CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CERTIFIED ADVANCED-208 COMPLIANT VEHICLE CRASH INVESTIGATION

SCI CASE NO. – CA05-053

SUBJECT VEHICLE – 2005 FORD ESCAPE

LOCATION - STATE OF NEW YORK

CRASH DATE – AUGUST 2005

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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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SUBJECT VEHICLE – 2005 FORD ESCAPE
LOCATION - STATE OF NEW YORK
CRASH DATE – AUGUST 2005

BACKGROUND

This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) safety system in a 2005 Ford Escape **(Figure 1)**. A CAC vehicle is certified by the manufacturer to be compliant to Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual stage frontal air bags, safety belt buckle switch sensors, safety belt buckle pretensioners, and an occupant detection sensor for the front right seat. In addition, the Ford was also equipped with a Restraints Control Module (RCM) that had event data recording capabilities. The RCM was removed from the Ford and was forward to NHTSA for download by Ford. The RCM output is summarized in this report. The Ford was occupied by a restrained 45-year-old female driver. The Ford was involved in a front-to-rear collision with a 2002 Chevrolet Cavalier. This collision resulted in the deployment of the driver's frontal air bag and the firing the driver's buckle pretensioner in the Ford. Subsequent to this impact the Ford rolled over onto its roof. The driver of the Ford sustained minor injuries and was transported to a local hospital where she was treated and released.

Figure 1. Subject vehicle 2005 Ford Escape.

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA) that identified Certified Advanced 208-Compliant vehicles that had been involved in crashes. The list was forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The Ford was located at an insurance auction facility and cooperation was established with the facility to inspect the vehicle and remove the RCM. An on-site investigation was assigned to the Calspan SCI team on October 6, 2005. The vehicles and crash site were inspected during the week of October 10, 2005.

SUMMARY

Crash Site

This crash occurred during the daylight hours of August 2005. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred on the outboard lane of a four-lane east-west roadway. The roadway consisted of two through traffic lanes and a two-way center left turn lane. White fog lines bordered the travel lanes and

asphalt shoulders extended 1.1 meters (3.6 feet) beyond the fog lines. Concrete barrier curbs were located adjacent to the shoulders. A T-intersection was located immediately west of the crash location. The posted speed limit for roadway was 80 km/h (50 mph). The scene schematic is included as **Figure 10** of this report.

Vehicle Data – 2005 Ford Escape

The 2005 Ford Escape was identified by the Vehicle Identification Number (VIN): 1FMYU92Z95 (production sequence omitted). The odometer reading at the time of the inspection was 27,987 kilometers (17,391 miles). The Ford was a four-door sport utility vehicle that was equipped with a 2.3-liter, four-cylinder engine, 4-speed automatic transmission, four-wheel drive, power front disc/rear drum brakes, OEM alloy wheels, power steering, and a tilt steering wheel. The Ford was equipped with General Grabber AW tires, size P225/75R16. The manufacturer recommended front and rear tire pressure was 221 kPa (32 PSI). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	159 kPa (23 PSI)	9 mm (11/32)	No	No
LR	165 kPa (24 PSI)	7 mm (9/32)	No	No
RF	0 kPa	9 mm (11/32)	No	De-beaded
RR	179 kPa (26 PSI)	7 mm (9/32)	No	No

The front seating positions in the Ford were cloth upholstered bucket seats with height adjustable head restraints. The front seat head restraints were both adjusted to the lower third position at the time of the vehicle inspection. The second row was three-passenger split bench seat (60/40) and height adjustable head restraints. These head restraints were adjusted to lower third position.

2002 Chevrolet Cavalier

The 2002 Chevrolet Cavalier was identified by the VIN: 1G1JC12452 (production sequence deleted). The vehicle was a two-door coupe that was equipped with a 2.2 liter, four-cylinder engine, 4-speed automatic transmission, front-wheel drive, power front disc/rear drum brakes. The tires on the Chevrolet were Goodyear Eagle RS-A, size P205/55R16. The tire data at time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	200 kPa (29 PSI)	3 mm (4/32)	No	No
LR	Tire flat	6 mm (7/32)	No	Cut sidewall
RF	200 kPa (29 PSI)	3 mm (4/32)	No	No
RR	200 kPa (29 PSI)	6 mm (7/32)	No	No

Crash Sequence

Pre-Crash

The restrained 45-year-old female driver of the 2005 Ford Escape was operating the vehicle westbound on the four-lane roadway in the right lane (**Figure 2)**. The 26-year-old female driver of a 2002 Chevrolet Cavalier initiated a right turn from a business driveway and began to travel westbound in the right lane at a police reported speed of approximately 32 km/h (20 mph). A non-contact vehicle was traveling ahead of the Ford and changed lanes to the left to avoid contact with the Chevrolet. The driver of the Ford also attempted to change lanes and applied and left steering input.

Figure 2. Ford's westbound travel.

Crash

Although the driver of the Ford applied a left steering input, she was unable to avoid contact the Chevrolet. Consequently, the front right of the Ford impacted the rear left of the Chevrolet in an off-set corner type impact configuration **(Figure 3)**. The resulting directions of force were 12 o'clock for the Ford and 6 o'clock for the Chevrolet. The RCM calculated delta-V was approximately 22.5 km/h (14 mph) at 112 ms. The RCM did not capture the entire crash due to memory limitation. At 112 ms the delta-V was increasing; therefore, only a portion of the delta-V was recorded. The WINSMASH program was used to calculate a delta-V for this impact. The total delta-V for the Ford was 12 km/h (7.5 mph) with longitudinal and lateral components of -12 (-7.5 mph) and 0 km/h, respectively. The total delta-V for the Chevrolet was 15.0 km/h (9.3 mph). The longitudinal and lateral components were 15 km/h (9.2) and -3 km/h (1.9 mph), respectively. Due to the off-set corner impact the WINSMASH program under estimated the delta-V. The driver's frontal air bag deployed in the Ford due to the deceleration sustained during the front-to- rear impact.

Figure 3. Area of impact between the Ford and Chevrolet.

Figure 4. Approximate area of rollover event.

The impact location to both vehicles was outboard of the frame rails. The Ford continued forward remaining engaged with the Chevrolet. The Ford's right front wheel contacted the rear left wheel of the Chevrolet. As a result, the Ford rotated clockwise allowing the left tires to roll under the alloy wheels and contact the asphalt road surface. This contact tripped the vehicle and it rolled two quarter turns left side leading onto its roof **(Figure 4)**. There was no physical evidence at the crash site to indicate the point of trip and rollover.

Post-Crash

Police and emergency medical personnel responded to the crash site. The driver of the Ford sustained minor injuries and was transported to a local hospital where she was treated and released. The Ford and the Chevrolet sustained moderate severity damage and were towed from the crash site. Both vehicles were deemed a total loss by their respective insurance companies.

Vehicle Damage

Exterior Damage – 2005 Ford Escape

The 2005 Ford Escape sustained minor severity frontal damage as a result of the impact with the Chevrolet **(Figure 5 and 6)**. The direct contact damage began 45 cm (17.7") right of the vehicle's centerline and extended 21 cm (8.3") to the front right bumper corner. Due to the corner impact, the direct contact damage extended down the right front fender 77 cm (30.3"), terminating rear of the right front wheel. The maximum crush measured 4 cm (1.6") and was located at the front right corner of the bumper beam. The crush was documented utilizing six equidistant points along the 112 cm (44.0') width of the front bumper beam and were as follows: C1 = 0 cm, C2 = 0, C3 = 0, C4 = 0, C5 = 2 cm (0.8"), C6 = 4 cm (1.6"). Crush was noted to the front right frame rail which was deformed 4 cm (1.6") rearward. The Collision Deformation Classification (CDC) for this impact was 12-FREE-4.

The right front wheel contacted the rear left wheel of the Chevrolet during the crash sequence. This contact resulted in a 19 cm (7.5") reduction of the right wheelbase.

Figure 5. Frontal damage from the impact with Chevrolet.

Figure 6. Direct contact damage on right front.

The Ford sustained moderate roof damage with the maximum area of deformation occurring along the windshield header **(Figure 7)**. The direct contact damage measured 114 cm (44.8”) and extended across the full width of the windshield header. The direct contact damage also extended rearward 62 cm (24.4”) terminating at the B-pillar. The maximum crush measured 20 cm (7.9”) and was located at the right A-pillar. Abrasions and scattered dents were noted along the full length of the left side rail of 235 cm (92.5”). A crush profile was documented across the windshield header which was as follows: C1 = 10 cm (3.9”), C2 = 7 cm (2.8”), C3 = 10 cm (3.9”), C4 = 13 cm (5.1”), C5 = 19 cm (7.5”), C6 = 20 cm (7.9”). The CDC for this impact was 00-TYDO-3.

Figure 7. Roof crush profile.

Exterior – 2002 Chevrolet Cavalier

The 2002 Chevrolet Cavalier sustained moderate severity damage to the rear as a result of the impact with the Ford. The direct contact damage began 41 cm (16.2”) left of the centerline and extended 17 cm (6.8”) to the rear left corner of the bumper beam. The maximum crush measured 18 cm (7.1”) and was located at the left corner of the bumper beam. Due to the corner impact, the direct contact damage also extended onto the left side 178 cm (70.0”) terminating at the B-pillar **(Figure 8)**. A crush profile **(Figure 9)** was documented across the full width of the rear bumper beam of 116 cm (45.5”). The crush profile was as follows: C1 = 18 cm (7.1”), C2 = 15 cm (5.9”), C3 = 8 cm (3.1”), C4 = 4 cm (1.6”), C5 = 4 cm (1.6”), C6 = 0 cm. The CDC for this impact was 06-BLEE-4.

Figure 8. Direct contact damage on the left side.

Figure 9. Crush profile of the rear bumper beam.

Interior Damage – 2005 Ford Escape

The interior of the Ford sustained moderate interior damage as result of passenger compartment intrusion and occupant contact points. The occupant contact points consisted of three scuffmarks on the front left headliner and minor tears at the same locations. The passenger compartment intrusions were as follows:

Seat Position	Intruded Component	Magnitude	Direction
Front Left	Roof	8 cm (3.1”)	Vertical
Front Left	Windshield header	9 cm (3.5”)	Vertical
Front Left	A-pillar	6 cm (2.4”)	Vertical
Front Center	Windshield header	10 cm (3.9”)	Vertical
Front Center	Roof	8 cm (3.1”)	Vertical
Front Right	Roof	18 cm (7.1”)	Vertical
Front Right	Windshield Header	18 cm (7.1”)	Vertical
Front Right	A-pillar	18 cm (7.1”)	Vertical

Certified Advanced 208-Compliant Safety System – 2005 Ford Escape

The 2005 Ford Escape was equipped with a Certified Advanced 208-Compliant (CAC) safety system. A CAC vehicle is certified by the manufacturer to be compliant to Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual stage frontal air bags, safety belt buckle switch sensors, safety belt buckle pretensioners, and an occupant detection sensor for the front right seat. A Restraints Control Module (RCM) controlled the system. The RCM measures and predicts crash severity and monitors belt status, and occupant presence to deploy the appropriate safety system. In the subject crash, the module commanded the deployment of the driver frontal air bag and firing of the driver’s buckle pretensioner. Additionally, the RCM had Event Data Recording (EDR) capabilities. This RCM was removed from the vehicle and was forwarded to NHTSA for download by Ford. The RCM output is summarized in this report.

The driver’s air bag was conventionally located in the center of the steering wheel hub. Two cover flaps were used to conceal the air bag. The top cover flap measured 16 cm (6.3”) in width and 8 cm (3.0”) in height. The lower cover flaps measured 16 cm (6.3”) in width and 5 cm (1.9”) in height. The air bag membrane measured 53 cm (20.9”) in diameter in its deflated state. The driver’s air bag was tethered by two wide band tethers at the 12 and 6 o’clock positions. Two vent ports vented the airbag at the 9 and 3 o’clock positions on the rear panel. The maximum excursion of the air bag membrane at the tethers measured 26 cm (10.2”). No occupant contacts were present on the air bag membrane.

The front right passenger air bag was a top-mount design in the right instrument panel. The front right seating position was not occupied; therefore, the CAC system did not warrant the deployment of the front right air bag.

Restraints Control Module – 2005 Ford Escape

The 2005 Ford Escape was equipped with a Restraints Control Module (RCM) that had Event Data Recording (EDR) capabilities. Permission from the insurance company was obtained to remove the RCM from the Ford. The RCM was located within the center tunnel, which required partial disassembly to facilitate the removal. The RCM was removed and was forwarded to NHTSA for download by Ford. The output data indicated that the front pretensioners were commanded to fire at 5 ms. The first stage of the driver's frontal air bag deployed at 42 ms with a disposal of the second stage at 142 ms. The front right seat status was recorded as empty suppressing the deployment of the frontal air bag for this position. However, the deployment logic for this air bag consisted of a 38 ms first stage deployment for an unbelted passenger and a 42 ms deployment for a belted passenger.

The calculated delta-V for this event was approximately 22.5 km/h (14 mph) at 112 ms. This data point was approximated because the delta-V continued to rise beyond the maximum recorded 112 ms time frame. Additionally, there were no Diagnostic Trouble Codes stored within the RCM at the time of the impact.

Manual Restraint Systems – 2005 Ford Escape

The 2005 Ford Escape was equipped with manual continuous loop 3-point lap and shoulder safety belts for the five seating positions. The driver safety belt was configured with a sliding latch plate, Emergency Locking Retractor (ELR), height adjustable D-ring that was in the full-down position, and a buckle pretensioner which fired. The driver utilized her safety belt in the crash, which was supported by the frictional abrasions on the latch plate.

The safety belts for the remaining four seating positions were configured with continuous loop webbing with sliding latch plates that retracted onto switchable ELR/Automatic Locking Retractor's (ALR). The front right safety belt was equipped with a buckle pretensioner; however, the front right seat was not occupied during the crash, therefore the pretensioner did not fire.

Occupant Demographics – 2005 Ford Escape

Driver

Age/Sex:	45-year-old/Female
Height:	Not available
Weight:	Not available
Seat Track Position:	Mid-track
Manual Restraint Use:	Manual 3-point lap and shoulder safety belt
Usage Source:	Vehicle inspection
Eyewear:	Not available
Type of Medical Treatment:	Transported to a hospital, treated and released.

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Not available	Unknown	Unknown

Driver Kinematics

The 45-year-old female driver of the 2005 Ford Escape was seated in a presumed upright posture and was restrained by the manual 3-point lap and shoulder safety belt. At impact with the Chevrolet, the frontal air bag deployed and the safety belt pretensioner fired. The driver initiated a slight forward trajectory in response to the 12 o'clock direction of force. She loaded the safety belt, which restricted her forward movement. Although not supported by contact evidence, the driver's mid-track position and forward response probably resulted in facial contact to the deployed air bag.

The Ford subsequently rolled over two-quarter turns with the left side leading. The safety belt usage and the fired pretensioner resulted in minimal displacement. The driver sustained minor injuries and was transported to local hospital where she treated and released.

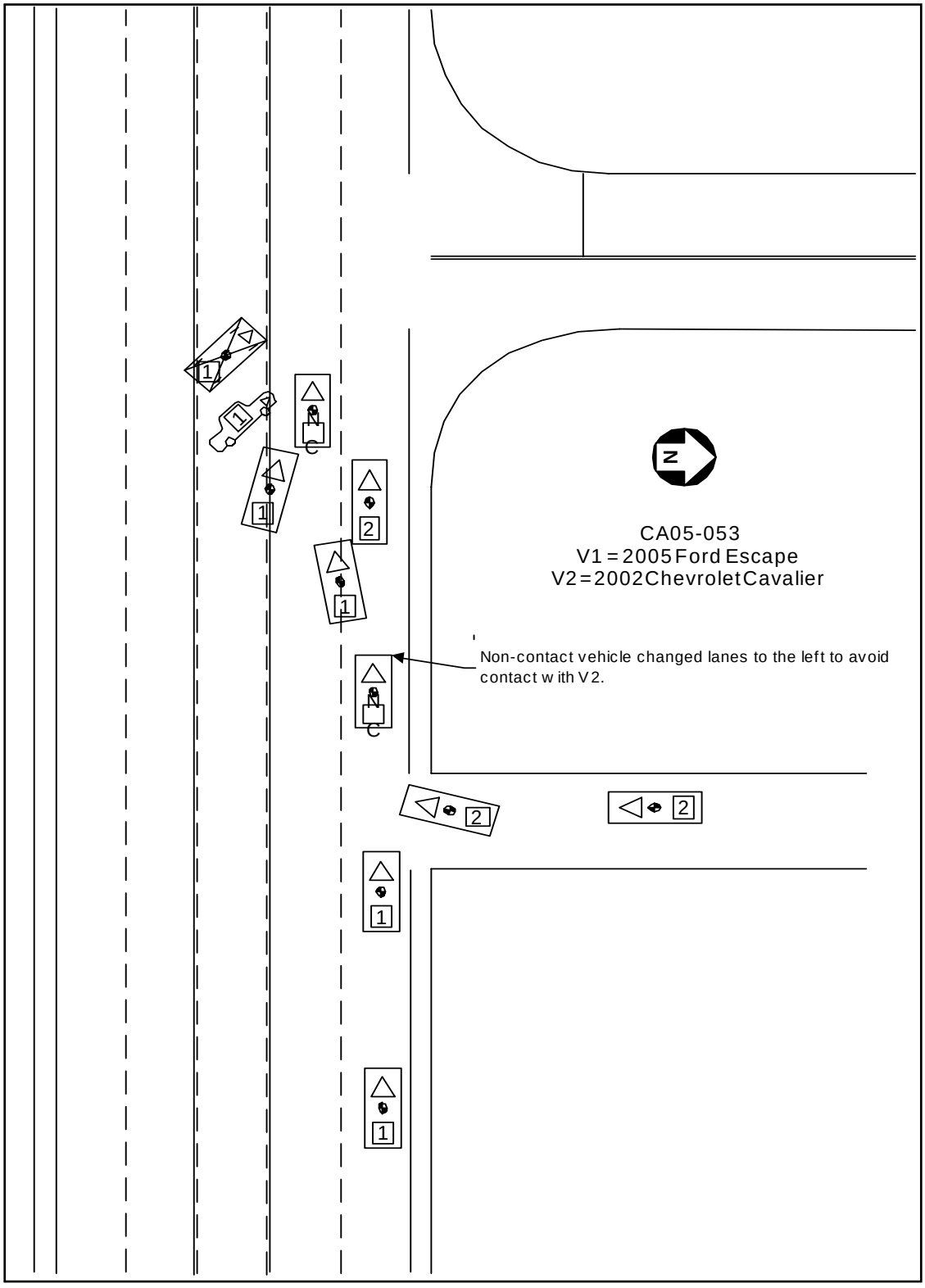

Figure 10. Scene schematic