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ON-SITE REAR OCCUPANT PROTECTION PROGRAM INVESTIGATION

CASE NUMBER - IN-06-009

LOCATION - WISCONSIN

VEHICLE - 2002 TOYOTA COROLLA LE

CRASH DATE - May 2006

Submitted:

January 30, 2007

Revised: March 10, 2008



Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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.

Technical Report Documentation Page

1. <i>Report No.</i> IN-06-009		2. <i>Government Accession No.</i>		3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> On-Site Rear Occupant Protection Program Investigation Vehicle - 2002 Toyota Corolla Location - Wisconsin			5. <i>Report Date:</i> January 30, 2007		
			6. <i>Performing Organization Code</i>		
7. <i>Author(s)</i> Special Crash Investigations Team #2			8. <i>Performing Organization Report No.</i>		
9. <i>Performing Organization Name and Address</i> Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501			10. <i>Work Unit No. (TRAIS)</i>		
			11. <i>Contract or Grant No.</i> DTNH22-01-C-07002		
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation (NPO-122) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003			13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: May 2006		
			14. <i>Sponsoring Agency Code</i>		
15. <i>Supplementary Notes</i> On-site rear occupant protection program investigation involving a 2002 Toyota Corolla LE equipped with manual safety belts and driver and front right passenger air bag system.					
16. <i>Abstract</i> This report covers an on-site rear occupant protection program investigation that involved a 2002 Toyota Corolla LE (case vehicle) and a 2002 Kenworth W900 truck-tractor with semi-trailer (other vehicle), which were involved in an intersection crash on a two-lane U.S. highway. This crash is of special interest because the case vehicle's restrained back left passenger [66-year-old, (White, non-Hispanic) female] sustained critical injuries as a result of the crash, resulting in her death. The case vehicle was traveling north in the northbound lane. The Kenworth was traveling south in the southbound lane. The Kenworth's driver turned left to enter an access road to a truck stop. The front of the case vehicle impacted and underrode the front of the Kenworth causing the case vehicle's driver air bag and front right passenger air bag to deploy. The case vehicle came to rest in the northbound lane against the front of the Kenworth heading northwest. The Kenworth came to final rest with the front of the vehicle in the northbound lane heading southeast and the semi-trailer blocking the southbound lane. The case vehicle's back left passenger was restrained by her three-point, lap-and-shoulder safety belt system. She sustained a flail chest injury due to heavily loading her shoulder belt during the crash and died as a result of her injuries. The case vehicle's driver (30-year-old, female) was restrained by her three-point, lap-and-shoulder safety belt system. She sustained police reported "A" (incapacitating) injuries and was transported to a hospital and admitted. The case vehicle's back right passenger (1-year-old, female) was restrained in a child safety seat. She sustained police reported "C" (possible) injuries and was transported to a hospital and admitted.					
17. <i>Key Words</i> Rear Occupant Fatality Air Bag Deployment			Motor Vehicle Traffic Crash Injury Severity		18. <i>Distribution Statement</i> General Public
19. <i>Security Classif. (of this report)</i> Unclassified		20. <i>Security Classif. (of this page)</i> Unclassified		21. <i>No. of Pages</i> 14	22. <i>Price</i> \$8,600

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This investigation was brought to NHTSA's attention on or before May 18, 2006 by a Wisconsin newspaper article. This crash involved a 2002 Toyota Corolla LE(case vehicle) and a 2002 Kenworth W900 truck-tractor with semi-trailer (other vehicle), which were involved in an intersection crash. The crash occurred in May, 2006 at 4:02 p.m., in Wisconsin and was investigated by the applicable county sheriff's department. This crash is of special interest because the case vehicle's restrained back left passenger [66-year-old, (White, non-Hispanic) female] sustained critical injuries as a result of the crash, resulting in her death. This contractor inspected the case vehicle and scene on June 8 and 9, 2006, and interviewed the case vehicle's driver on June 27, 2006. This report is based on the police crash report, scene and vehicle inspections, an interview with the case vehicle's driver, police on-scene photographs, discussions with investigating sheriff deputy, occupant medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in the northbound lane of a two-lane U.S. highway. The Kenworth was traveling south in the southbound lane. The Kenworth's driver turned left to enter an access road to a truck stop. The case vehicle's driver locked the brakes and the case vehicle skidded to impact. The Kenworth's driver braked and was nearly stopped at the time of impact. The front of the case vehicle impacted the front of the Kenworth causing the case vehicle's driver air bag and front right passenger air bag to deploy. The front of the case vehicle underrode the front of the Kenworth and rotated counterclockwise. The case vehicle came to rest in the northbound lane against the front of the Kenworth heading northwest. The Kenworth came to final rest with the front of the vehicle in the northbound lane heading southeast and the semi-trailer blocking the southbound lane. At the time of the crash, the light condition was daylight, the atmospheric condition was cloudy, and the roadway pavement was dry.

The case vehicle's CDC was determined to be **12-FDEW-5 (0 degrees)**. Due to the underride, the case vehicle's level of maximum crush occurred above the bumper level and was measured as 102 centimeters (40.1 inches) occurring at C₂. The WinSMASH reconstruction program, could not be used to reconstruct the case vehicle's Delta Vs because collisions with heavy trucks are out-of-scope for the program. However, the WinSMASH program, barrier algorithm, was used to calculate a Barrier Equivalent Speed (BES) based on the case vehicle's averaged front crush values. The calculated BES was: 41.7 km.p.h. (25.9 m.p.h.). The case vehicle was towed due to damage.

The TDC for the Kenworth was determined from police on-scene photographs and was: **01-FDEW-1 (20 degrees)**. The Kenworth was towed due to damage.

The case vehicle's back left passenger (66-year-old, female) was restrained by her three-point, lap-and-shoulder safety belt system. She heavily loaded her safety belt assembly during the crash causing a flail chest injury. She was transported by ambulance to a hospital and pronounced dead at the hospital 62 minutes following the crash.

The case vehicle's driver (30-year-old, female) was restrained by her three-point, lap-and-shoulder safety belt system. She sustained a thoracic cavity injury and a fracture of her third cervical vertebrae due to riding down her deployed air bag and loading the steering wheel rim. She also sustained a comminuted fracture of the left acetabulum due to loading her knee bolster. She was transported by ambulance to a hospital and hospitalized for 8 days.

The back right passenger (1-year-old, female) was restrained in her forward facing child safety seat. She sustained an abrasion and contusion on the right side of her neck from the child seat harness strap. She was transported by ambulance to a hospital and admitted overnight.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a two-lane U.S. highway traversing in an north and south direction. The case vehicle was approaching a three-leg (i.e., "Tee") intersection. The Kenworth was traveling on the same trafficway and was approaching the "Tee" intersection from the opposite direction. The intersecting roadway was an access to a truck stop. The trafficway on which the case vehicle and Kenworth were traveling had one northbound and one southbound lane and was bordered by bituminous shoulders. The northbound lane was 3.6 meters (11.8 feet) in width. The southbound lane was 3.7 meters (12 feet) in width. The east shoulder was 3.5 meters (11.5 feet) in width. The west shoulder was 3.7 meters (12 feet) in width. The case vehicle was traversing down an approximate 1% negative grade. Roadway pavement markings consisted of solid white edge lines and double-yellow, no-passing, center lines. The speed limit was 89 km.p.h. (55 m.p.h.). At the time of the crash, the light condition was daylight, the atmospheric condition was cloudy, and the roadway pavement was dry bituminous with an estimated coefficient of friction of 0.72. Traffic density is unknown. The site of the crash was rural. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling north in the northbound lane (**Figure 1**). The case vehicle's driver was intending to continue northbound. The Kenworth was traveling south in the southbound lane (**Figure 2** below). The Kenworth's driver was intending to turn left at the "Tee" intersection to enter the truck stop. The police on-scene photographs show front skid marks from the case vehicle leading to impact (**Figure 3** below) indicating the case vehicle's driver reacted to the Kenworth encroaching into her lane and locked the brakes in an attempt to avoid the crash. The case vehicle's skid marks were no longer visible when this contractor conducted the scene inspection. The position of the Kenworth shown in the police on-scene photographs and the damage to the case vehicle indicated that the Kenworth was moving very slowly and almost stopped at the time of the impact. The crash occurred in the "Tee" intersection of the two trafficways (**Figure 4** below).

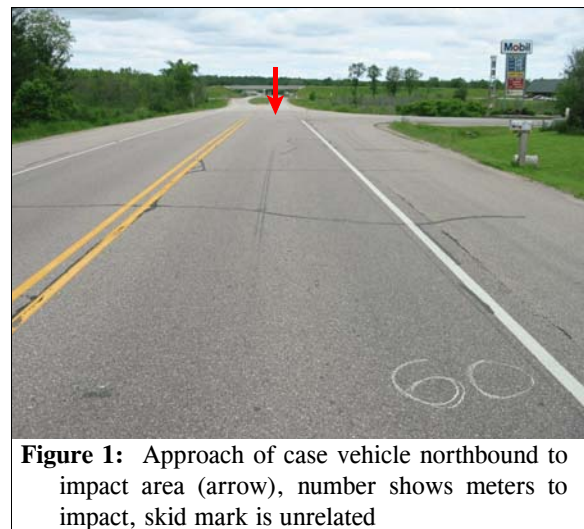


Figure 1: Approach of case vehicle northbound to impact area (arrow), number shows meters to impact, skid mark is unrelated



Figure 2: Approach of Kenworth southeastbound turning onto intersecting roadway



Figure 3: Police on-scene photo showing rest positions of case vehicle and Kenworth, arrows show case vehicle's pre-impact skid marks



Figure 4: Approach of case vehicle northbound to impact, arrow shows impact gouges on pavement



Figure 5: Damage to front of case vehicle from impact with the Kenworth, each increment on rods is 5 cm (2 in), vertical scale is graduated in tenths of meter

Crash: The front of the case vehicle (**Figure 5**) impacted the front of the Kenworth causing the case vehicle's driver air bag and front right passenger air bag to deploy. The front of the case vehicle underrode the front of the Kenworth (**Figure 6**).

Post-Crash: Based on the police on-scene photographs, the case vehicle rotated counterclockwise and came to rest in the northbound lane against the front of the Kenworth heading northwest (**Figures 3** and **6**). The Kenworth came to final rest with the front of the vehicle in the northbound lane heading southeast (**Figures 3** and **6**). The Kenworth's semi-trailer was blocking the southbound lane.



Figure 6: View southwest showing case vehicle's underride of front of Kenworth

The 2002 Toyota Corolla LE was a front wheel drive, four-door sedan (VIN: 1NXBR12E32Z-----) equipped with a 1.8 L, L4 engine and four-speed automatic transmission. The front seating row was equipped with bucket seats with adjustable head restraints, tilt steering column, redesigned driver and front right passenger air bags and driver and front right passenger manual, three-point, lap-and-shoulder safety belt systems with pretensioners. The back seat was equipped with a bench seat with adjustable head restraints in the outboard seating positions and manual, three-point, lap-and-shoulder safety belt systems in all three seat positions. In addition, the back seat was equipped with a LATCH system for securing child safety seats. Lastly, the case vehicle was not equipped with anti-lock brakes.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle’s impact with the Kenworth involved the front plane. The front bumper, left front fender, grille, radiator and hood were directly damaged and crushed rearward (**Figure 7**). The hood was folded back and contacted the windshield during the crash. Rescue personnel cut the left “B”-pillar, partially cut the left “A”-pillar and pried the driver’s door open. The direct damage began at the front left bumper corner and extended 102 centimeters (52.8 inches) across the front bumper and hood. Crush measurements were taken at the bumper level, the radiator level and the hood level (**Figures 8 and 9** below). The residual maximum crush occurred at the hood level and was measured as 102 centimeters (40.1 inches) occurring at C₂. The residual maximum crush at the bumper level was 37 centimeters (14.6 inches) occurring at C₄. The residual maximum crush at the upper radiator support level was 64 centimeters (25.2 inches) occurring at C₂. The table below shows the case vehicle’s crush profile following the averaging of the crush values at the bumper level and upper radiator support level.

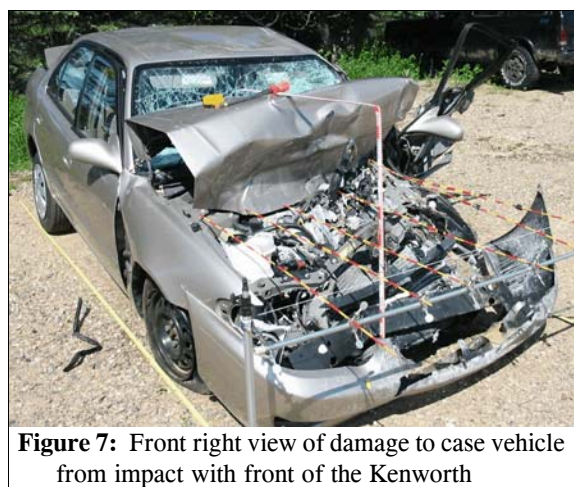


Figure 7: Front right view of damage to case vehicle from impact with front of the Kenworth

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	102	102	125	47	49	35	37	25	11	-16	0
in		40.2	40.2	49.2	18.5	19.3	13.8	14.6	9.8	4.3	-6.3	0.0



Figure 8: Top view of crush to case vehicle's front bumper

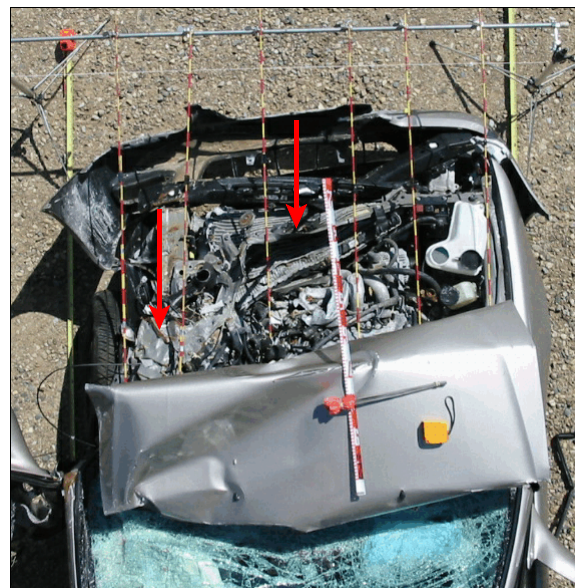


Figure 9: Top view of crush to case vehicle's hood and hood contact with the windshield, red arrows show crush to radiator frame

The impact reduced the case vehicle's left side wheelbase 10 centimeters (4 inches). The right side wheelbase was extended 1 centimeter (0.4 inch). Induced damage involved the hood, both fenders, the left "A"-pillar, roof, right and left "C" pillars and the left rocker panel.

The recommended tire size was: P185/65R14 and the case 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	0	0	207	30	7	9	Cut in sidewall	No	Yes
RF	0	0	207	30	7	9	None	No	Yes
LR	214	31	207	30	6	8	None	No	No
RR	221	32	207	30	6	8	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed deformation to the driver's knee bolster (**Figure 10** below). In addition, the steering column was found displaced considerably upward, which was inconsistent with loading by the restrained driver. It was subsequently determined that the steering column deformation was the result of driver extrication activities. The back of the driver's seat had a small scuff at the bottom and a small localized impression at the top (**Figure 11** below), which appeared to be probable occupant contact by the back left passenger. No other occupant contact evidence was found. Intrusion involved the left

side panel forward of the left “A”-pillar, which had intruded laterally approximately 12 centimeters (4.7 inches). In addition, the windshield intruded approximately 8 to 15 centimeters (3 to 6 inches) into and across the front seat occupant space.



Figure 10: Overview of steering wheel, instrument panel and windshield, arrow shows deformation of driver's knee bolster



Figure 11: Yellow tape shows probable occupant contact marks from back left passenger on the back of the driver's seat

Damage Classification: Based on the vehicle inspection, the case vehicle's CDC was determined to be **12-FDEW-5 (0 degrees)**. The WinSMASH reconstruction program, could not be used to reconstruct the case vehicle's Delta Vs because collisions with heavy trucks are out-of-scope for the program. However, the WinSMASH program, barrier algorithm was used to calculate a Barrier Equivalent Speed (BES) based on the case vehicle's averaged front crush values. The calculated BES was: 41.7 km.p.h. (25.9 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with redesigned driver and front right passenger air bags. Both air bags deployed as a result of the impact with the front of the Kenworth.

The case vehicle's driver air bag was located in the steering wheel hub. The air bag module cover consisted of two trapezoidal-shaped cover flaps constructed of pliable vinyl. The upper flap had overall dimensions of 16 centimeters (6.3 inches) in width and 7 centimeters (2.8 inches) in height. The lower flap was a more defined trapezoid shape and was 16 centimeters (6.3 inches) in width at the horizontal tear seam, 12.5 centimeters (4.9 inches) in width at the hinge and 8 centimeters (3.1 inches) in height. There was a semi-circular cut-out at the top center of the lower flap to accommodate the manufacturer's logo in the center of the upper flap. An inspection of the air bag module cover flaps revealed that the cover flaps opened at the designated tear points. There was no damage to the flaps due to the deployment. Inspection of the air bag fabric revealed an approximate 10 centimeters (4 inches) by 4 centimeters (1.6 inches) hole in the back of the air bag just above the 9 o'clock position (**Figure 12**)below. There were also small cuts in the fabric near this area. This was possibly due to the interaction of the air bag with the broken windshield during rescue activities when the steering column was bent severely upward to facilitate removal of the driver from the front seat, or possibly due to interaction with the broken windshield during

the crash. The deforming hood may have dynamically deformed the windshield to the extent that it interacted with the air bag during the crash. The deployed driver's air bag (**Figure 13**) was round with a diameter of approximately 60 centimeters (23.6 inches). The air bag was designed with two tethers, each approximately 14.5 centimeters (5.7 inches) in width. There were two vent ports on the back of the air bag, each approximately 2.5 centimeters (1 inch) in diameter, located at the 11 and 1 o'clock positions. There were two large blood stains located on the front surface of the air bag at the approximate 11 o'clock and 8 o'clock positions.

The front right passenger air bag was located at the top of the instrument panel. The air bag module cover consisted of a two rectangular cover flaps. The upper flap was 23 centimeters (9.1 inches) in width and 4 centimeters (1.6 inches) in height. The lower flap was 23 centimeters (9.1 inches) in width and 6 centimeters (2.4 inches) in height. An inspection of the air bag module cover flaps revealed that the cover flaps opened at the designated tear points. There was no evidence of damage to the cover flaps or the air bag fabric. The evidence showed that the front right air bag impacted and fractured the windshield during the deployment. The deployed front right passenger's air bag (**Figure 14**) was approximately rectangular in shape. The air bag was 75 centimeters (29.5 inches) in height and 65 centimeters in width (25.6 inches). The air bag was designed without tethers. There were two vent ports on the back of the air bag, each approximately 5.5 centimeters (2.2 inches) in diameter, located at approximately the 9:30 and 2:30 o'clock positions. Inspection of the air bag fabric revealed some blood stains, most likely due to blood splatter from the driver, located on the upper left quadrant of the air bag. There was also some type of fluid spill/stain at the lower right corner.



Figure 12: Close view of tear in driver's air bag



Figure 13: Overview of driver's air bag



Figure 14: Overview of front right passenger air bag

Immediately prior to the crash the case vehicle's back left passenger [66-year-old, (White, non-Hispanic) female; 61 kilograms and 160 centimeters (135 pounds, 63 inches)] was seated in an upright position with both feet on the floor and her hands in her lap. Her seat track and seat back were not adjustable.

The case vehicle's back left passenger was restrained by her manual, three-point, lap-and-shoulder safety belt system. Inspection of the safety belt assembly (**Figure 15**) revealed a scuff on the safety belt webbing (**Figure 16**) and a load mark on latch plate belt guide (**Figure 17** below).

Just prior to the crash, the driver locked the brakes and the case vehicle skidded to the impact. As a result of the brake application, the back left passenger's safety belt retractor most likely locked and she moved forward and loaded her safety belt. The case vehicle's impact with the Kenworth then caused the back left passenger to continue forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated. The back left passenger severely loaded her shoulder belt causing a flail chest injury and her lower legs and possibly her hands made contact with the back of the driver's seat (**Figure 11** above)lacerating both lower legs. She then rebounded back into her seat and fell over to her right and likely contacted the back right passenger's head with her head. The back left passenger was removed from the case vehicle through the left rear door by rescue personnel.

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The police crash report indicated the back left passenger sustained a "K" (fatal) injury and was transported from the scene to a hospital. She was pronounced dead at the hospital 62 minutes following the crash. The table below shows the back left passenger's injuries and injury mechanisms.



Figure 15: Overview of back left seat position with safety belt buckled

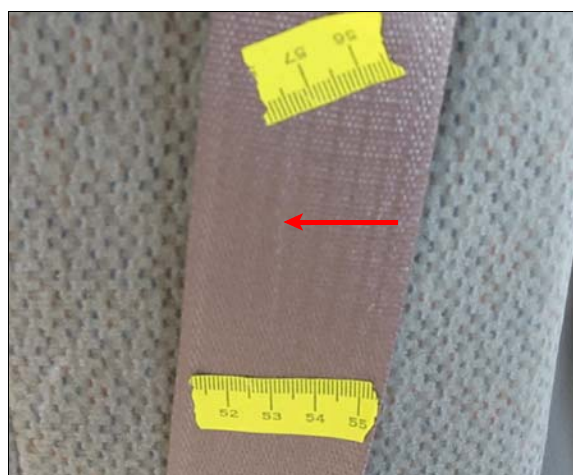


Figure 16: Arrow shows scuff on back left passenger's safety belt from latch plate belt guide

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Flail chest noted with chest compressions during CPR ¹ , not further specified	severe 450260.4,9	Torso portion of safety belt system	Certain	Emergency room records
2	Abrasion chest, not further specified	minor 490202.1,4	Torso portion of safety belt system	Certain	Emergency room records
3	Contusion {bruising} across chest with seat belt marks	minor 490402.1,4	Torso portion of safety belt system	Certain	Emergency room records
4	Contusion {bruising} across abdomen with seat belt marks; abdomen distended	minor 590402.1,8	Lap portion of safety belt system	Certain	Emergency room records
5	Contusion {bruising} on left shoulder with seat belt marks	minor 790402.1,2	Torso portion of safety belt system	Certain	Emergency room records
6	Laceration right lower leg and left lower extremity, not further specified	minor 890600.1,3	Seat back, driver's {near floor}	Certain	Emergency room records

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [30-year-old, (White, non-Hispanic) female; 160 centimeters and 60 kilograms (63 inches, 133 pounds)] was seated in an upright position. She had her right foot on the brake pedal, both hands on the steering wheel, and she was most likely bracing for impact. Her seat track was adjusted to between the middle and forward-most position. Her seat back was adjusted to its upright position. The driver was not wearing glasses or contact lenses at the time of the crash.

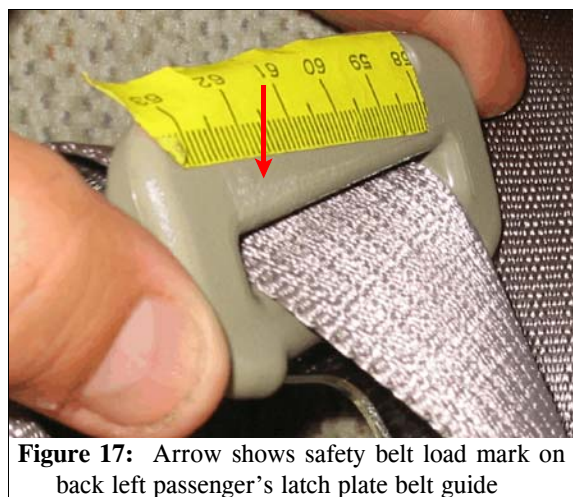


Figure 17: Arrow shows safety belt load mark on back left passenger's latch plate belt guide

The case vehicle's driver was restrained by her manual, three-point, lap-and-shoulder safety belt. Inspection of the safety belt assembly revealed load marks on the shoulder belt webbing (**Figure 18** below) and on the "D"-ring (**Figure 19** below). In addition, the safety belt had been cut by rescue personnel in order to remove the driver from the vehicle.

¹ Cardiopulmonary arrest: this occupant was unconscious at scene and never regained consciousness; in the emergency department she was unresponsive with pupils fixed and dilated, agonal respirations, asystole, and a GCS =3. However, there is no indication of head or neck lesions.

Just prior to the crash, the driver locked the brakes and the case vehicle skidded to the impact. As a result of the brake application, the driver's safety belt retractor most likely locked and she moved forward and loaded her safety belt. The case vehicle's impact with the Kenworth then 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. The driver's safety belt pretensioner actuated, she loaded her safety belt and both knees impacted the knee bolster (**Figure 10** above). The load on her left knee transferred to her hip causing a comminuted fracture to her left acetabulum with moderate displacement. Her face and chest loaded her deployed air bag, she rode down the air bag and loaded the steering wheel rim causing a fracture to her third cervical vertebrae. Her left hand impacted the left instrument panel fracturing her left 2nd metacarpal. Her right foot loaded the brake pedal and her left foot loaded the toe pan causing a fracture of her left 5th metatarsal, a severely comminuted fracture of her right talus neck and comminuted fracture of her right calcaneus. She also sustained multiple abrasions and contusions. The driver rebounded back into her seat and remained in her seat as the case vehicle came to final rest. Rescue personnel cut the left "B"-pillar, pried the left front door open, pried the steering assembly considerably upward and cut the driver's safety belt off of her and removed the driver from the case vehicle through the left front door.



Figure 18: Load mark on driver's shoulder belt

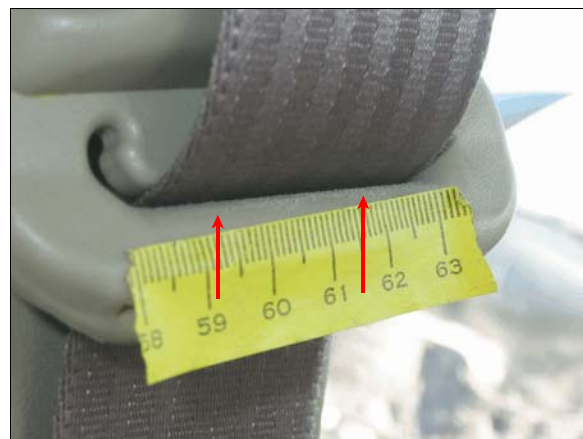


Figure 19: Arrows show load mark on belt guide of driver's "D"-ring

CASE VEHICLE DRIVER INJURIES

The police crash report indicated the driver sustained an "A" (incapacitating) injury and was transported by ambulance to a local hospital. The driver was admitted to the hospital for treatment of her injuries. She was hospitalized for 8 days and had received one follow-up medical visit by the time she was interviewed by this contractor. The driver was not working at the time of the crash. The table below shows the case vehicle driver's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Thoracic cavity injury with left apical pneumothorax, 25%, small-resolved post chest tube placement	serious 442202.3,2	Steering wheel hub and/or spokes and rim	Probable	Hospitalization records
2	Fracture, comminuted, oblique, left acetabulum with moderate displacement; no dislocation	serious 852604.3,2	Knee bolster, driver's, left of steering column { <i>indirect injury</i> }	Certain	Emergency room records
3	Fracture C ₃ facet without cord involvement/compromise	serious 650222.3,6	Steering wheel rim { <i>indirect injury</i> }	Probable	Hospitalization records
4	Fracture left 2 nd metacarpal at base, not further specified	moderate 752002.2,2	Left instrument panel and below	Probable	Hospitalization records
5	Fracture left 5 th metatarsal at base, not further specified	moderate 852200.2,2	Floor, including toe pan	Certain	Hospitalization records
6	Fracture, severely comminuted, right talus neck	moderate 853200.2,1	Floor, foot controls	Certain	Hospitalization records
7	Fracture, comminuted, right calcaneus	moderate 851400.2,1	Floor, foot controls	Certain	Hospitalization records
8	Abrasion over right chest, not further specified	minor 490202.1,1	Torso portion of safety belt system	Probable	Emergency room records
9	Contusion {ecchymosis, bruising} right lower sternum	minor 490402.1,4	Torso portion of safety belt system	Probable	Emergency room records
10	Abrasions right subcostal in epigastrium	minor 590202.1,7	Torso portion of safety belt system	Probable	Hospitalization records
11	Contusion {bruising}, faint, over upper abdomen	minor 590402.1,7	Torso portion of safety belt system	Probable	Emergency room records
12	Abrasions over left and right hips (e.g., right iliac crest area)	minor 590202.1,8	Lap portion of safety belt system	Certain	Emergency room records
13	Contusion {bruising, ecchymosis} right hip, over anterior, superior iliac spine	minor 590402.1,1	Lap portion of safety belt system	Certain	Hospitalization records
14	Abrasions on dorsal left hand and all fingers and right hand, not further specified	minor 790202.1,3	Air bag, driver's	Probable	Hospitalization records
15	Contusion {ecchymosis} left hand, not further specified	minor 790402.1,2	Left instrument panel and below	Probable	Hospitalization records
16	Abrasions over bilateral knees, not further specified	minor 890202.1,3	Knee bolster, driver's left and right of steering column	Certain	Hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
17	Contusion {bruising} left knee, not further specified	minor 890402.1,2	Knee bolster, driver's, left of steering column	Certain	Emergency room records
18	Contusion {bruising; ecchymosis}, large, right knee, not further specified	minor 890402.1,1	Knee bolster, driver's, right of steering column	Certain	Hospitalization records
19	Contusion {ecchymosis} left foot, not further specified	minor 890402.1,2	Floor, including toe pan	Certain	Hospitalization records

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's back right passenger [1-year-old, (White, non-Hispanic) female; 64 centimeters and 9 kilograms (25 inches, 20 pounds)] was restrained in a forward facing child safety seat. The child safety seat was secured in the vehicle by the case vehicle's three-point, lap-and-shoulder safety belt. The lap and shoulder belt were fastened together with a safety belt locking clip. The deformed locking clip was found in the case vehicle during the inspection (**Figure 20**). In addition, load marks were found on the safety belt webbing (**Figure 21**). The child safety seat was not available for inspection. The specific location of the locking clip relative to the belt routing on the child safety seat is not known.



Figure 20: Deformed safety belt locking clip for back right child safety seat



Figure 21: Arrows show load marks on back right passenger safety belt, photo view from top left

Just prior to the crash, the driver locked the brakes and the case vehicle skidded to the impact. As a result of the brake application, the back right passenger moved forward in her child safety seat and loaded the harness straps. The case vehicle's impact with the Kenworth then caused the back 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 she loaded her harness straps. The back right passenger rebounded back into her child safety seat and remained in the child safety seat until removed from the case vehicle. The back right passenger sustained an abrasion and contusion on

the left side of her neck from the child safety seat harness. In addition, she sustained a contusion on the top of her head due to likely contact with the head of the back left passenger as that passenger fell over into the back right passenger.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The police crash report indicated the back right passenger sustained an “C” (possible) injury and was transported by ambulance to a local hospital. She was admitted overnight and released the next day. The table below shows the back right passenger’s injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion {bruise}, faint, 2 x 2 cm (0.8 x 0.8 in), over top of scalp, mid-frontal area	minor 190402.1,5	Other occupant: back left passenger	Possible	Emergency room records
2	Abrasion, large, superficial, over left anterolateral neck	minor 390202.1,2	Child safety seat harness straps	Certain	Emergency room records
3	Contusion left side of neck with swelling, not further specified	minor 390402.1,2	Child safety seat harness straps	Certain	Emergency room records

OTHER VEHICLE

The 2002 Kenworth W900 was a 4x6 truck-tractor (VIN: 1XKWDB9XX2J-----) equipped with a Caterpillar 3406 diesel engine. The Kenworth was pulling a 16.2 meter (53 foot) box semi-trailer.

Exterior Damage: The police on-scene photographs show that the impact involved the front of the Kenworth. The front bumper, lower grille and left fender were directly damaged. Based on the damage visible in the police on-scene photographs, the TDC was determined to be: **01-FDEW-1** (20 degrees). The Kenworth was towed due to damage.

Kenworth’s Occupants: According to the police crash report, the driver of the Kenworth [45-year-old, (unknown race and ethnic origin) male] was restrained by his manual, three-point, lap-and-shoulder, safety belt system. The police crash report indicated the driver was not injured in the crash.

