caused the case vehicle's front suspension to load, and the front of the case vehicle dipped down and underrode the back of the Chrysler.

Post-Crash: As a result of the impact, the case vehicle continued north an unknown distance and came to rest in the left middle lane facing north. The Chrysler was accelerated northbound by the impact and traveled to the left an unknown distance across the outside lane. The left side of the Chrysler then impacted the concrete median barrier. The Chrysler came to rest with its left side against the concrete median barrier.



Figure 1: Approach of case vehicle northbound in middle left lane



Figure 2: Overview of damage to the front of case vehicle due to impact with the back of the Chrysler

The 2004 Ford Taurus SE was a front wheel drive, four-door sedan (VIN: 1FAFP53U14G-----) equipped with a 3.0 L, V-6 engine, a three-speed automatic transmission, and power assisted disc brakes. The front seating row was equipped with driver and front right passenger knee bolsters, a split bench seat with adjustable driver and front right passenger head restraints, a driver seat position sensor and front right passenger seat weight sensor, dual stage driver and front right passenger air bags, driver and front right passenger manual, three-point, lap-and-shoulder safety belt systems with safety belt usage sensors and buckle-mounted, safety belt pretensioners and energy management retractors, and a middle seat lap belt. The back seating row was equipped with bench seats with high-back head restraints and manual, three-point, lap-and-shoulder safety belt systems in all three seat positions. Side impact air bags were an option for the case vehicle, but it was not so equipped. Four-wheel anti-lock brakes and traction control are also an option, but it is not known if the case vehicle was equipped with these options. Due to the electronic odometer, the vehicle mileage could not be determined. The case vehicle's wheelbase was 276 centimeters (105.1 inches).

The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity and driver and front right passenger safety belt usage to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seat position, an occupant weight sensor determines first, if an occupant is on the seat and, second, if the weight on the seat is at or below a threshold value. If no front right occupant is seated or the weight on the seat is at or below the threshold value, then the advanced restraint system will suppress deployment of the front right passenger air bag.



Figure 3: Damage to front of case vehicle due to impact with back of Chrysler, each stripe on rods is 5 cm (2 in)

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the Chrysler involved the front bumper, both headlamp/turn lamp assemblies, grille, and the hood (**Figure 3**). The direct damage began at the left corner of the front bumper and extended 146 centimeters (57.5 inches) across the bumper. The direct damage also involved the front portion of the hood. The hood damage indicates the case vehicle underrode the back of the Chrysler (**Figure 4**). Crush measurements were taken at the bumper level, on the bumper bar (i.e., the bumper cover was torn off), and maximum crush



Figure 4: Damage to hood from underride, damage to back of fender from opening driver's door against damaged fender

was measured as 23.0 centimeters (9.1 inches) occurring at C₂ and C₃. The table below shows the case vehicle’s crush profile.

Units	Event	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	154	23	127	22	23	23	14	14	14	0	0
in		60.6	9.1	50.0	8.7	9.1	9.1	5.5	5.5	5.5	0.0	0.0

The case vehicle’s wheelbase was unchanged by the damage. Induced damage involved the hood and both fenders. In addition, the front of the driver’s door was damaged due to being opened against the displaced left fender (**Figure 4** above).

The recommended tire size was: P215/60R16 and the vehicle was equipped with tires of this size. The case vehicle’s tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	179	26	207	30	8	10	None	No	No
RF	Flat	Flat	207	30	8	10	None	No	Yes
LR	172	25	207	30	8	10	None	No	No
RR	207	30	207	30	8	10	None	No	No

Vehicle Interior: Inspection of the case vehicle’s interior revealed evidence that the driver’s left knee impacted the left knee bolster. The knee bolster panel was observed to be slightly displaced. No other occupant contact marks were found on the case vehicle’s interior front surfaces. No obvious occupant contact marks were found on the driver’s air bag; however, one small stain of unknown origin was found at the bottom of the left quadrant of the air bag. An occupant contact scuff was found on the back of the driver’s seat back, and both front seat backs were bent forward indicating the back seat passenger was not restrained and impacted the back of the front seats during the crash. The back of the driver’s seat intruded forward into the driver’s occupant space



Figure 5: Case vehicle’s steering wheel and steering column showing no deformation

about 23 centimeters (9.1 inches), and the back of the front right passenger seat intruded forward into the front right passenger's occupant space about 14 centimeters (5.5 inches). No other occupant contact evidence was found, and there was no evidence of compression of the energy absorbing steering column or deformation of the steering wheel rim (**Figure 5** above).

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be **12-FDEW 1 (0 degrees)**.

The WinSMASH reconstruction program, missing vehicle algorithm, was used to reconstruct the case vehicle's Delta V. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 27.0 km.p.h. (16.8 m.p.h.), -27.0 km.p.h. (16.8 m.p.h.), and 0.0 km.p.h. (0.0 m.p.h.). The EDR data indicated that the case vehicle's Delta V was approximately -44 km.p.h. (-27 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant air bags at the driver and front right passenger positions. The driver's air bag deployed as a result of the case vehicle's impact with the Chrysler. The front right passenger's air bag did not deploy. The weight sensor evaluated the front right passenger as "small" indicating the air bag deployment was suppressed.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points (**Figure 6**). There was no evidence of damage during the deployment to the air bag module cover flaps or the air bag fabric. One small stain of unknown origin was found at the bottom of the left quadrant of the air bag; however, no clear occupant contact marks were observed on the air bag (**Figure 7** below). The deployed driver's air bag was round with a diameter of approximately 59 centimeters (23.2 inches). The air bag was designed with one cone-shaped tether sewn to the circumference of the center portion of the air bag. The air bag had two vent ports (**Figure 8** below), each approximately 2.0 centimeters (0.8 inches) in diameter, located at the 11 and 1 o'clock positions. The air bag module cover flaps (**Figure 6**) were constructed of vinyl and plastic, and the tear seam was configured across the middle of the air bag module. The top module cover flap was 22 centimeters (8.7 inches) in width and 6.0 centimeters (2.4 inches) in height. The bottom module



Figure 6: Steering wheel and air bag module cover flaps

cover flap was 22 centimeters (8.7 inches) in width and 10 centimeters (3.9 inches) in height. The distance between the mid-center of the driver’s seat back, as positioned at the time of the vehicle inspection, and the front surface of the air bag’s fabric at full excursion was 25 centimeters (9.8 inches).



Figure 7: Case vehicle’s driver air bag, orange dots show small stain of unknown origin



Figure 8: Back of top portion of case vehicle’s air bag, arrows show vent ports

The front right passenger air bag was located in the middle of the instrument panel (Figure 9). The front right passenger air bag did not deploy in the crash. The EDR analysis provided by Ford indicated that the front right passenger seat weight sensor evaluated the passenger as “small”. This indicates that the weight on the seat was below the threshold value for air bag system activation and the deployment of the air bag was suppressed.



Figure 9: Case vehicle’s front right air bag located in middle of instrument panel above glove box door

CRASH DATA RECORDING

The RCM, which houses the EDR, was harvested from the case vehicle and sent to Washington, D.C., October 20, 2004 to be forwarded to Ford for analysis. The EDR analysis provided by Ford indicated that the driver and front right passenger’s safety belts were buckled and both buckle-mounted pretensioners activated at 4 milliseconds following algorithm wake-up. A stage 1 deployment of the driver’s air bag was commanded at 6 milliseconds following algorithm wake-up, and stage 2 disposal occurred after 106 ms. The analysis also indicated that the driver’s seat track was evaluated as “normal”, and the front right passenger seat weight sensor determined that the front right passenger seat was occupied and the passenger was evaluated as “small”. The case vehicle’s velocity change was recorded as approximately -44 km.p.h. (-27 m.p.h.) at approximately 112 milliseconds following algorithm wake-up.

Immediately prior to the crash the case vehicle's driver [20-year-old, unknown race (Hispanic) male; unknown height and weight] was most likely seated in an upright driving posture. The driver had one of his feet on the brake and most likely had both hands on the steering wheel bracing for impact. The driver's seat track was adjusted to the middle track position. His seat back was most likely slightly reclined, but the specific recline position could not be determined due to deformation of the seat back from loading by the back middle seat passenger. The tilt steering wheel was adjusted to its center position.

The evidence indicates the case vehicle's driver was restrained by his manual, three-point, lap-and-shoulder safety belt system. The shoulder belt was observed to be slightly scuffed in an area that corresponded to the D-ring when the belt was placed in the approximate in-use position (**Figure 10**). In addition, the EDR data indicated the driver's safety belt was buckled, and the safety belt buckle-mounted pretensioner activated during the crash (**Figure 11**) indicating the safety belt was buckled. The pretensioner piston movement was approximately 2.5 centimeters (1.0 inch).



Figure 10: Case vehicle driver's seat belt, orange dots show small area of scuffing

The evidence indicates the driver was most likely applying the brakes just prior to the crash. The damage to the bumper and hood of the case vehicle is consistent with the case vehicle underriding the back of the Chrysler, indicating the front end was dipped down due to hard braking just prior to the crash.



Figure 11: Driver's seat belt buckle stalk is compressed indicating pretensioner activated

Due to the pre-impact braking, the driver's seat belt retractor most likely locked, and the driver continued forward into his safety belt. The case vehicle's impact with the Chrysler caused the driver to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. At the same time, the unrestrained back, middle passenger also moved forward and impacted the right portion of the driver's seat back, pushing the driver forward and deforming the seat back (**Figure 12** below). The driver loaded his seat belt and his face and chest most likely contacted his deployed air bag. The driver's left knee also contacted the left knee bolster and slightly displaced the knee bolster panel. Following the impact, the driver most likely rebounded back into his seat. The driver remained in his seat as the case vehicle came to final rest.

It is not known if the case vehicle's driver was injured in this crash. The investigating police officer did not complete the driver's injury element values on the police crash report. However, no ambulance was called to the scene, and the other two occupants in the case vehicle were reported as not injured. It is not known if the case vehicle's driver lost any work days as a result of the crash.

FRONT RIGHT PASSENGER KINEMATICS

Immediately prior to the crash, the case vehicle's front right passenger [14-year-old, unknown race (Hispanic) male; unknown height and weight] was seated in an unknown posture. His feet were likely on the floor, but the position of his hands and arms is not known. The front right seat track was adjusted to its rear-most position. The seat back was most likely slightly reclined, but the specific recline position could not be determined due to deformation of the seat back from loading by the back middle seat passenger.

The evidence indicates the front right passenger was restrained by his manual, three-point, lap-and-shoulder safety belt system. The EDR data indicated the passenger's safety belt was buckled, and the safety belt buckle-mounted pretensioner activated (**Figure 13**) indicating the safety belt was buckled. The pretensioner piston movement was approximately 3.0 centimeters (1.2 inches).

Due to the pre-impact braking, the front right passenger's safety belt retractor most likely locked, and he continued forward into his safety belt. The case vehicle's impact with the Chrysler caused the front right passenger to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated, and he loaded his safety belt. At the same time, the unrestrained back middle passenger moved forward and impacted the left portion of the front right passenger's seat back, pushing the passenger forward and deforming the seat back (**Figure 14** below). There was no evidence he made contact with the instrument panel. Following the impact, the front right passenger rebounded back into his seat and remained in his



Figure 12: Back of driver's seat, orange dot shows occupant contact, seat back bent forward on right



Figure 13: Front right seat belt buckle stalk is compressed indicating pretensioner activated

seat as the case vehicle came to final rest. It is likely the front right passenger was able to exit the case vehicle without assistance.

FRONT RIGHT PASSENGER INJURIES

The police crash report indicated the front right passenger was not injured in this crash.

BACK MIDDLE PASSENGER KINEMATICS

The police crash report indicated this passenger was seated in the back seat, but did not give a specific seat location. The contact evidence on the inside portions or both front seat backs and the deformation of the seat backs indicates the back seat passenger was most likely unrestrained and seated in the back middle seat position.

Immediately prior to the crash the case vehicle's back middle passenger [16-year-old, unknown race (Hispanic) male; unknown height and weight] was seated in an unknown posture. The position of his feet are unknown. Due to the pre-crash braking, he may have been bracing with one hand on the back of each front seat back. The case vehicle's impact with the Chrysler caused the back middle passenger to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated, and he impacted the inside portion of each front seat back. The back middle passenger may have passed between the front seat backs and contacted the middle instrument panel and the rearview mirror. No occupant contact marks were found on the instrument panel, but the rearview mirror was displaced (**Figure 15**) indicating it may have been contacted. The position of the back middle passenger following the crash is not known. It is likely the back middle passenger was able to exit the case vehicle without assistance.

BACK MIDDLE PASSENGER INJURIES

The police crash report indicated the back middle passenger was not injured in this crash. There was no indication on the police crash report that an ambulance was called to the scene.



Figure 14: Front right passenger's seat back bent forward on left



Figure 15: Overview of instrument panel and displaced rearview mirror

The 2001 Chrysler Sebring LX was a front-wheel drive, two-door hardtop (VIN: 4C3AG42G33E-----). The Chrysler was equipped with driver and front right passenger air bags, which did not deploy as a result of the impact with the case vehicle.

Exterior Damage: The Chrysler was not inspected. It had been sold at auction and could not be located. No photographs of the vehicle were available; therefore, a CDC could not be estimated. The Chrysler was towed due to damage.

Chrysler's Occupants: According to the police crash report, the Chrysler's driver [27-year-old, (unknown race and ethnic origin) female] was restrained by her manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated the driver did not sustain any injuries as a result of the crash.

