TRANSPORTATION RESEARCH CENTER

Indiana University
Bloomington, Indiana 47403-1501

ON-SITE AIR BAG GAS FIRE INVESTIGATION

CASE NUMBER - IN97-011
LOCATION - ILLINOIS
VEHICLE - 1995 TOYOTA COROLLA DX
CRASH DATE - March, 1997

Submitted:

November 26, 2002

Contract Number: DTNH22-94-D-17058

Prepared for:

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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

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15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1995 Toyota Corolla DX, four-door sedan, with manual safety belts and dual front air bags, an unknown automobile, and a concrete longitudinal barrier

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1995 Toyota Corolla DX (case vehicle), an unknown automobile (other vehicle), and a concrete longitudinal median barrier. This crash is of special interest because the coat worn by the case vehicle's restrained, driver (26-year-old female) allegedly caught fire as a result of the heat contained in the exhaust gases of her deploying driver air bag. The case vehicle was traveling south in the inside lane on a six-lane, divided, trafficway and intended to continue traveling southbound (i.e., both north and south roadways had three lanes). The other vehicle was traveling south in the center lane of same southbound roadway. The crash occurred when the other vehicle changed into the inside southbound lane. The case vehicle's right rear was impacted by the other vehicle's left front. The case vehicle swerved leftwards striking the barrier with its left rear, then rebounded and reentered the roadway impacting the other vehicle's left side with its right front. The case vehicle veered back leftward striking the median barrier with its front left, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Subsequently, the case vehicle rotated counterclockwise and impacted the median barrier with its rear. The case vehicle continued to rotate counterclockwise, departing the barrier heading southwestward, drifting across the three southbound lanes, and impacting a guardrail on the west roadside. The case vehicle's driver was seated slightly reclined with her seat track between its middle and forward-most positions and her tilt steering wheel in its down-most position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained minor injuries which included: contusions to her left scalp, left chin, and a left finger. The front right passenger in the case vehicle (7-year-old female) was seated slightly reclined with her seat track between its middle and forward-most positions. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained minor abrasions across her right neck and to a right finger. Upon exiting the case vehicle, a bystander pointed out to the case vehicle's driver that her corduroy coat was on fire and told her to take it off. The bystander helped the driver pull off her coat, threw the coat on the ground, and proceeded to stomp out the fire.

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CASE SUMMARY

TRC/IU ON-SITE AIR BAG GAS FIRE INVESTIGATION

SCI Team #2, TRC/IU Case Number IN97-011

Illinois

March, 1997

This on-site investigation was brought to NHTSA's attention on March 19, 1997 by office personnel of NHTSA, Region V in Chicago, Illinois. This crash involved a 1995 Toyota Corolla (case vehicle), an unknown automobile (other vehicle), and a concrete longitudinal median barrier. The crash occurred in March, 1997, at 6:20 p.m., in Illinois and was investigated by the Illinois State Police Department. This crash is of special interest because the coat worn by the case vehicle's driver (26-year-old female) allegedly caught fire as a result of the heat contained in the exhaust gases of her deploying driver air bag. This contractor inspected the vehicle on Monday, March 31, 1997. This contractor interviewed the case vehicle's driver on April 1, 1997. This summary is based on the Police Crash Report, interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

The case vehicle was traveling south in the inside lane of a six-lane, divided, Interstate highway and intended to continue its southbound path of travel (i.e., both the north and south roadways had three through lanes). The other vehicle was traveling south in the center lane of the same three-lane, southbound roadway; however, its intended path of travel is unknown. According to the case vehicle's driver and an eyewitness, the case vehicle's driver attempted to avoid the crash by steering to the left onto the median shoulder. The crash occurred when the other vehicle changed into the inside southbound lane.

The right rear of the case vehicle was impacted by the left front of the other vehicle (1st event), causing the case vehicle to swerve to the left towards the concrete longitudinal median barrier. The case vehicle's driver then steered back to the right, but struck the barrier with its left rear (2nd event). Next, the case vehicle's driver steered back to the right, but over corrected, and contacted the left side of the other vehicle with its right front (3rd event). The case vehicle's driver then steered back to the left but struck the median barrier with its front left (4th event), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle subsequently rotated approximately 180 degrees counterclockwise before impacting the median barrier with its rear (5th event). The case vehicle continued to rotate counterclockwise, approximately another 60 degrees, and departed the barrier heading southwestward. The case vehicle drifted across the three southbound lanes and impacted a guardrail (6th event) on the west roadside. The case vehicle's primary impact with the concrete longitudinal median barrier was moderate.

The case vehicle's driver [163 centimeters and 73 kilograms (64 inches, 160 pounds)] and the front right passenger [7-year-old female, 122 centimeters and 37 kilograms (48 inches, 81 pounds)] were both restrained by their available, active, three-point, lap-and-shoulder, safety belt systems. An inspection of the case vehicle's driver and front right passenger seat belt webbings and "D"-rings showed evidence of loading. In addition, there were abrasions to the right side of the front right passenger's neck and upper chest from her seat belt webbing.

The case vehicle's driver attempted to avoid the impacts by first steering left into the median's shoulder–away from the other vehicle, and then back to the right, Based on occupant kinematic principles, these avoidance maneuvers caused both occupants to sway first to their right, then back to their left. As a result of these attempted avoidance maneuvers, the use of their available safety belts kept them from getting out-of-position. After the second impact with the other vehicle (3rd event) and the resulting leftward movement, the driver and front right passenger moved slightly forward and to their right just prior to the primary impact with the concrete median barrier (4th event). Based on the vehicle inspection, the case vehicle's primary impact with the concrete barrier, not only deployed the driver's air bag, but thrust the driver forward and slightly upward. The driver's safety belt was fully loaded at this point and kept the driver's forward excursion to a minimum. The driver's safety belt and her deploying air bag, along with the vehicle's counterclockwise rotation off the barrier, then sent the case vehicle's driver back to the left where she hit her left shoulder on the door panel. The vehicle's rear impact with the concrete barrier (5th event) forced the driver further backwards and upwards along the door panel into the "B"-pillar, contacting it with her head causing the bump just above her left ear. After the rear impact with the barrier and the vehicle's subsequent counterclockwise rotation, the driver rebounded back forward still being restrained by her available safety belts. As the driver drifted across the three southbound lanes of traffic, she was still in a relatively good seating position due to her safety belt, and upon impact with the guardrail on the west roadside, she moved slightly forward and to the right prior to rebounding backwards off the loaded restraint and coming to rest.

According to the case vehicle's driver, upon exiting the case vehicle, a bystander pointed out to the case vehicle's driver that her corduroy coat was on fire and told her to take it off. The bystander helped the driver pull off her coat, threw the coat on the ground, and proceeded to stomp out the fire. This contractor was able to acquire the driver's coat and determine that there was a burnt area on the right side toward the bottom of the coat. Furthermore, inspection of the case vehicle revealed that there was a matching burnt area on the right side of the driver's seat cushion. The coat was sent to the agency for examination.

The driver and front right occupant were transported by ambulance to the hospital. Both the driver and the front right occupant sustained minor injuries and were treated and released. According the driver and their medical records, the injuries sustained by the case vehicle's driver included: a contusion to the left side of her head just above the ear, a contusion over her left mandible, a bruised left finger (dorsal aspect), and a sore left shoulder. The injuries sustained by the front right passenger included: a seat belt abrasion across the right side of her neck, angling down from just below the right ear and extending downward onto her chest, and an abrasion to a right finger.

The case vehicle was a front wheel drive 1995 Toyota Corolla DX, four-door sedan (VIN: 1NXAE09B4SZ------). The case vehicle was not equipped with anti-lock brakes. The other vehicle was an unknown make and model automobile. The case vehicle was towed due to damage. The other vehicle drove away from the scene. Based on the vehicle inspection, the CDCs for the case vehicle are: **06-RBES-1**–1st event, **11-LBES-2**–2nd event, **05-RFEW-1**–3rd event, **01-FDEW-2 (20)**–4th event, **07-BDLW-1**–5th event, and **12-FREE-1**–6th event [maximum crush was approximately 26 centimeters (10.2 inches) and occurred during the fourth (deployment) impact. The WinSMASH reconstruction program, barrier algorithm, was used on the highest severity impact to the case vehicle. The Total, Longitudinal, and Lateral Delta V's are, respectively: 20.0

km.p.h. (12.4 m.p.h.), -18.8 km.p.h. (-11.7 m.p.h.), and -6.8 km.p.h. (-4.2 m.p.h). These results appear to be reasonable.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the driver air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was evidence of contact (i.e., eye make-up) to the upper left portion of the air bag. The front right passenger's air bag was located in the middle of the right instrument panel. An inspection of the front right passenger air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points, and there was evidence of contact to the center left (mucous) and to the center right (black skin flakes) portions. Neither the driver nor the front right passenger air bag modules's cover flaps showed any evidence of contact. As instructed, this contractor removed the case vehicle's air bag modules and air bags and sent them to the agency for examination.

Immediately prior to the crash, the case vehicle's driver was seated slightly reclined with her back against the seat back, her left foot on the floor, her right foot on the brake, her right hand on the steering wheel rim, and her left hand on the arm rest. Her seat track was located between its middle and forward-most positions, her seat back was sightly reclined, and her tilt steering wheel was located in its down-most position.

According to the case vehicle's driver, immediately prior to the crash the front right passenger (7-year-old daughter) was seated slightly reclined with her back against the seat back, both feet hanging down over the front edge of the seat, and both hands on her lap. Her seat track was located in between its middle and forward-most positions.

TRC/IU ON-SITE AIR BAG INVESTIGATION

TRC/IU CASE NO. IN97-011

VEHICLE - 1995 TOYOTA COROLLA DX
LOCATION - ILLINOIS

CRASH DATA

Location/Street:	U.S. Interstate
State:	Illinois
Area/Type:	Urban, residential
Crash Date/Time:	Month, 1997, @ 6:20 p.m.
Investigating Police Agency:	State police
Crash Type:	Car / Unknown vehicle - acute angle
Occupant Injury Severity (air bag vehicle):	Contusion left mandible (AIS-1)

AMBIENT CONDITIONS

Light Conditions:	Darkness, lighted
Weather Condition:	Clear
Precipitation:	None
Road Surface:	Dry
Temperature:	36 degrees F (2 degrees C) @ nearest metropolitan airport

ROADWAY

	Case Vehicle	**Other Vehicle**
Location:	Interstate highway	Interstate highway
Number of Travel Lanes:	Six-lane, divided trafficway (north and south roadways each had three through lanes	Six-lane, divided trafficway (north and south roadways each had three through lanes
Lane Width:	3.8 meters (12.6 feet) for inside southbound lane	3.8 meters (12.6 feet) for inside southbound lane
Surface Type:	Bituminous	Bituminous
Median:	Paved with concrete longitudinal barrier	Paved with concrete longitudinal barrier
Shoulders:	3.5 meters (11.6 feet) on both east and west sides	3.5 meters (11.6 feet) on both east and west sides
Vertical alignment:	Level per Police Crash Report	Level per Police Crash Report

ROADWAY (Continued)

	Case Vehicle	Other Vehicle
Horizontal alignment:	Straight	Straight
Estimated Coefficient of Friction:	.70	.70
Traffic Density:	Light	Light

TRAFFIC CONTROLS

	Case Vehicle	Other Vehicle
Signals:	None	None
Signs:	Regulatory SPEED LIMIT sign	Regulatory SPEED LIMIT sign
Markings:	Solid yellow edge line on east, dash white lane lines	Solid yellow edge line on east, dash white lane lines
Speed Limit:	89 km.p.h. (55 m.p.h.)	89 km.p.h. (55 m.p.h.)

VEHICLES

	Case Vehicle	Other Vehicle
Year:	1995	Unknown
Make:	Toyota	Unknown, hit-and-run vehicle
Model:	Corolla DX	Unknown
Body Type:	Four-door sedan, five passenger	Unknown
V.I.N.	1NXAE09B4SZ------	Unknown
Color:	Copper	Green, per Police Crash Report
Mileage:	37,939 km (23,574 miles)	Unknown
Engine:	1.6 liters, I-4	Unknown
Transmission:	Three-speed automatic	Unknown
Steering:	Power-assisted, rack-and-pinion	Unknown
Brakes:	Power-assisted, four-wheel disc	Unknown
Padding:	Steering wheel and hub, sun visors, dash, "A"-pillars, side door surfaces	Unknown
Active Restraints:	Three-point, manual, lap and shoulder belts in front and rear outboard seating positions; lap belt only at rear center position	Unknown

VEHICLES (Continued)

	Case Vehicle	Other Vehicle
Passive Restraints:	Factory installed driver and front right passenger supplemental restraint systems (air bags)	Unknown
Anti-lock brakes:	Optional four-wheel anti-lock brakes	Unknown
Defects:	None	Unknown
Fleet:	Private vehicle	Unknown
Tow status:	Towed due to damage	Left scene

VEHICLE DAMAGE[1]

EXTERIOR	Case Vehicle
Deployment Impact	
Event number:	Four
Object Struck:	Concrete longitudinal barrier
Damage location	
Damaged Plane:	Front
Vertical Location	
On Plane:	Bumper level
Direct Begins:	At left bumper corner
Length Direct:	138.0 cm (54.3 in)
Field L:	146.0 cm (57.5 in)
C_1:	26.0 cm (10.2 in)
C_2:	18.0 cm (7.1 in)
C_3:	15.0 cm (5.9 in)
C_4:	11.0 cm (4.3 in)
C_5:	6.0 cm (2.4 in)
C_6:	4.0 cm (1.6 in)
D:	-4.0 cm (-1.6 in)
Maximum Crush:	26.0 cm (10.2 in)
Location:	C_1
CDC:	01-FDEW-2 (20)
Damaged Components:	Bumper, grille, left and right headlight assemblies, and hood

[1] This contractor was given a minimal amount of time to inspect this case vehicle by the body shop at which the vehicle was stored. This contractor focused on the frontal impact which caused the case vehicle's air bags to deploy. In addition, only the front of the vehicle was readily assessable.

VEHICLE DAMAGE (Continued)

EXTERIOR	**Case Vehicle**	**Other Vehicle**
1st Non-deployment Impact		
Event number:	One	One
Object Struck:	Other vehicle	Case vehicle
Damage location		
Damaged Plane:	Right	Left
Vertical Location		
On Plane:	Above sill	Above sill
Direct Begins:	Not measured	Unknown
Length Direct:	49.0 cm (19.3 in)	Unknown
Field L:	Not measured	Unknown
C_1:	Not measured	Unknown
C_2:	Not measured	Unknown
C_3:	Not measured	Unknown
C_4:	Not measured	Unknown
C_5:	Not measured	Unknown
C_6:	Not measured	Unknown
D:	Not measured	Unknown
Maximum Crush:	3.0 cm (1.2 in)	Unknown
Location:	Unknown	Unknown
CDC:	06-RBES-1	Unknown
Damaged Components:	Right quarter panel	Unknown
3rd Non-deployment Impact		
Event number:	Three	Three
Object Struck:	Other vehicle	Case vehicle
Damage location		
Damaged Plane:	Right	Left
Vertical Location		
On Plane:	Sill and above	Unknown
Direct Begins:	Masked damage	Unknown
Length Direct:	40.0 cm (15.7 in)	Unknown
Field L:	Masked damage	Unknown
C_1:	Masked damage	Unknown
C_2:	Masked damage	Unknown
C_3:	Masked damage	Unknown
C_4:	Masked damage	Unknown
C_5:	Masked damage	Unknown
C_6:	Masked damage	Unknown
D:	Masked damage	Unknown
Maximum Crush:	~6.0 cm (2.4 in)	Unknown
Location:	Masked damage	Unknown

VEHICLE DAMAGE (Continued)

EXTERIOR (Continued)	**Case Vehicle**	**Other Vehicle**
3rd Non-deployment Impact		
CDC:	05-RFEW-1	Unknown
Damaged Components:	Right front fender	Unknown
2nd Non-deployment Impact		
Event number:	Two	
Object Struck:	Concrete barrier	
Damage location		
Damaged Plane:	Left	
Vertical Location		
On Plane:	Sill and above	
Direct Begins:	Left rear bumper corner	
Length Direct:	Not measured	
Field L:	Not measured	
C_1:	Not measured	
C_2:	Not measured	
C_3:	Not measured	
C_4:	Not measured	
C_5:	Not measured	
C_6:	Not measured	
D:	Not measured	
Maximum Crush:	Not measured	
Location:	Not measured	
CDC:	**11-LBES-2**	
Damaged Components:	Left quarter panel	
4th Non-deployment Impact		
Event number:	Five	
Object Struck:	Concrete barrier	
Damage location		
Damaged Plane:	Back	
Vertical Location		
On Plane:	Bumper level	
Direct Begins:	Back left bumper corner	
Length Direct:	146.0 cm (57.5 in)	
Field L:	146.0 cm (57.5 in)	
C_1:	Not measured	
C_2:	Not measured	
C_3:	Not measured	
C_4:	Not measured	

VEHICLE DAMAGE (Continued)

EXTERIOR (Continued)	**Case Vehicle**
4th Non-deployment Impact	
C_5:	Not measured
C_6:	Not measured
D:	Not measured
Maximum Crush:	13.0 cm (5.1 in)
Location:	Unknown
CDC:	**07-BDLW-1**
Damaged Components:	Back bumper
5th Non-deployment Impact	
Event number:	Six
Object Struck:	"W" beam longitudinal barrier (guardrail)
Damage location	
Damaged Plane:	Front
Vertical Location	
On Plane:	Bumper level and above
Direct Begins:	At front right bumper corner
Length Direct:	24.0 cm (9.4 in)
Field L:	Masked damage
C_1:	Masked damage
C_2:	Masked damage
C_3:	Masked damage
C_4:	Masked damage
C_5:	Masked damage
C_6:	Masked damage
D:	Masked damage
Maximum Crush:	6.0 cm (2.4 in)
Location:	C_6
CDC:	**12-FREE-1**
Damaged Components:	Front bumper, right headlight assembly

INTERIOR	**Case Vehicle**
Damaged Components:	Driver and front right passenger air bag modules
Other Evidence of	
Occupant Contact:	Knee bolsters
Manual Restraint	
System Failures:	None
Seat Performance	
Failures:	None

VEHICLE DAMAGE (Continued)

REPAIR

Cost Estimate: $ 13,633

VEHICLE VELOCITY ESTIMATES

HIGHEST DELTA "V"	**Case Vehicle**
Reconstruction Program:	WinSMASH
Program Algorithm:	Barrier algorithm
Barrier Equivalent Delta V:	20 km.p.h. (12 m.p.h.)
Total Delta "V":	20 km.p.h. (12 m.p.h.)
Longitudinal Delta "V":	-19 km.p.h. (-12 m.p.h.)
Lateral Delta "V":	-7 km.p.h. (-4 m.p.h.)

COLLISION SEQUENCE

The following is based on the Police Crash Report, interviews with the case vehicle's driver, scene and vehicle inspections, occupant medical records, and this contractor's evaluation of the evidence.

PRE-CRASH: The case vehicle (Corolla) was traveling south in the inside lane on a six-lane, divided, Interstate highway and intended to continue its southbound path of travel (i.e., both the north and south roadways had three through lanes). The other vehicle was traveling south in the center lane on the same three-lane, southbound roadway, and its intended path of travel is unknown. According to the case vehicle's driver and an eyewitness, the case vehicle's driver attempted to avoid the crash by steering to the left onto the median shoulder. The case vehicle was straddling the east shoulder just prior to impact. It is unknown if the driver of the other vehicle made any pre-crash avoidance maneuvers. The other vehicle continued southbound while changing lanes, just prior to impact, from the center to the inside through lanes. The crash occurred when the other vehicle changed into the inside southbound lane.

CRASH: The right rear of the case vehicle was impacted by the left front of the other vehicle (1st event), causing the case vehicle to swerve to the left towards the concrete longitudinal median barrier. The case vehicle's driver then steered back to the right, but struck the barrier with its left rear (2nd event). Next, the case vehicle's driver steered back to the right, but over corrected, and contacted the left side of the other vehicle with its right front (3rd event). The case vehicle's driver then steered back to the left but struck the median barrier with its front left (4th event), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle subsequently rotated approximately 180 degrees counterclockwise before impacting the median barrier with its back (5th event). The case vehicle continued to rotate counterclockwise, approximately another 60 degrees, and departed the barrier heading southwestward. The case

COLLISION SEQUENCE (Continued)

CRASH: (Continued)

vehicle drifted across the three southbound lanes and impacted a guardrail (6th event) on the west roadside.

POST-CRASH:

Occupants: The case vehicle's driver and front right passenger remained inside the vehicle at final rest. Both occupants were conscious and able to exit the case vehicle without any assistance. The case vehicle's driver and front right passenger were restrained by their available, active, three-point, lap-and-shoulder, safety belt systems.

Upon exiting the case vehicle, a bystander pointed out to the case vehicle's driver that her coat was on fire, and the bystander told her to take it off. The bystander helped the driver pull off her coat, and the bystander threw the coat on the ground and proceeded to stomp out the fire. This contractor acquired the coat and air bags from the case vehicle's driver and determined that there was a burnt area on the right side toward the bottom of the coat. Furthermore, inspection of the case vehicle revealed that there was a matching burnt area on the right side of the driver's seat cushion; see **CASE PHOTOGRAPHS #28** through **#31**. The coat was sent to the agency for testing. The coat was shipped prior to being photographed.

Police: The investigating police agency was notified of the crash within three minutes post-crash and arrived on-scene an unknown amount of time later. Traffic control procedures were established and emergency medical and towing services were called to assist.

Rescue: The driver and front right passenger were transported by ambulance to a hospital where they both were treated and released. Both the driver and the front right occupant sustained minor injuries. According the driver and their medical records, the injuries sustained by the case vehicle's driver included: a contusion to the left side of her head just above the ear, a contusion over her left mandible, a bruised left finger (dorsal aspect), and a sore left shoulder. The injuries sustained by the front right passenger included: a seat belt abrasion across the right side of her neck, angling down from just below the right ear and extending downward onto her chest, and an abrasion to a right finger.

Removal: Following the police investigation, the case vehicle was towed from the scene. The other vehicle fled the scene without being identified.

HUMAN FACTORS/OCCUPANT DATA

CASE VEHICLE:	**Driver**	**Front Right Passenger**
Age:	26 year-old	7 year-old
Sex:	Female	Female

HUMAN FACTORS/OCCUPANT DATA (Continued)

CASE VEHICLE:	**Driver**	**Front Right Passenger**
Height:	157 cm (68 in)	124 cm (49 in)
Weight:	68 kg (150 lbs)	37 kg (81 lbs)
Occupation:	Hair stylist	Not applicable
Active Restraint System/Usage:	Three-point, lap-and-shoulder/Used	Three-point, lap-and-shoulder/Used
Usage Source:	Vehicle inspection, interviewee, and Police Crash Report	Vehicle inspection, interviewee, and Police Crash Report
Passive Restraint System/Usage:	Factory installed air bag/air bag deployed	Factory installed air bag/air bag deployed
Usage Source:	Vehicle inspection, interviewee, and Police Crash Report	Vehicle inspection, interviewee, and Police Crash Report
Eyeglasses/contacts:	Prescription glasses	None
Vehicle Familiarity:	16,093 km (10,000 mi) in last twelve months	Not applicable
Route Familiarity:	Very infrequently	Not applicable
Trip Plan:	Parents house to home	Not applicable
Manner of Leaving Scene:	Ambulance	Ambulance
Type of Medical Treatment:	Treated and released	Treated and released

CASE VEHICLE DRIVER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion left temporal scalp	190402.1 minor	Left roof rail	Probable	Emergency room records
2	Contusion over left mandible	290402.1 minor	Air bag, driver's side	Probable	Emergency room records
3	Contusion to left fifth finger	790402.1 minor	Interior surface left front door	Possible	Interviewee (driver)

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Abrasion right neck[2], angling down partially across chest	390202.1 minor	Shoulder belt portion of safety belt	Probable	Interviewee (driver)
2	Abrasion right second {index} finger[2]	790202.1 minor	Air bag, front right	Possible	Interviewee (driver)

CASE VEHICLE DRIVER KINEMATICS

The following is based on the interview with the case vehicle's driver, the vehicle inspection, and occupant kinematic principles. Immediately prior to the crash, the case vehicle's driver was seated slightly reclined with her back against the seat back, her left foot on the floor, her right foot on the brake, her right hand on the steering wheel rim, and her left hand on the arm rest. Her seat track was located between its middle and forward-most positions, her seat back was sightly reclined, and her tilt steering wheel was located in its down-most position. The case vehicle's driver told police and this investigator that she had been wearing her available, active, three-point, lap-and-shoulder, safety belt system. An inspection of the case vehicle's driver seat belt webbing and "D"-ring showed evidence of loading; see **CASE PHOTOGRAPHS #32** and **#33**.

The case vehicle's driver steered to the left, straddling the median shoulder in an attempt to avoid the other vehicle. Based on occupant kinematic principles, this avoidance maneuver and the use of her available safety belts, most likely caused the driver to sway slightly to her right just prior to impact.

The case vehicle's glancing impact from the other vehicle (1st event), caused the case vehicle to veer farther to the left and the driver to steer back to the right, attempting to avoid the concrete longitudinal barrier in the medium. Despite this second avoidance maneuver, the case vehicle struck the median barrier (2nd event) with its left rear and rebounded. Again, the driver steered to the right, but her steering resulted in an over correction which caused the case vehicle to reenter the inside southbound lane and strike the left side of the other vehicle. Based on occupant kinematic principles, both right steering maneuvers caused the driver to sway back to her left. As a result of these attempted avoidance maneuvers (i.e., left steering followed by right steering), the use of her available safety belts kept the driver from getting out-of-position.

After the second impact with the other vehicle (3rd event) and the resulting leftward movement, the driver moved slightly forward and to her right just prior to the case vehicle's primary impact with the concrete median barrier (4th event). Based on the vehicle inspection, the case vehicle's primary impact with the concrete barrier, not only deployed the driver's air bag, but thrust the driver forward and slightly upward and to her right toward the **20** degree Direction of Principal Force. The driver's safety belt was fully loaded at this point and kept the driver's forward

[2] Medical records were obtained for this occupant with her records only reporting her complaints of pain. The recorded ICD.9.CM codes only pertained to pain as well; however, the anatomical locations of her pain correspond with the interviewee's reported lesions.

CASE VEHICLE DRIVER KINEMATICS (Continued)

excursion to a minimum and the driver in a relatively good driving position. The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was evidence of contact (i.e., eye make-up) to the upper left portion of the air bag; see **CASE PHOTOGRAPHS #22** and **#24**. The driver air bag modules's cover flaps showed no visible evidence of contact; see **CASE PHOTOGRAPHS #25** and **#26**. The only other visible evidence of contact by the driver was a scuff to the left knee bolster, presumably by the driver's left knee; see **CASE PHOTOGRAPH #27**.

As the case vehicle reached maximum engagement it rotated approximately 180 degrees counterclockwise off the barrier before striking the barrier again with its back. The driver's safety belt and her deploying air bag, along with the vehicle's counterclockwise rotation off the barrier, sent the case vehicle's driver back to the left where she hit her left shoulder on the door panel. The vehicle's rear impact with the concrete barrier (5th event) forced the driver further backwards and upwards along the door panel into the "B"-pillar, contacting it with her head causing the bump just above her left ear. After the rear impact with the barrier, the case vehicle continued to rotate counterclockwise, approximately 140 degrees. As a result of the vehicle's subsequent counterclockwise rotation, the driver rebounded back forward still being restrained by her available safety belts. As the case vehicle drifted across the three southbound lanes of traffic, she was still in a relatively good seating position due to her safety belt, and upon impact with the guardrail on the west roadside, she moved slightly forward and to the right prior to rebounding backwards and coming to rest in her seat back.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

Based on the interview with the case vehicle's driver (i.e., mother), the vehicle inspection, and occupant kinematic principles, immediately prior to the crash the front right passenger (7-year-old daughter) was seated slightly reclined with her back against the seat back, both feet hanging down over the front edge of the seat, and both hands on her lap. Her seat track was located in between its middle and forward-most positions. According to the driver's interview and this occupant's medical records, she was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. An inspection of the front right passenger seat belt webbing and "D"-ring showed evidence of loading on the webbing; see **CASE PHOTOGRAPH #43**. In addition, there were abrasions to the right side of the front right passenger's neck and upper chest from her seat belt webbing.

As a result of the case vehicle's attempted avoidance maneuver (i.e., left steering) and the use of her available safety belts, the right front passenger most likely swayed slightly to her right just prior to impact.

The case vehicle's glancing impact from the other vehicle (1st event), caused the case vehicle to veer farther to the left and the driver to steer back to the right, attempting to avoid the concrete longitudinal barrier in the medium. Despite this second avoidance maneuver, the case vehicle struck the median barrier (2nd event) with its left rear and rebounded. Again, the driver steered to the right, but her steering resulted in an over correction which caused the case vehicle to reenter

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS (Continued)

the inside southbound lane and strike the left side of the other vehicle. Based on occupant kinematic principles, both of the driver's right steering maneuvers caused the front right passenger to sway back to her left. As a result of these attempted avoidance maneuvers (i.e., left steering followed by right steering), the use of her available safety belts kept the front right passenger from getting out-of-position.

After the second impact with the other vehicle (3rd event) and the resulting leftward movement, the front right passenger moved slightly forward and to her right just prior to the case vehicle's primary impact with the concrete median barrier (4th event). Based on the vehicle inspection, the case vehicle's primary impact with the concrete barrier, not only deployed the front right passenger's air bag, but thrust the front right passenger forward and slightly upward and to her right toward the **20** degree Direction of Principal Force. The front right passenger's safety belt was fully loaded at this point and kept the passenger's forward excursion to a minimum and the front right passenger in a relatively good seating position. The front right passenger's air bag was located in the middle {i.e., mid-front} of the instrument panel. An inspection of the air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points, and there was evidence of contact to the center left (mucous) and to the center right (black skin flakes) portions; see **CASE PHOTOGRAPHS #35** through **#37**. The front right passenger air bag modules's cover flap showed no visible evidence of contact; see **CASE PHOTOGRAPH #38**. The only other visible evidence of contact by the front right passenger was a scuff to the glove box/knee bolster, presumably by the front right passenger's feet; see **CASE PHOTOGRAPH #41**.

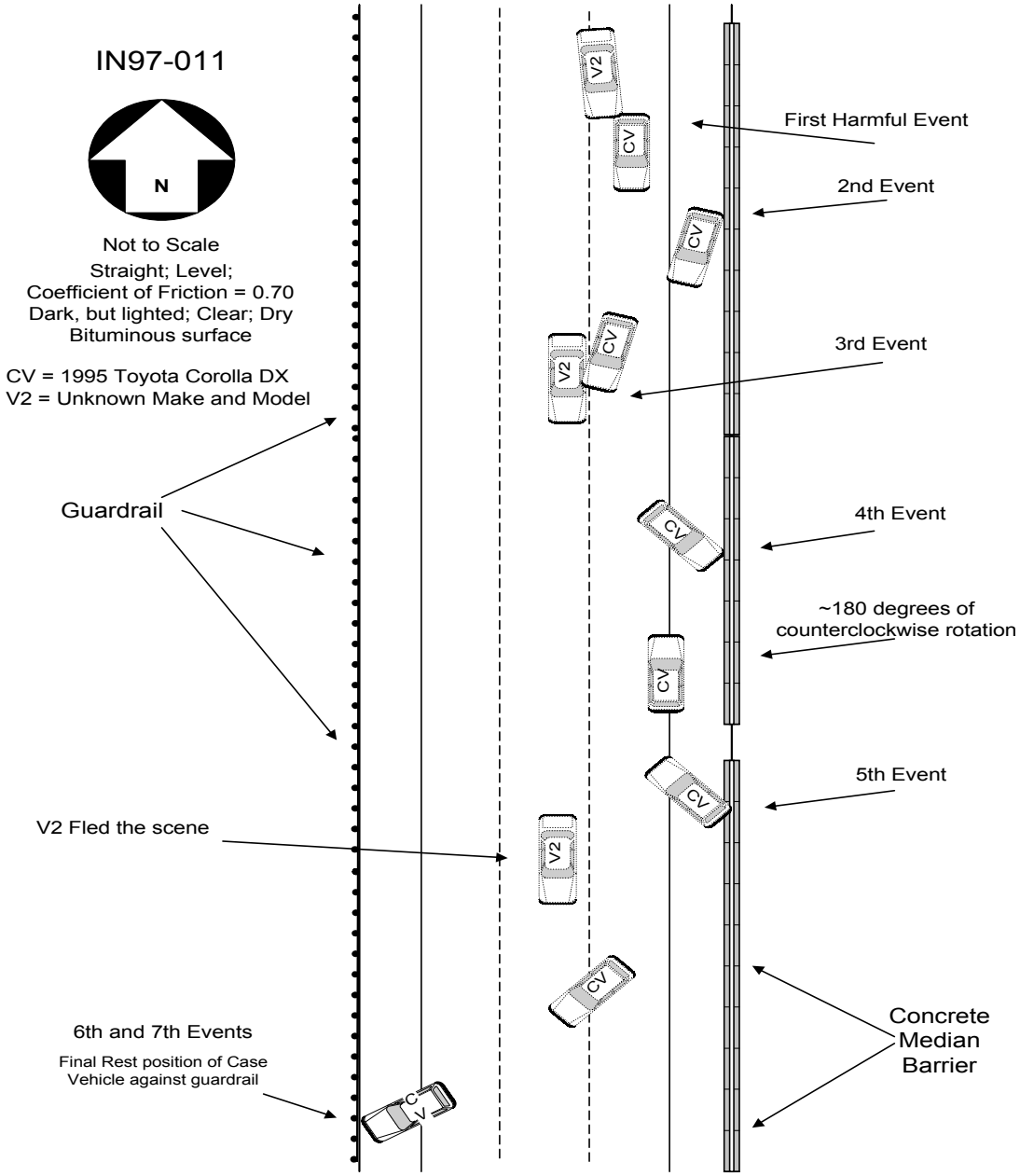
As the case vehicle reached maximum engagement it rotated approximately 180 degrees counterclockwise off the barrier before striking the barrier again with its back. The front right passenger's safety belt and her deploying air bag, along with the vehicle's counterclockwise rotation off the barrier, sent the passenger back to the left where she hit her seat back with the back left side of her head. The vehicle's rear impact with the concrete barrier (5th event) forced the front right passenger further backwards and upwards along her seat back. After the rear impact with the barrier, the case vehicle continued to rotate counterclockwise, approximately 140 degrees. As a result of the vehicle's subsequent counterclockwise rotation, the front right passenger rebounded back forward still being restrained by her available safety belts. As the case vehicle drifted across the three southbound lanes of traffic, she was still in a relatively good seating position due to her safety belt, and upon impact with the guardrail on the west roadside, she moved slightly forward and to the right prior to rebounding backwards and coming to rest in her seat back.

CASE VEHICLE AIR BAG SYSTEM

	DRIVER AIR BAG	**FRONT RIGHT AIR BAG**
Air Bag Diameter (seam-to-seam, deflated):	Diameter: 65 cm (25.6 in)	Width: 55 cm (21.7 in) Height: 54 cm (21.3 in)
Number of Vent Holes:	Two	Two
Vent Hole Diameter:	2.5 cm (1.0 in)	4.5 cm (1.8 in)

CASE VEHICLE AIR BAG SYSTEM (Continued)

	DRIVER AIR BAG	FRONT RIGHT AIR BAG
Vent Hole Clock Positions:	Approximately 11 and 1 o'clock	Approximately 8:30 and 3:30 o'clock positions
Number of Air Bag Tethers:	None	None
Number of Air Bag Module Cover Flaps:	Two	One
Upper Cover Flap Dimensions:	Width: 15 cm (5.9 in) Height: 7 cm (2.8 in)	Width: 36 cm (14.2 in) Height: 15 cm (5.9 in)
Lower Cover Flap Dimensions:	Width: 15 cm (5.9 in) Height: 7 cm (2.8 in)	Not applicable
Distance between Dash and leading (i.e., closest) edge of Module's Cover Flap:	**Not applicable**	Even with dash
Mount Location:	Steering wheel hub	Mid instrument panel
Generant Residue:	No unusual amount found	No unusual amount found


IN97-011
N
Not to Scale
Straight; Level;
Coefficient of Friction = 0.70
Dark, but lighted; Clear; Dry
Bituminous surface
CV = 1995 Toyota Corolla DX
V2 = Unknown Make and Model
Guardrail
V2 Fled the scene
6th and 7th Events
Final Rest position of Case Vehicle against guardrail
First Harmful Event
2nd Event
3rd Event
4th Event
~180 degrees of counterclockwise rotation
5th Event
Concrete Median Barrier
V2
CV