

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

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**GENERAL DYNAMICS REMOTE CERTIFIED ADVANCED 208-COMPLIANT
VEHICLE CRASH INVESTIGATION**

SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 2004-47-013C

VEHICLE – 2004 FORD F-150

LOCATION - STATE OF ALABAMA

CRASH DATE – FEBRUARY 2004

Contract No. DTNH22-01-C-17002

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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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<p>16. <i>Abstract</i> This remote investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in a 2004 Ford F-150 pickup truck. The manufacturer of this vehicle has certified that this 2004 Ford F-150 meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual-stage frontal air bags, seat track position sensors for the front seats, an occupant presence sensor for the front right seat, safety belt buckle pretensioners, and safety belt buckle switch sensors. The Ford was also equipped with a Restraints Control Module (RCM) that had event data recording capabilities. The NASS researcher attempted to retrieve the RCM; however, the owner of the vehicle refused permission for the removal of the RCM. The Ford was occupied by a restrained 18-year-old male driver, a restrained 16-year-old female front right occupant, and two unrestrained rear seat occupants of unknown age and sex. The Ford was involved in a multiple event crash with two W-beam guardrails, a ditch, and brush. As result of the crash, the driver's frontal air bag deployed and the safety belt pretensioners actuated. The driver was not injured or transported. The front right occupant sustained a left tibia fracture and was transported to a local trauma center where she was treated and released. The rear occupants were not injured or transported. The Ford sustained moderate severity damage and was towed from the crash site.</p>			
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**GENERAL DYNAMICS REMOTE CERTIFIED ADVANCED 208-COMPLIANT
VEHICLE CRASH INVESTIGATION
SCI SUMMARY TECHNICAL REPORT
NASS/SCI COMBO CASE NO. 2004-47-013C
SUBJECT VEHICLE – 2004 FORD F-150
LOCATION - STATE OF ALABAMA
CRASH DATE - FEBRUARY 2004**

BACKGROUND

This remote investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system (**Figure 1**) in a 2004 Ford F-150 pickup truck. The manufacturer of this vehicle has certified that this 2004 Ford F-150 meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual-stage frontal air bags, seat track position sensors for the front seats, an occupant presence sensor for the front right seat, safety belt buckle pretensioners, and safety belt buckle switch sensors. The Ford was also



Figure 1. Subject vehicle 2004 Ford F-150.

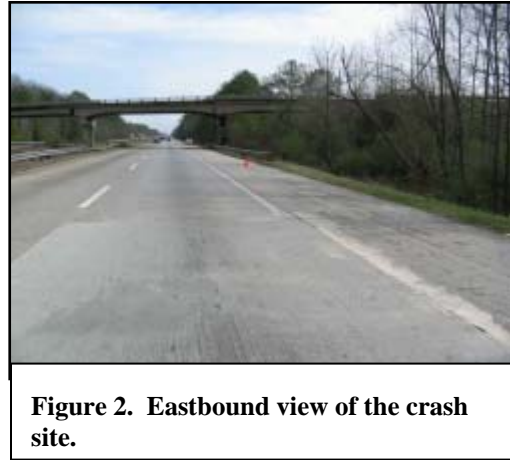
equipped with a Restraints Control Module (RCM) that had event data recording capabilities. The NASS researcher attempted to retrieve the RCM; however, the owner of the vehicle refused permission for the removal of the RCM. The Ford was occupied by a restrained 18-year-old male driver, a restrained 16-year-old female front right occupant, and two unrestrained rear seat occupants of unknown age and sex. The Ford was involved in a multiple event crash with two W-beam guardrails, a ditch, and brush. As result of the crash, the driver's frontal air bag deployed and the safety belt pretensioners actuated. The driver was not injured or transported. The front right occupant sustained a left tibia fracture and was transported to a local trauma center where she was treated and released. The rear occupants were not injured or transported. The Ford sustained moderate severity damage and was towed from the crash site.

This crash was identified by the National Automotive Sampling System (NASS) PSU 47 during the weekly sampling of Police Accident Reports (PARs). This crash was selected and researched as CDS Case No. 03-47-013C. The NASS PSU performed the vehicle and scene inspections. Due to the presence of the Certified Advanced 208-Compliant safety system in the 2004 Ford F-150, NHTSA assigned the tasks of case review and report preparation to the General Dynamics SCI team.

SUMMARY

Crash Site

This multiple event crash occurred during the morning hours of February 2004 in the state of Alabama. At the time of the crash, it was raining/snowing and the asphalt road surface was wet. The crash events occurred on the roadside of a local east/west interstate roadway. The east/westbound roadway consisted of two travel lanes in each direction and was delineated by a center grass median. The left roadside (north) was bordered by an asphalt shoulder, a W-beam guardrail and a grass median. The right (south) roadside consisted of an asphalt shoulder, W-beam guardrail, ditch, grass, and several trees. An overpass was located near the crash site. The posted speed limit for the roadway was 97 km/h (60 mph). **Figure 2** is an eastbound view of the crash site. The NASS scene schematic is included as **Figure 15** of this report.



Vehicle Data

2004 Ford F-150

The 2004 Ford F-150 was identified by the Vehicle Identification Number (VIN): 1FTPW1257K (production sequence omitted). The odometer reading was unknown due to the vehicle having no power at the time of the NASS inspection. The vehicle was a four-door pickup truck that was equipped with a 5.4-liter, eight-cylinder engine linked to a four-speed automatic transmission, rear-wheel drive, and four-wheel disc brakes with ABS. The tires on the Ford were Continental Contitrac, size P255/65R17. The maximum pressure for these tires was 303 kpa (44 psi). The manufacturer recommended front and rear tire pressure was 241 kpa (35 psi). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	234 kpa (34 psi)	9 mm (11/32)	No	None
LR	234 kpa (34 psi)	9 mm (11/32)	No	None
RF	Flat	9 mm (11/32)	Yes	Unknown
RR	234 kpa (34 psi)	9 mm (11/32)	No	None

The Ford was configured with a front three-passenger split bench seat with height adjustable head restraints for the outboard positions. The front head restraints were adjusted to the full-down position at the time of the NASS inspection. The second row was configured with a three-passenger bench seat with height adjustable head restraints for the outboard seating positions. The rear left head restraint was adjusted between the

mid to full-up position and the rear right head restraint was adjusted to the full-down position at the time of the vehicle inspection.

Crash Sequence

Pre-Crash

The restrained 18-year-old male driver of the Ford was operating the vehicle eastbound in the outboard lane. The driver of the Ford stated to the investigating police officer that he swerved left to avoid an object on the roadway. As a result of this maneuver, the driver lost directional control of the vehicle and departed the right (south) road edge.

Crash

The front right aspect of the Ford impacted the W-beam guardrail (**Figure 3**) in a swiping impact configuration. The resulting direction of force was within the 12 o'clock sector. The WINSMASH program was not used to calculate a delta V for this impact due to the Ford sustaining multiple overlapping frontal impacts.

The Ford was subsequently redirected and began to travel in a northeast direction. The Ford departed the left (north) road edge and the front left bumper corner of the Ford impacted a second W-beam guardrail (**Figure 4**). The resultant direction of force was 12 o'clock for this impact. The residual damage was of a sideswiping pattern that began at the front left bumper corner and extended down the left side plane of the vehicle. Due to the damage type and the multiple overlapping frontal impacts, the WINSMASH program was not used to calculate a delta V for this event.



Figure 3. Impact to the first W-beam guardrail.



Figure 4. Impact to the second W-beam guardrail.

The second guardrail impact redirected the Ford back onto the travel lanes. The Ford departed the left (south) road edge and impacted a ditch (**Figure 5**) with its frontal plane. The resultant direction of force for this impact was 12 o'clock. The SCI investigator used the WINSMASH barrier equivalent algorithm to calculate a delta V for this event since the impact involved the full frontal



Figure 5. Area of ditch impact.

width of the vehicle. The total delta V was 20.0 km/h (12.4 mph). The longitudinal and lateral components were -20.0 km/h (-12.4 mph) and 0.0 km/h, respectively. The NASS researcher did not calculate a delta V due to multiple overlapping frontal impacts.

The Ford continued its southeast travel and impacted brush that was located beyond the ditch. This impact was minor in severity and did not result in damage to the Ford. The Ford came to rest against the brush facing a southeast direction.

Post-Crash

The restrained 18-year-old male driver of the Ford was not injured and refused transport to a hospital. The restrained 16-year-old female front right passenger sustained a left tibia fracture and was transported to a local trauma center where she was treated for her injury and released. The rear occupants were not injured or transported. The Ford sustained moderate severity damage and was towed from the crash site.

Vehicle Damage

Exterior – 2004 Ford F-150

The 2004 Ford F-150 sustained moderate severity damage as a result of the initial impact with the W-beam guardrail (**Figure 6**). The direct damage began at the front right bumper corner and extended down the right side to the right rear bumper corner. The NASS researcher did not document a crush profile or direct damage length due to the multiple overlapping impacts. The damage consisted of longitudinal deformation of the front bumper and the rear right bumper was displaced longitudinally rearward. The Collision Deformation Classification (CDC) for this impact was 12-FREE-9.



Figure 6. Front right damage from the first W-beam guardrail impact.

The Ford sustained minor severity damage as a result of the second W-beam guardrail impact (**Figure 7**). The NASS researcher did not document direct damage width or a crush profile. The damage consisted of longitudinally oriented abrasions on the front left bumper corner and the left side plane of the Ford. The lower aspect of the bumper fascia was comprised of metal and the upper aspect was plastic. The front left corner of the plastic was fractured from this impact. The left side sustained lateral deformation that began at the leading edge of the front left fender and extended the length of the vehicle. The CDC for this impact was 12-FLES-9.



Figure 7. Front left and left side damage from the second W-beam guardrail impact.

The Ford sustained moderate severity frontal damage as a result of the impact with the ditch (**Figure 8**). The direct damage began at the front right bumper corner and extended left 153.0 cm (60.2"). The maximum crush was located at the front right bumper corner and measured 25.0 cm (9.8"). It should be noted that this damage resulted from the initial W-beam guardrail impact and the subsequent ditch impact. The damage consisted of longitudinal deformation of the front bumper which was displaced rearward and punctured the front right tire. The NASS researcher noted that the right wheelbase was elongated 7.0 cm (2.8") from damaged suspension components. Six equidistant measurement were documented along the front bumper using a combined direct and induced damage width of 196.0 cm (77.2") and were as follows: C1 = 9.0 cm (3.5"), C2 = 6.0 cm (2.4"), C3 = 14.0 cm (5.5"), C4 = 16.0 cm (6.3"), C5 = 11.0 cm (4.3"), C6 = 25.0 cm (9.8"). The NASS researcher documented CDC for this impact was 12-FDLW-2. Based on the SCI evaluation of the damage, the CDC was revised to 12-FDLW-1 to reflect the maximum crush of 25.0 cm (9.8").



Figure 8. Frontal damage from the ditch impact.

The Ford sustained no damage as a result of the impact to the brush. The NASS researcher documented no residual crush or direct damage to the vehicle. The NASS researcher's CDC for this impact was 99-F-999-9 (9's = unknown). Based on the impact location to the vehicle the SCI revised CDC was 12-FDLU-1 for this report.

Interior – 2004 Ford F-150

The 2004 Ford F-150 sustained minor damage as a result of occupant contacts (**Figure 9**). There was no intrusion of the passenger compartment. The NASS researcher noted steering wheel deformation as a result of loading from the driver's chest. Due to the driver's belted status and frontal air bag deployment, it was unlikely that he engaged the steering wheel with his chest. The steering wheel deformation was probably a result of the driver bracing. The driver's left knee contacted the knee bolster which was evidenced by a scuffmark. The driver contacted the roof with his right hand as a scuffmark was noted to the area of contact. The front right occupant contacted the right knee bolster with her knees. The right knee contact was evidenced by a scuffmark. The NASS researcher noted two occupant contact points to the rear roof area from the two unrestrained rear occupants. The occupant contacts to the rear roof were evidenced by hair.



Figure 9. Left knee bolster contacts.

Certified Advanced 208-Compliant Safety System – 2004 Ford F-150

The 2004 Ford F-150 was equipped with a Certified Advanced 208-Compliant safety system. The manufacturer of this vehicle has certified that this 2004 Ford F-150 meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual-stage frontal air bags, seat track position sensors for the front seats, an occupant presence sensor for the front right seat, safety belt buckle pretensioners, and safety belt buckle switch sensors. The system was monitored and controlled by a Restraints Control Module (RCM). The RCM deploys the appropriate safety system dependant on crash severity, occupant presence, safety belt buckle status, and seat track position. In the subject crash, the RCM warranted the deployment of the driver's frontal air bag, and the actuating of the front safety belt pretensioners. The stage of the driver's air bag deployment was unknown due to the lack of RCM data. Based on the crash events it was speculated that the deployment occurred at the ditch impact (Event #4).

The driver's frontal air bag deployed from the center of the steering wheel hub (**Figures 10 and 11**). The air bag was configured with H-configuration cover flaps. The top flap measured 11.0 cm (4.3") in width and 7.0 cm (2.8") in height at the ends and 10.0 cm (3.9") in height at the center. The bottom flap measured 11.0 cm (4.3") in width and 12.0 cm (4.7") in height at the ends and 10.0 cm (3.9") in height at the center. The NASS researcher measured the air bag at 50.0 cm (19.7") in diameter in its deflated state. The air bag contained two tethers and two vent ports. The vent ports were located at the 11 and 1 o'clock positions on the rear aspect of the air bag. No occupant contacts were noted to the air bag.



Figure 10. Upper aspect of the deployed driver's air bag.



Figure 11. Lower aspect of the deployed driver's air bag.

The front right air bag was a top-mount design on the instrument panel. The RCM did not deploy the front right air bag (**Figure 12**). It was unknown why the front right air bag was suppressed.



Figure 12. Non-deployed front right air bag.

Restraints Control Module – 2004 Ford F-150

The Ford was equipped with a RCM that had event data recording capabilities. The NASS researcher attempted to retrieve the RCM; however, the owner of the vehicle refused permission to allow the removal of the RCM.

Manual Restraint Systems – 2004 Ford F-150

The 2004 Ford F-150 was equipped with manual 3-point lap and shoulder safety belts for the front outboard seating positions. The driver's safety belt was configured with a sliding latch plate, Emergency Locking Retractor (ELR), and a buckle pretensioner. The driver utilized his safety belt in the crash, which was evidenced by the minimal contacts and actuated status of the pretensioner (**Figure 13**). The front right safety belt was configured with a sliding latch plate, switchable Emergency Locking Retractor/Automatic Locking Retractor (ELR/ALR), and buckle pretensioner. The front right occupant utilized her safety belt in the crash which was evidenced by the actuated pretensioner (**Figure 14**). The front center position was equipped with a manual 2-point lap belt that was configured with a locking latch plate and no retractor. The rear outboard safety belts were equipped with manual 3-point lap and shoulder belts. The rear outboard safety belts were configured with sliding latch plates, and switchable ELR/ALR. Although the NASS researcher indicated that the rear occupants used the safety belts in the crash, the rear occupant contacts to the rear roof area that were evidenced by hair supported non-use of the safety belts. The rear center position was equipped with an integrated manual 3-point lap and shoulder safety belt. The rear center safety belt was configured with a sliding latch plate and a switchable ELR/ALR.



Figure 13. Fired driver's safety belt pretensioner.



Figure 14. Fired passenger's safety belt pretensioner.

Occupant Demographics – 2004 Ford F-150

Driver

Age/Sex: 18-year-old male
Height: Unknown
Weight: Unknown
Seat Track Position: Between middle and rear
Manual Restraint Use: Manual 3-point lap and shoulder belt
Usage Source: Vehicle inspection
Eyewear: Unknown
Type of Medical Treatment: None

Driver Kinematics

The 18-year-old male driver of the 2004 Ford F-150 was seated in a presumed upright driving posture and was restrained by the manual 3-point lap and shoulder belt. The seat was adjusted between the middle and rear most track position. At impact with the first W-beam guardrail, the driver initiated a slight forward trajectory as he braced against the upper steering wheel rim. The driver's torso was not displaced from this impact due to his belted status; however the bracing of the steering wheel resulted in the deformation of the upper aspect of the steering wheel rim.

At impact with the second W-beam guardrail, the driver initiated a slight forward trajectory. The driver was minimally displaced forward and his left knee contacted the knee bolster which was evidenced by a scuffmark

At impact with the ditch, the driver's frontal air bag deployed and the safety belt pretensioner actuated. The deploying air bag deflected the driver's right hand which contacted the roof. Due to the air bag deployment and use of the safety belt system, the driver was not injured.

The stage of the driver's air bag deployment was unknown due to the lack of RCM data. Based on the crash events it was speculated that the deployment occurred at the ditch impact.

The vehicle continued forward and impacted brush where it came to rest. This impact was minor and did result in movement of the driver. The driver was not injured and refused transport.

Front Right Occupant

Age/Sex: 16-year-old female
Height: Unknown
Weight: Unknown
Seat Track Position: Forward third track
Manual Restraint Use: Manual 3-point lap and shoulder belt
Usage Source: Vehicle inspection
Eyewear: Unknown
Type of Medical Treatment: Transported and released

Front Right Occupant Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Fracture of the left tibia condyles/plateau, posteriorly (minimally) displaced	Serious (853408.3,2)	Knee bolster

Front Right Occupant Kinematics

The 16-year-old female front right occupant of the 2004 Ford F-150 was seated in a presumed upright posture and was restrained by the manual 3-point lap and shoulder belt. The seat was adjusted to the forward third track position. At impact with the first W-beam guardrail, she initiated a forward trajectory. Her left knee contacted the knee bolster which resulted in the fracture of the left tibia condyles/plateau posteriorly (minimally) displaced. The NASS injury mechanism was improperly coded as the glove box door; however, the occupant contact point was located on the knee bolster.

At impact with the second W-beam guardrail, she initiated a slight forward trajectory. The front right occupant was minimally displaced from this impact due to her belted status

At impact with the ditch, the front right safety belt pretensioner fired and the front right occupant initiated a forward trajectory as a result of the 12 o'clock impact force. Her belted status resulted in minimal displacement.

The vehicle continued forward and impacted brush where it came to rest. This impact was minor and did result in movement of the front right occupant.

Front Right Occupant – Medical Treatment

As a result of her injury, the front right occupant was transported to a local trauma center where she was treated for her injury and released.

Rear Left and Rear Right Occupants

Age/Sex: Unknown
Height: Unknown
Weight: Unknown
Seat Track Position: Not adjustable
Manual Restraint Use: None used
Usage Source: Vehicle inspection
Eyewear: Unknown
Type of Medical Treatment: Not injured

Rear Left and Rear Right Occupant Kinematics

The rear occupants of the 2004 Ford F-150 were seated in a presumed upright posture and were not restrained by the manual 3-point lap and shoulder safety belts. At impact with the first W-beam guardrail, the occupants initiated a forward trajectory and probably

contacted the rear of the front seatbacks which arrested the occupant's forward movement.

At impact with the second W-beam guardrail, the occupants initiated a forward trajectory and probably contacted the rear of the front seatbacks which restricted the occupant's forward motion.

At impact with the ditch, the rear occupants initiated a forward trajectory. As the vehicle continued forward the Ford bottomed into the ditch and the occupants rebounded in a vertical upward direction. As a result of the vehicle's motion, the rear occupants' heads contacted the roof which was evidenced by hair.

The vehicle continued forward and impacted brush where it came to rest. This impact was minor and did result in the movement of these occupants. The occupants were not injured or transported.

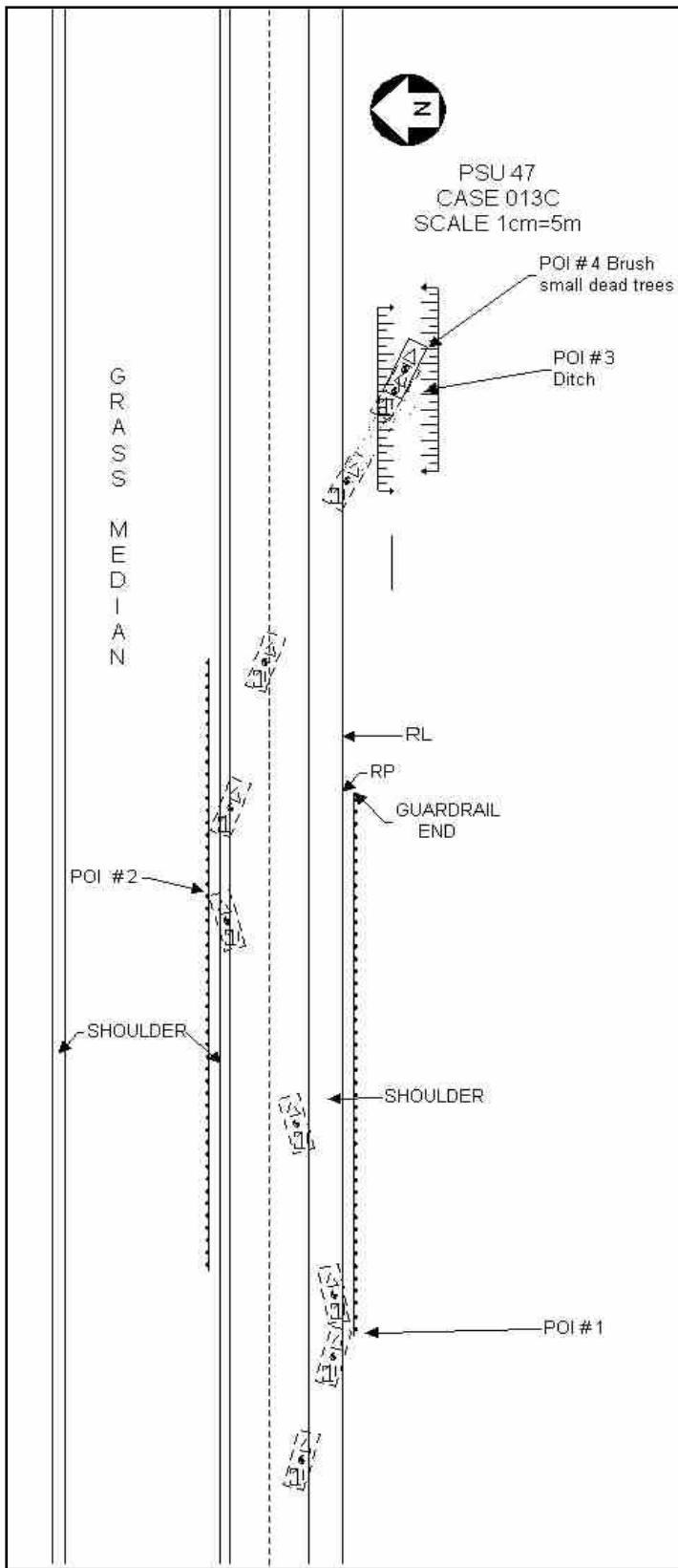


Figure 15. NASS Scene Schematic