CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE VEHICLE COMPATABILITY CRASH INVESTIGATION

CASE NO: CA02-057

VEHICLE: 2002 TOYOTA TUNDRA
1990 DODGE GRAND CARAVAN

LOCATION: MARYLAND

CRASH DATE: NOVEMBER 2002

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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16. Abstract This on-site investigation focused on the impact configuration, crash severity, and vehicle compatibility of a 2002 Toyota Tundra pickup truck that was involved in an offset, head-on crash with a 1990 Dodge Grand Caravan. A restrained 62-year old female driver of the Toyota was traveling southbound on a two-lane roadway at a police estimated speed of 56 km/h (35 mph). The driver of the Toyota allowed the vehicle to drift onto the right shoulder and sideswipe a street sign. The driver applied a rapid counterclockwise (CCW) steering input in an attempt to regain directional control of the vehicle. The CCW input redirected the vehicle across the eastbound travel lane and into the westbound lane. The 1990 Dodge Caravan was traveling in a westerly direction and was struck in offset, head-on configuration by the Toyota. The 62-year old female driver of the Tundra was restrained by the manual 3-point lap and shoulder system. In addition to the seat belt system, the driver was provided supplemental crash protection by the deployment of the frontal air bag system. She sustained fractures to her right ankle and left fibula and multiple soft tissue injuries related to the loading of the belt system and knee bolster. She was transported to a local hospital where she was treated and released. The 55-year old male driver of the Dodge sustained fatal injuries. There was significant intrusion into the driver's seating area of the Dodge and considerable loading of the steering assembly. The Dodge was not equipped with frontal air bags.			
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BACKGROUND

Figure 1 - Damaged 2002 Toyota Tundra.

This on-site investigation focused on the impact configuration, crash severity, and vehicle compatibility of a 2002 Toyota Tundra pickup truck **(Figure 1)** that was involved in an offset, head-on crash with a 1990 Dodge Grand Caravan. A restrained 62-year old female driver of the Toyota was traveling southbound on a two-lane roadway at a police estimated speed of 56 km/h (35 mph). The driver of the Toyota allowed the vehicle to drift onto the right shoulder and sideswipe a street sign. The driver applied a rapid counterclockwise (CCW) steering input in an attempt to regain directional control of the vehicle. The CCW input redirected the vehicle across the eastbound travel lane and into the westbound lane. The 1990 Dodge Caravan was traveling in a westerly direction and was struck in offset, head-on configuration by the Toyota. The 62-year old female driver of the Tundra was restrained by the manual 3-point lap and shoulder system. In addition to the seat belt system, the driver was provided supplemental crash protection by the deployment of the frontal air bag system. She sustained fractures to her right ankle and left fibula and multiple soft tissue injuries related to the loading of the belt system and knee bolster. She was transported to a local hospital where she was treated and released. The 55-year old male driver of the Dodge sustained fatal injuries. There was significant intrusion into the driver's seating area of the Dodge and considerable loading of the steering assembly. The Dodge was not equipped with frontal air bags.

The investigating officer notified the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) of the crash. The notification was forwarded to the Calspan SCI team on Wednesday, November 20, 2002 and assigned an on-site investigation. Cooperation was established with the investigating officer and the SCI investigation was conducted on November 25, 2002.

SUMMARY

Crash Site

The two-vehicle crash occurred during daylight hours in November 2002 in the state of Maryland. At the time of the crash there were no adverse weather conditions and the asphalt roadway was dry. The north/south roadway consisted of one lane in each direction and was separated by a single yellow and broken yellow centerline, which allowed passing for northbound traffic. Asphalt shoulders delineated by white painted

fog lines were present outboard of both travel lanes. The roadside environment consisted of multiple private homes in a residential setting. A shallow ditch was present on the west roadside. The roadway characteristics included a pronounced curve (left curve for southbound traffic and right curve for northbound). The roadway was straight and level and had a posted speed limit of 56 km/h (35 mph). The crash schematic is included as **Figure 15** at the end of this narrative report.

Vehicle Data – 2002 Toyota Tundra

The 2002 Toyota Tundra was identified by the Vehicle Identification Number: 5TBRT3417S (production number omitted). The vehicle's odometer at the time of the SCI inspection read 12,508 km (7,772 miles). The vehicle was a four-door extended cab pickup truck equipped with an 8-cylinder, 4.7-liter engine linked to an automatic transmission. The rear-wheel drive vehicle was equipped with 41 cm (16") steel wheels and Dunlop AT 21 Grand Trac P265/70R16 tires. The specific tire information at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage/Restricted
LF	0 kPa	7 mm (9/32")	Restricted and cuts in the tread
LR	193 kPa (28 PSI)	7 mm (9/32")	None
RF	193 kPa (28 PSI)	7 mm (9/32")	None
RR	207 kPa (30 PSI)	6 mm (8/32")	None

The front row of the Tundra was configured with a split bench seat with separate cushions for the driver, center, and front right passenger positions. The driver and passenger seats were adjusted to the mid-track position. The outboard frontal seats were equipped with adjustable head restraints. The driver's head restraint was adjusted 3 cm (1.2") above full down and the front right was in the full down position. The second row was configured with a bench seat with a folding back for both outboard positions.

Vehicle Data – 1990 Dodge Grand Caravan

The 1990 Dodge Caravan was identified by the VIN: 1B4FK44R5LX (production number omitted). The vehicle's odometer at the time of the SCI inspection read 86,434 km (53,709 miles). The vehicle was a four-door mini-van equipped with a 6-cylinder, 3.3-liter engine linked to an automatic transmission. The front-wheel drive vehicle was equipped with 36 cm (14") steel wheels and P195/75R14 tires.

Crash Sequence

Pre-Crash

The 62-year old female driver of the 2002 Toyota Tundra pickup truck was traveling on the southbound lane of a two-lane roadway and was negotiating a left curve **(Figure 2)**. The 55-year old male driver of the 1990 Dodge Caravan was traveling northbound on the same roadway and was negotiating a right curve **(Figure 3)**. The Toyota drifted off the right roadside evidenced by visible furrow marks on the west roadside grass.

Crash

As the Toyota exited the right side of the roadway, the vehicle sideswiped a road sign located approximately 1 m (3.3') outboard of the roadway on the west roadside **(Figure 4)**. After the initial impact, the driver of the Toyota applied a left steering input, attempting a corrective action. The Toyota reentered the roadway, crossed the roadway's centerline, and entered the northbound traffic lane. The Toyota left visible tire marks illustrating its trajectory to the point of impact with the Dodge Caravan. The front plane of the Toyota contacted the front center and left aspect of the Dodge in off-set configuration on the northbound travel lane. The directions of force for the Toyota and Dodge were in the 01 o'clock and 12 o'clock sectors, respectively. The impact resulted in frontal damage to both vehicles and was sufficient to deploy the frontal air bags of the Toyota. The damage algorithm of the WinSMASH program calculated a total delta-V of 41 km (25.5 mph) for the Toyota and 45 km (28 mph) for the Dodge. The specific longitudinal and lateral components were -39 km (-24.2 mph) and -14 km (-8.7 mph) for the Toyota and -44 km (-27.3 mph) and 8 km (5 mph) for the Dodge.

Figure 2 - Southbound approach of Toyota.

Figure 3 - Northbound approach of Dodge.

Figure 4 - Right side road departure and impacted street sign.

Post-Crash

The driver of the Toyota sustained fractures to her lower extremities and multiple soft-tissue injuries and was transported to a local hospital by ambulance where she was treated and released. The driver of the Dodge sustained fatal injuries and was removed from his vehicle by emergency personnel. An autopsy was performed; however, a copy of the medical examiner's report was not received for inclusion within this narrative report.

2002 Toyota Tundra

Exterior Damage

The 2002 Toyota Tundra **(Figure 5)** sustained moderate damage as a result of the impact with the 1990 Dodge Caravan. The direct damage for the third and highest severity impact began 39 cm (15.3") right of the vehicle's centerline and extended 122 cm (48") to the left front bumper corner. The direct damage terminated at the left front bumper corner. The maximum crush was located at the left front bumper corner and measured 58 cm (22.8") in depth. The

Figure 5 - Damaged 2002 Toyota Tundra.

combined direct and induced damage encompassed the entire front end of the vehicle and measured 157 cm (61.8”) in length. The crushed bumper contacted the left front wheel deflating the tire and compressing the left side wheelbase 22 cm (8.6”). The induced damage emanated down the left side and the inertial forces shifted the bed of the pickup 2.5 cm (1”) to the left from the vehicle cab bodyline. The crush profile was measured to the vehicle’s chrome bumper at six equidistant placements and was as follows: C1 = 58 cm (22.8”), C2 = 43 cm (17”), C3 = 41 cm (16.1”), C4 = 21 cm (8.3”), C5 = 0 cm, C6 = 0 cm. The Collision Deformation Classification (CDC) for this event was 01-FDEW-1

Two additional events involving the Toyota occurred as the vehicle exited the west roadside prior to its impact with the Dodge. The Toyota sideswiped a stationary road sign located approximately 1 m (3.3’) off the west roadside with its right side in two separate locations. The first area of damage was located on the right fender of the Toyota beginning 48 cm forward of the front right axle extending rearward to the right outside rear view mirror. No identifiable crush was associated with this event. The CDC for this impact was 12-RFMS-1.

The second area of damage along the right side of the Toyota began 50 cm (19.8”) forward of the right rear axle and extended 149 cm (58.5”) rearward. The direct contact damage terminated 8 cm (3.1”) forward of the right rear taillight. The maximum crush for this impact was 2.5 cm (1”). The CDC for this impact was 12-RBMS-1.

Interior Damage

The 2002 Toyota Tundra sustained minor interior damage as a result associated with occupant contact and minor intrusion. Scuff marks coupled with blue fabric transfers were present at two locations on the left side knee bolster. The first transfer was located 55 – 60 cm (21.5 - 23.5”) left of the vehicle’s centerline and 43 – 48 cm (17 – 18.75”) below the top of the instrument panel’s brow. This contact was consistent with occupant loading. The second transfer was 43 – 51 cm (17- 20”) left of the vehicle’s centerline and 37 – 39 cm (14.5 – 15.3”) below the top of the instrument panel’s brow. Both transfers are illustrated in **Figure 6**. As the vehicle reached the point of maximum engagement, in addition to loading the restraint systems, the driver’s lower torso loaded the front left seat cushion resulting in a frictional fabric abrasion **(Figure 7)**. This abrasion ran parallel to the instrument panel and was located 1 – 15 cm (0.5 – 5.75”) left of the vehicle’s centerline and was 7 cm (2.75”) in width at its widest point. The only discernable intruded component was the driver’s toe pan which was displaced 8 cm (3.2”) longitudinally.

Figure 6 - Contact evidence to left knee bolster.

Figure 7 - Frictional abrasion to driver's seat cushion.

1990 Dodge Grand Caravan
Exterior Damage
The 1990 Dodge Caravan **(Figures 8 and 9)** sustained severe damage as a result of the impact with the 2002 Toyota Tundra pickup truck. The direct damage began at the left front bumper corner and extended along the bumper 76 cm (30") to the right. The combined direct and induced damage encompassed the entire front bumper and measured 131 cm (51.5") in width. The maximum crush was located 39 cm (15.4") left of the vehicle's centerline and measured an averaged 68 cm (26.8") in depth. The crush profile was measured to the aluminum bumper and also to the upper radiator support. The averaged results of the crush profile were as follows: C1 = 65 cm (25.6"), C2 = 68 cm (26.8"), C3 = 59 cm (23.2"), C4 = 35 cm (13.8"), C5 = 9 cm (3.5"), C6 = 0 cm. The CDC for this impact was 12-FYEW-4.


Figure 8 - Damaged 1990 Dodge Caravan.


Figure 9 - Damaged 1990 Dodge Caravan (side view).

Manual Safety Belt Systems
2002 Toyota Tundra
The 2002 Toyota Tundra was equipped with 3-point continuous loop safety belt systems for the front outboard seating positions. The driver's belt was configured with a sliding


Figure 10 - Loading evidence on driver shoulder belt webbing.


Figure 11 - Loading evidence on left front D-ring.

latch plate, Emergency Locking Retractor (ELR), and an adjustable D-ring, which was in the full-down position at the time of the SCI inspection. Loading evidence in the form of a blue fabric transfer was identified on the interior shoulder belt webbing **(Figure 10)**. This transfer began 71 cm (28") above the belt's stop button and extended forward 26 cm

(10.2”). Additional loading evidence, attributed to the adjustable D-ring, was identified on the interior shoulder belt that began 118 cm (46.4”) above the stop button and extended 10 cm (3.9”) forward thereof. A correlating grey fabric transfer was present within the inside aspect of the D-ring **(Figure 11)**. The driver’s belt was also equipped with a retractor pretensioner that fired during the third crash event. The ELR locked the belt webbing into the worn position, indicative of belt usage.

Additional manual restraints were present at the front center and right seating positions and the second row outboard seating location. The front center position consisted of a fixed length lap belt with a locking latch plate. The front right and second row seating positions contained manual lap and shoulder restraints with sliding latch plates and adjustable ELR/Automatic Locking Retractors (ALR’s). The front right safety belt webbing was in a locked position along the right B-pillar attributable to the firing of the belt’s retractor pretensioner.

Frontal Air Bag System
2002 Toyota Tundra

The 2002 Toyota Tundra was equipped with redesigned frontal air bags for the driver and front right seating positions. The frontal air bags deployed as a result of the impact with the 1990 Dodge Caravan. The driver’s air bag **(Figure 12)** deployed through asymmetrical H-configuration cover flaps. The upper flap was 17 cm (6.7”) in width and 10 cm (3.9”) in height. The lower flap was 17 cm (6.7”) in width and 8 cm (3.1”) in height. The air bag membrane measured 66 cm (26”) in diameter in its deflated state. The air bag was tethered by a single reinforcement strap that was 16 cm (6.4”) in width and was vented by two 4 cm (1.6”) diameter ports located at the 11:30 and 12:30 o’clock positions on the back aspect of the air bag. The following nomenclature was stamped on the back of the air bag membrane:

Figure 12 - Driver's deployed air bag.

45165-0C021
0007376
E 548 E548
23 11 01
S
Assembled in Mexico
With USA Components
B411G0889

The top-mount front right passenger’s air bag deployed from a single rectangular cover flap that measured 37 cm (14.5”) horizontally and 17 cm (6.2”) vertically **(Figure 13)**. The air bag membrane measured 71 cm (28”) horizontally and 64 cm (25”) vertically in its deflated state. The air bag’s maximum excursion was 50 cm (20”) from the mid

instrument panel. The air bag was vented by two 6 cm (2.3") diameter ports located at the 3 and 9 o'clock positions on the back of the air bag. The air bag was not tethered. A manual cut-off switch was present in the vehicle which was designed to suppress the deployment of the front right air bag; however, the switch was in the "on" position enabling deployment. A deep linear abrasion was located on the air bag membrane from interaction with the fractured windshield. The following nomenclature was stamped on the back aspect of the air bag:

Figure 13 - Front right passenger's deployed air bag.

0005778
G324 G324
13 12 01
L2
S
Assembled in Mexico
With USA Components

Occupant Demographics
Driver – 2002 Toyota Tundra

Age/Sex:	62-year old/Female
Height:	Not reported
Weight:	75 kg (165 lb)
Seat Track Position:	Mid-track
Manual Restraint Usage:	3-point lap and shoulder restraint
Usage Source:	Vehicle inspection
Eyewear:	Not reported
Type of Medical Treatment:	Transported by ambulance to a local hospital; treated and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Left fibula fracture (non-displaced transverse fracture of proximal third of mid-shaft)	Moderate (851606.2,2)	Knee bolster
Right ankle avulsion fracture of lateral malleolus	Moderate (840402.2,1)	Intruded toe pan
Abrasion to left anterior aspect of neck	Minor (390202.1,6)	Driver's shoulder belt webbing
Neck sprain	Minor (640278.1,6)	Driver's shoulder belt webbing
Large contusion to medial	Minor (890402.1,2)	Knee bolster

aspect of the left femur and tibia.		
Right knee contusion	Minor (890402.1,1)	Knee bolster

**Medical records*

Driver Kinematics

The 62-year old female driver of the 2002 Toyota Tundra was seated in an upright attitude and was restrained by the 3-point manual lap and shoulder belt. As the Toyota departed the right roadside it is possible that the driver was slightly displaced forward as the vehicle sideswiped the street sign. The driver steered left and reentered the roadway before impacting the 1990 Dodge Caravan. At impact with the Dodge, the driver responded to the 1 o'clock direction of force by initiating a forward and slightly right trajectory. The driver loaded the manual shoulder restraint evidenced by loading marks located on the shoulder belt webbing and a corresponding abrasion and sprain to her neck. The driver also loaded the expanding driver's air bag. The driver's lower extremities contacted the left knee bolster leaving discernable blue fabric transfers and scuffing patterns consistent with occupant contact. This contact resulted in a large contusion to the driver's left upper and lower leg, a right knee contusion, and a fracture of the left fibula. The driver's lower leg loaded the intruding front left toe pan resulting in an avulsion fracture of her right ankle. A fabric abrasion was present on the driver's seat cushion indicative of possible occupant contact; however, no correlative injury was identified. Emergency personnel arrived on scene and transferred the driver to a local hospital where she was treated and released for minor soft tissue injuries. Repeated attempts to obtain medical records for the driver have been unsuccessful.

Occupant Demographics

Driver – 1990 Dodge Grand Caravan

Age/Sex:	55-year old/Male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Not reported
Manual Restraint Usage:	None
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Fatal injuries, no treatment administered

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Unspecified fatal injuries	Unknown	Unknown

**Source police report*

Driver Kinematics

The 55-year old male driver of the 1990 Dodge Grand Caravan was seated in presumed upright position prior to the impact with the 2002 Toyota Tundra. The driver was reportedly unrestrained. The driver initiated a forward trajectory responding to the 12 o'clock direction of force and loaded the severely intruded steering assembly. This is evidenced by the deformed steering wheel rim and subsequent column separation **(Figure 14)**. The driver sustained unspecified fatal injuries and was entrapped within the vehicle upon arrival of emergency personnel. After extrication procedures, emergency personnel removed the driver form the vehicle and transported the remains to the county medical examiner for autopsy. Repeated attempts to obtain copies of the autopsy report have been unsuccessful.

Figure 14 - 1990 Dodge Caravan steering assembly.

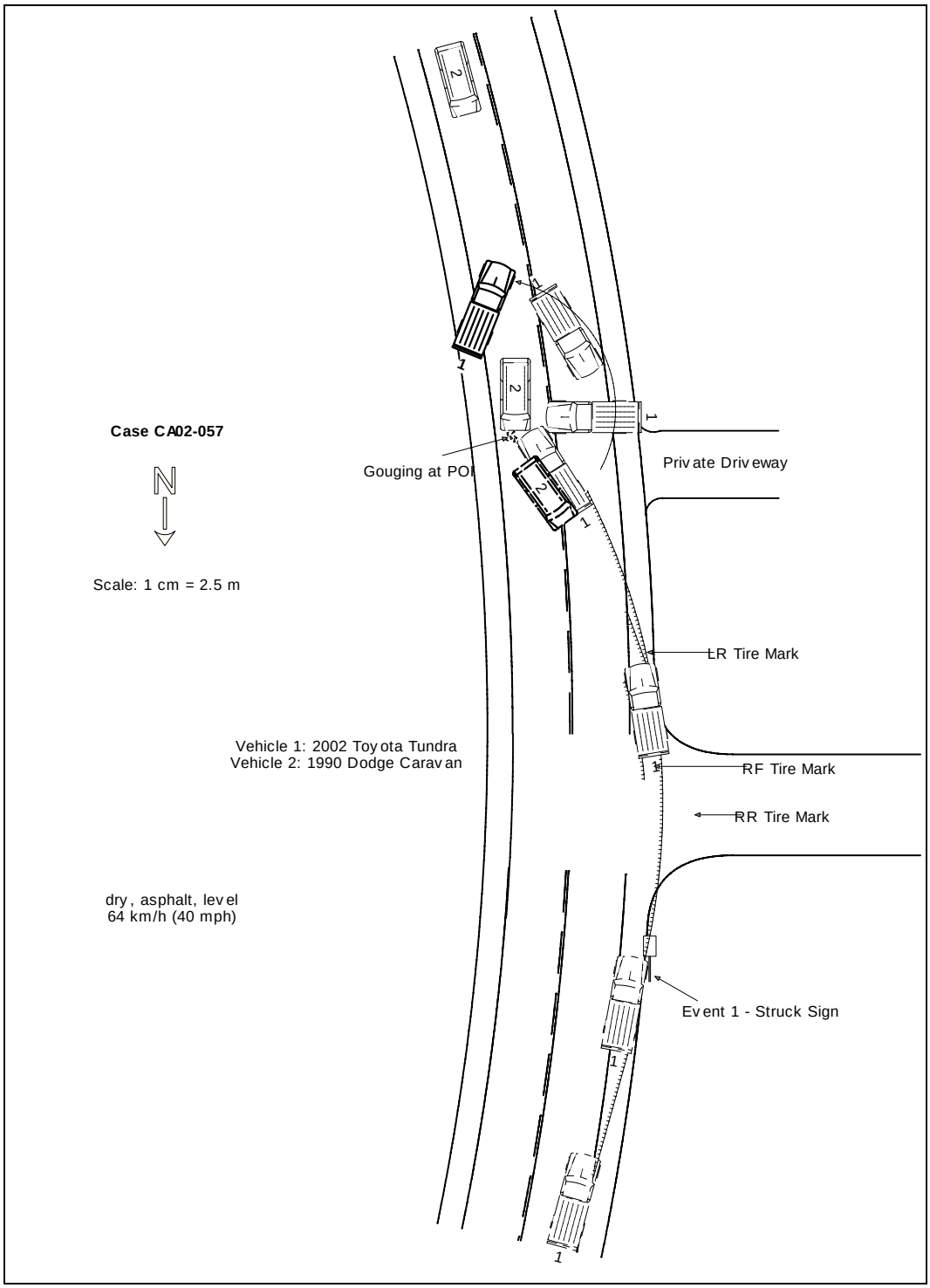

Figure 15 – Scene Schematic