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ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN-03-009
LOCATION - MARYLAND
VEHICLE - 2003 FORD EXPLORER EDDIE BAUER
CRASH DATE - January 2003

Submitted:

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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.

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16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 2003 Ford Explorer (case vehicle) and a 1997 Chevrolet K1500 pickup (other vehicle). This crash is of special interest because the case vehicle's second seat center passenger (1-year-old, female) was seated in a child safety seat and was reported to have sustained police-reported "A" (incapacitating) injuries during the crash. The trafficway on which both vehicles had been traveling was a five-lane, divided, state highway, traversing in a north-northwesterly and south-southeasterly direction, and both the case vehicle and the Chevrolet were approaching a four-leg intersection. Both the northern and southern roadways were gently curved and had two through lanes and one left-hand turn lane. The case vehicle had been traveling in the left-hand turn lane of the northern roadway and had nearly completed making a left-hand turn. The Chevrolet was traveling in the outside through lane of the southern roadway. The crash occurred in the outside through lane of the southern roadway, within the four-leg intersection of the two trafficways. The right side of the case vehicle was impacted by the front of the Chevrolet. The case vehicle's redesigned driver and front right passenger supplemental restraints (air bags) did not deploy. The Chevrolet's impact with the case vehicle caused the case vehicle to roll about its longitudinal axis, landing on its left side as the case vehicle continued in its westerly travel path. The case vehicle continued to roll, one more quarter turn, landing on its top, across the centerline in the easterly lane, heading in a westerly direction. The case vehicle's second seat center passenger was restrained in a child safety seat and was seated in a 40/20/40 split/folding seat whose seat back was not adjustable. The child safety seat was secured by her available, active, three-point, lap-and-shoulder, safety belt system. According to her medical records and the interview with the case vehicle's driver, she did not sustain any injuries as a result of this crash. The case vehicle's driver (28-year-old, female) was seated with her seat track located in its middle position, and the tilt steering wheel was located in its middle position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to her interview and her medical records, a moderate laceration to her left forearm when her arm contacted the roadway during the rollover.

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This on-site investigation was brought to NHTSA's attention on February 26, 2003 by NASS CDS sampling activities. This crash involved a 2003 Ford Explorer (case vehicle) and a 1997 Chevrolet K1500 pickup (other vehicle). The crash occurred in January 2003 at 7:04 a.m. in Maryland and was investigated by the applicable state police department. This crash is of special interest because the case vehicle's second seat center passenger [1-year-old, Black (non-Hispanic) female] was seated in a child safety seat and reported to have sustained police-reported "A" (incapacitating) injuries during the crash. This contractor inspected the scene and vehicles on 6-7 March 2003. This contractor interviewed the driver for the case vehicle on March 6, 2003. This report is based on the Police Crash Report, an interview with the case vehicle's driver, scene and case vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which both vehicles had been traveling was a five-lane, divided, state highway, traversing in a north-northwesterly and south-southeasterly direction, and both the case vehicle and the Chevrolet were approaching a four-leg intersection. Both the northern and southern roadways were gently curved and had two through lanes and one left-hand turn lane; the northern roadway curved to the right and the southern roadway to the left. Furthermore, and not counted among the lanes, each roadway had a channelized right-hand turn lane. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was a combination of rural residential and commercial; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle had been traveling north-northwestward in the left-hand turn lane of the northern roadway on the southern leg of the four-leg intersection and had nearly completed making a left-hand turn, intending to travel in a westerly direction on the intersecting trafficway. The Chevrolet was traveling south-southeastward in the outside through lane of the southern roadway on the northern leg of the same intersection and intended to continue straight ahead. According to the case vehicle's driver, she steered to the left, attempting to avoid the crash. The crash occurred in the outside through lane of the southern roadway, within the four-leg intersection of the two trafficways.

Crash: The right side of the case vehicle was impacted by the front of the Chevrolet. The case vehicle's redesigned driver and front right passenger supplemental restraints (air bags) did not deploy.

Post-Crash: The Chevrolet's impact with the case vehicle caused the case vehicle to roll about its longitudinal axis, landing on its left side as the case vehicle continued in its westerly travel path. The case vehicle continued to roll, one more quarter turn, landing on its top, across the centerline in the easterly lane, heading in a westerly direction.

Case Vehicle: The 2003 Ford Explorer Eddie Bauer edition was a rear wheel drive (4x2), four-door sport utility vehicle (VIN: 1FMZU64K23U------). The case vehicle was equipped with four-

wheel, anti-lock brakes. In addition, the case vehicle was equipped with **A**dvanced **O**ccupant **P**rotection **S**ystem (AOPS) features including redesigned air bags and power adjustable pedals, as well as an **E**vent **D**ata **R**ecorder (EDR). The case vehicle was not equipped with the optional safety canopy air curtain system or the stability enhancement system.

Vehicle Exterior: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **03-RYEW-2** (**80** degrees) for the impact with the Chevrolet and **00-TYDO-3** for the rollover impact. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 16.0 km.p.h. (9.9 m.p.h.), -2.8 km.p.h. (-1.7 m.p.h.), and -15.8 km.p.h. (-9.8 m.p.h.). The case vehicle was towed due to damage.

Exterior Damage: The case vehicle's contact with the Chevrolet involved primarily its right passenger area. Direct damage began 17 centimeters (6.7 inches) forward of the right rear axle and extended 219 centimeters (86.2 inches), along the right side mid-door level toward the front of the vehicle. Maximum crush was measured as 19 centimeters (7.5 inches) at C_4. The case vehicle's wheelbase was essentially unaltered from the crash. The case vehicle's right front and rear doors and right fender were directly damaged and crushed inward from the impact with the Chevrolet. The case vehicle's left quarter panel, left outside rearview mirror, left front and rear doors, left fender, roof, and hood were directly damaged during the rollover event and crushed inward or downward. There was induced damage to both the right and left front door glazings, the windshield's glazing, and the right outside rearview mirror. The right roof side rail was buckled inward. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior. The recommended tire size was: P245/65R17, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table below. None of the case vehicle's tires were damaged, deflated, or physically restricted.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	193	28	207	30	10	13	None	No	No
RF	62	9	207	30	10	13	None	No	No
LR	228	33	241	35	10	13	None	No	No
RR	193	28	241	35	10	13	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed lateral intrusion to both right interior door surfaces and the right "B"-pillar. Furthermore, there was vertical intrusion to both "A"-pillars, the windshield and roof over the front seating area, and both right and left front roof side rails. There was a hair on the roof over the driver's seating position, and an extensive smear of blood over the left and center second seating area. Finally, there was no evidence of

compression of the energy absorbing shear capsules in the base of the steering column and no deformation to the steering wheel rim.

Supplemental Restraints: The case vehicle's driver air bag was located in the steering wheel hub. The front right passenger's air bag was located in the middle of the instrument panel. Neither front air bag deployed as a result of this crash.

Child Safety Seat: The second seat center passenger was seated in a convertible child safety seat that was used in its forward facing configuration. The child safety seat was manufactured by Century but the label containing the date of manufacture was missing. The child seat was identified by Model name"3000 STE" and Model number **44331BEN**. The convertible seat was designed with a pullover tray-shield which attached between the child's legs into a recessed buckle. The seat had a top tether which was not in use, and there were three sets of slots to thread the harness through. The harness belts were threaded through the middle slots, which according to the manufacturer's instructions should only be used when the seat is in the rear facing configuration. The child seat was used in the forward facing configuration, in the upright position.

The convertible child safety seat consisted of a plastic one-piece shell and pullover shield. According to the case vehicle's inspection, the latch plate for this seating position's safety belt was the "sliding" type. The case vehicle's safety belt system had a switchable retractor. The case vehicle's driver indicated that she had read the child seat's instruction manual and the vehicle's manual on installation of a child safety seat using the vehicle's seat belts. The driver indicated that she had installed the child seat and had placed the child in the seat prior to the crash. The driver does not recall doing anything to lock the vehicle's seat belt while securing the child restraint. Therefore, it is unknown which mode the safety belt was in prior to the crash [i.e., **Automatic Locking Retractor** (ALR) mode versus **Emergency Locking Retractor** (ELR) mode]. The driver indicated that the child seat was "tight" and that no "locking clip" was used on this passenger's safety belt.

A close inspection of the child safety seat revealed no apparent damage or fractures to the base, shell, or shield. In addition, no damage or fractures were noted along the seat's path for the vehicle's safety belt. There was a manufacturer's label affixed to the left side (i.e., inboard side when used in the forward facing configuration) giving the child seat's weight limitations [i.e., up to 9-10 kilograms (20-22 pounds) for rear facing and 9-18 kilograms (20-40 pounds) for forward facing].

Another manufacturer's label was affixed to the right side (i.e., outboard side when used in the forward facing configuration) of the child safety seat which explained the importance of securing the child restraint with a vehicle's safety belt as specified in the vehicle manufacturer's instructions. The manufacturer's instructions for this child safety seat were not available on the back of the seat at the time of this contractor's inspection.

Both sides had labels that illustrated the proper way to install the vehicle's safety belts when the child safety seat was used in the forward facing configuration. None of the labels had any dates that were visible on the label.

Crash Data Recording: Permission was obtained to download the data from the **R**estraints **C**ontrol **M**odule, which houses the **EDR** technology. The RCM was located underneath the center console's carpeting. The download was attempted by this contractor's sponsor. Unfortunately, the data was either not able to be downloaded, or there was no data available from the **RCM**.

Other Vehicle: The 1997 Chevrolet K1500 was a four wheel drive (4x4), two-door, extended cab, pickup truck (VIN: 1GCEK19R1VE------). Four wheel, anti-lock brakes are standard on the Chevrolet pickup.

Exterior Damage: With no available vehicle photographs, the CDC for the Chevrolet is not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Chevrolet's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.0 km.p.h. (9.3 m.p.h.), -14.8 km.p.h. (-9.2 m.p.h.), and +2.6 km.p.h. (+1.6 m.p.h.). The Chevrolet were was towed due to damage.

Case Vehicle's Second Seat Center Passenger: Immediately prior to the crash the case vehicle's second seat center passenger [1-year-old, Black (non-Hispanic) female; 76 centimeters and 11 kilograms (30 inches, 24 pounds)] was restrained in a child safety seat and was seated in an upright posture with her back against the back of the child safety seat with her feet dangling over the front edge of the child safety seat's cushion, angled downward. In addition, the exact position of her hands is unknown but, according to the case vehicle's driver (i.e., mother), the child had a candy bar in her hands just prior to the crash. There was no seat track and, although the second seat had a 40/20/40 split/folding seat, the seat back was not adjustable.

The child safety seat for the case vehicle's second seat center passenger (i.e., driver's daughter) was secured by her available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of bruising and/or abrasions from the child seat's harness belt to the second seat center passenger's body, but the inspection of the second seat center passenger's integrated seat belt webbing and latch plate showed trace evidence of loading on the webbing (i.e., a crease).

According to the case vehicle's driver, she steered to the left, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts in conjunction with her convertible child safety seat, the second seat center passenger most likely moved slightly forward and to her right just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's child passenger to continue slightly forward and rightward along a path opposite the case vehicle's **80** degree Direction of Principal Force as the case vehicle decelerated. As a result the child passenger loaded her harness straps and the right side of her tray shield, while simultaneously the occupied child seat loaded her safety belts which, taken together, enabled this child passenger to remain within her child seat. The case vehicle rolled over onto its left side as a result of its collision with the Chevrolet and continued to roll leftward coming to rest on its top. As a result of the rollover impact, the second seat center passenger's child safety seat, as well as the child passenger, most likely rebounded slightly forward and to the left as the vehicle began to roll about its longitudinal axis. As the case vehicle rolled onto its top, the child safety seat and passenger most likely moved back toward the right and

eventually came to rest upside down, held in place by the safety belts of the second seat center's seating position. Because of her restraint use and the use of the vehicle's safety belts, the child passenger remained within the child safety seat where she came to rest with her head pointed downward. According to the interview with the case vehicle's driver, the child was removed from the vehicle with some assistance, most likely by the driver (i.e., her mother). Blood evidence was found on the harness straps of the child safety seat. In this contractor's opinion, this blood was most likely from the mother and was deposited by the mother when she removed the child safety seat and child from the vehicle. According to the child's medical records, she arrived at the hospital still strapped in the child safety seat.

The second seat center occupant was transported by ambulance to the hospital. She was examined for injuries and was released. The case vehicle's second seat center passenger did not sustain any injuries as a result of this crash.

Case Vehicle's Driver: According to the case vehicle's driver [28-year-old, Black (non-Hispanic) female; 170 centimeters and 70 kilograms (67 inches, 155 pounds)] she was seated in reclined posture with her back against the seat back, her left foot on the floor, her right foot on the accelerator, and both of her hands on the steering wheel. Her seat track was located in its middle position, the seat back was slightly reclined, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a buckle-mounted pretensioner. On one hand there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had not actuated. On the other hand, there was blood evidence on the webbing indicating that it was in use at the time of the crash.

In this contractor's opinion, the driver who according to her interview exited the vehicle under her own power, removed her safety belts while the vehicle was upside down, allowing her to drop downward onto the vehicle's roof and move over her seat's head restraint and unbuckle the child safety seat. The case vehicle's driver has no recollection of exactly how she physically got out of the vehicle and/or whether she and her child were assisted by persons passing-by as opposed to being assisted by emergency medical technicians.

The driver was transported by ambulance to the hospital. She sustained a moderate injury and was treated and released. According to her interview and medical records, the case vehicle's driver sustained a 23 centimeter (9.1 inch) laceration to her left forearm when her arm contacted the roadway during the rollover. The medical records described the injury as macerated with foreign bodies present in the wound. In this contractor's opinion, the blood found on the driver's seat belt webbing, on the child safety seat harness, and along the vehicle's roof, diagonally oriented between the second seat left and center seating positions were all deposited post-crash during the driver's extrication efforts.

Chevrolet's Occupants: According to the Police Crash Report, the Chevrolet's driver [47-year-old, (unknown race and/or ethnic origin) male] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and he did not sustain any injuries as a result of this crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which both vehicles had been traveling was a five-lane, divided, state highway, traversing in a north-northwesterly and south-southeasterly direction, and both the case vehicle and the Chevrolet were approaching a four-leg intersection (**Figures 1** and **2**). Both the northern (**Figure 1**) and southern (**Figure 2**) roadways were gently curved and had two through lanes and one left-hand turn lane; the northern roadway curved to the right and the southern roadway to the left. Furthermore, and not counted among the lanes, each roadway had a channelized right-hand turn lane (e.g., **Figure 2**). The state highway was curved slightly to the left for southern traffic and level at the area of impact. The pavement was bituminous, but traveled. For the case vehicle's northern roadway the width of the left-hand turn lane for the was 3.4 meters (11.2 feet), the width of the inside northern through lane was 3.4 meters (11.2 feet) and the outside northern through lane was 3.5 meters (11.5 feet). Furthermore, for the Chevrolet's southern roadway, the width of the three travel lanes were: 5.5 meters (18.0 feet) for the left-hand turn lane, and 3.6 meters (11.8 feet) for both the inside and outside through lanes. The shoulders were generally improved (i.e., bituminous). The eastern side of the northern roadway had a 3.4 meter (11.2 foot) paved shoulder and the western side had an minimal dirt shoulder as a part of the 11.8 meter (38.7 feet) wide unprotected grassy median. The western side of the southern roadway had a 2.9 meter (9.5 foot) paved shoulder and the eastern side had an minimal dirt shoulder as a part of the 9.1 meter (29.9 feet) wide unprotected grassy median. The trafficway was not bordered by curbs. Pavement markings for the northern roadway consisted of a solid yellow edge line on the western (left-hand, median) side and a solid white edge line on eastern (right-hand) side. In addition, the through lanes were divided by a dashed white line and the left-hand turn lane was separated from the through lanes by a solid white lane line. Likewise, the pavement markings for the southern roadway consisted of a solid yellow edge line on the eastern (left-hand, median) side and a solid white edge line on western (right-hand) side. Furthermore, the through lanes were divided by a

Figure 1: South-southeasterly view of case vehicle's north-northwesterly travel path (arrow) in left-hand turn lane (case photo #06)

Figure 2: Chevrolet's south-southeasterly travel path in inside through lane of southerly roadway approaching four-leg intersection (case photo #07)

dashed white line and the left-hand turn lane was separated from the through lanes by a solid white lane line. The estimated coefficients of friction were 0.70 for the case vehicle and 0.60 for the Chevrolet. For the case vehicle, traffic controls consisted of a regulatory **KEEP RIGHT** sign (Manual on Uniform Traffic Control Devices, R4-7) on the northern leg of the northern roadway and a **DO NOT ENTER** sign (MUTCD, R5-1) on the northern leg of the southern roadway. Likewise, these signs were also present on the southern legs of the two roadways for the Chevrolet. In addition, on-colors, pre-timed, vertical-mounted traffic control signals were located on all six travel lanes controlling the flow for both the northern and southern roadways. The statutory speed limit was 89 km.p.h. (55 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry. Traffic density was not determined, and the site of the crash was a combination of rural residential and commercial; see **CRASH DIAGRAM** at end.

Pre-Crash: The case vehicle had been traveling north-northwestward in the left-hand turn lane (**Figure 3**) of the northern roadway on the southern leg of the four-leg intersection and had nearly completed making a left-hand turn, intending to travel in a westerly direction on the intersecting trafficway. The Chevrolet was traveling south-southeastward in the outside through lane of the southern roadway on the northern leg of the same intersection and intended to continue straight ahead (**Figure 4**). According to the case vehicle's driver, she steered to the left, attempting to avoid the crash. The crash occurred in the outside through lane of the southern roadway, within the four-leg intersection of the two trafficways.

Crash: The right side (**Figure 5** and **Figure 6** below) of the case vehicle was impacted by the

Figure 3: North-northwestward travel path of case vehicle's driver in left-hand turn lane (case photo #01)

Figure 4: Chevrolet's south-southeastward travel path into four-leg intersection, viewed along edge line of southerly roadway's outside through lane; Note: arrow indicates approximate point of impact (case photo #12)

Figure 5: Case vehicle's right side damage viewed from right of back with contour gauge present (case photo #23)

front of the Chevrolet. The case vehicle's redesigned driver and front right passenger supplemental restraints (air bags) did not deploy.

Figure 6: Elevated view of damage to case vehicle's left side from impact with Chevrolet and rollover damage to hood and roof (case photo #26)

Figure 7: Elevated view from left of front showing rollover damage to case vehicle's hood, roof, and left front door areas (case photo #19)

Post-Crash: The Chevrolet's impact with the case vehicle caused the case vehicle to roll about its longitudinal axis, landing on its left side (**Figure 7**) as the case vehicle continued in its westerly travel path. The case vehicle continued to roll, one more quarter turn, landing on its top, across the centerline in the easterly lane, heading in a westerly direction (**Figure 8**).

Figure 8: Westward view of crash scene showing approximate point of impact (red arrow), case vehicle's approximate final rest position on roof (blue arrow), and Chevrolet's (white arrow) converging trajectory (case photo #04)

CASE VEHICLE

The 2003 Ford Explorer Eddie Bauer edition was a rear wheel drive (4x2), seven-passenger, four-door sport utility vehicle (VIN: 1FMZU64K23U------) equipped with a 4.0L, V-6 engine and a five-speed automatic transmission with overdrive. Braking was achieved by a power-assisted, front and rear disc, four-wheel, anti-lock system. The case vehicle's wheelbase was 289 centimeters (113.8 inches), and the odometer reading at inspection was 1,257 kilometers (781 miles). The case vehicle was equipped with **A**dvanced **O**ccupant **P**rotection **S**ystem (AOPS) features including redesigned air bags, height adjustable seat belts, seat belt pretensioners, and power adjustable pedals. The case vehicle was ***not*** equipped with the optional safety canopy air curtain system, the stability enhancement system, or a new tire pressure monitor. Finally, the case vehicle was also equipped with an **E**vent **D**ata **R**ecorder (**EDR**).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints. A non-adjustable 40/20/40 split bench seat with folding backs and adjustable head

restraints was located in the second seating area. Similarly there was a non-adjustable 60/40 back bench seat with folding backs and adjustable head restraints for both back outboard seating positions. Continuous loop, three-point, lap-and-shoulder, safety belt systems were positioned at all seven occupant seating positions. For the second seat center position the belt was integrated into the seat. The front and second row seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. The driver and front right passenger and both second seat outboard positions had their upper anchorage adjusters located in the upmost positions. The vehicle was equipped with knee bolsters for both the driver and front right seating positions, neither of which showed evidence of occupant contact or deformation. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a redesigned frontal air bag for the driver and front right passenger seating positions. Neither frontal air bag deployed as a result of the case vehicle's right side impact with the Chevrolet.

CASE VEHICLE DAMAGE

Figure 9: Closer-in view of case vehicle's right side damage with contour gauge present (case photo #24)

Figure 10: Case vehicle's right side damage viewed from left of front with contour gauge present (case photo #25)

Exterior Damage: The case vehicle's contact with the Chevrolet involved primarily its right passenger area (**Figures 9** and **10**). Direct damage began 17 centimeters (6.7 inches) forward of the right rear axle (**Figure 9**) and extended 219 centimeters (86.2 inches), along the right side mid-door level toward the front of the vehicle. Maximum crush was measured as 19 centimeters (7.5 inches) at C_4 (**Figures 10** and **11**). The table below shows the case vehicle's crush profile.

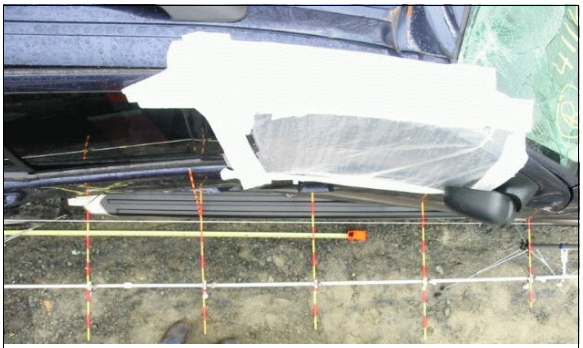


Figure 11: Overhead view of case vehicle's left side damage showing crush with contour gauge present (case photo #27)

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	219	19	223	0	16	18	19	14	3	-17	-18
in		86.2	7.5	87.8	0.0	6.3	7.1	7.5	5.5	1.2	-6.7	-7.1

The case vehicle's wheelbase was essentially unaltered from the crash. The case vehicle's right front and rear doors and right fender were directly damaged and crushed inward from the impact with the Chevrolet. The case vehicle's left quarter panel (**Figure 12**), left outside rearview mirror, left front and rear doors (**Figure 7** above), left fender, roof, and hood (**Figure 6** above) were directly damaged during the rollover event and crushed inward or downward. There was induced damage to both the right and left front door glazings, the windshield's glazing, and the right outside rearview mirror. The right roof side rail was buckled inward. No obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior. The manufacturer's recommended tire size was: P245/65R17, and the case vehicle tires were the recommended size. The case vehicle's tire data are shown in the table below. None of the case vehicle's tires were damaged, deflated, or physically restricted.

Figure 12: Rollover damage to case vehicle's left quarter panel and tail/brake/stop light assembly (case photo #20)

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	193	28	207	30	10	13	None	No	No
RF	62	9	207	30	10	13	None	No	No
LR	228	33	241	35	10	13	None	No	No
RR	193	28	241	35	10	13	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed lateral intrusion to both right interior door surfaces and the right "B"-pillar. Furthermore, there was vertical intrusion to both

"A"-pillars, the windshield and roof over the front seating area (**Figures 13** and **14**), and both right and left front roof side rails (**Figure 15**). There was a hair on the roof over the driver's seating position (**Figure 16**), and an extensive smear of blood over the left and center second seating area (**Figures 17** and **18** below). Finally, there was no evidence of compression of the energy absorbing shear capsules in the base of the steering column and no deformation to the steering wheel rim.

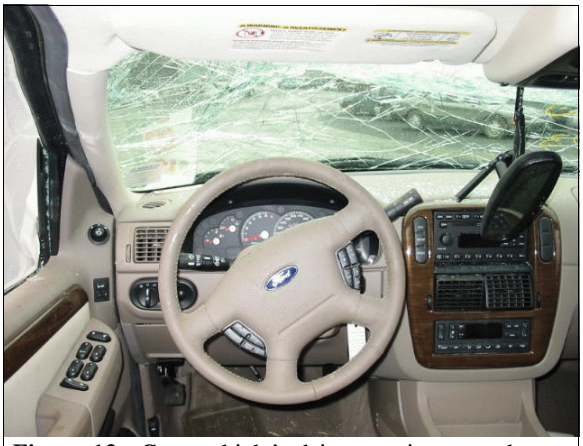


Figure 13: Case vehicle's driver seating area showing non-deployed driver air bag, roof and left "A"-pillar intrusions, and no apparent evidence of occupant contact (case photo #34)

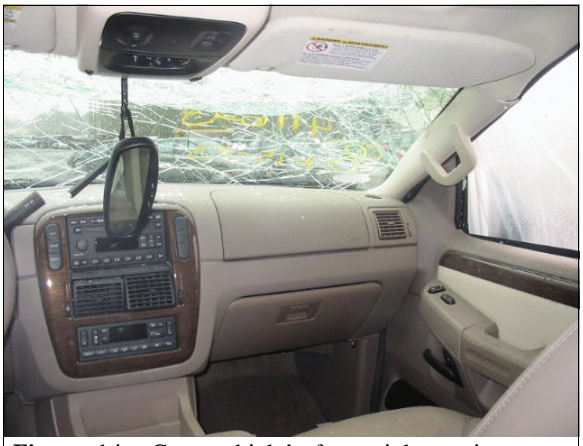


Figure 14: Case vehicle's front right seating area showing non-deployed front right air bag, dislodged rearview mirror, right "A"-pillar and door intrusions, and no occupant contact evidence (case photo #36)

Figure 15: Case vehicle's driver seating area showing non-deployed driver air bag and intrusion into occupant's space from roof, roof side rail, left "A"-pillar, and windshield (case photo #33)

Figure 16: Hair (yellow tape) on roof above driver's seating area (case photo #37)

Damage Classification: Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **03-RYEW-2** (**80** degrees) for the impact with the Chevrolet and **00-TYDO-3** for the rollover impact. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 16.0 km.p.h. (9.9 m.p.h.), -2.8 km.p.h. (-1.7 m.p.h.), and -15.8 km.p.h. (-9.8 m.p.h.). The case vehicle was towed due to damage.

Figure 17: Case vehicle's second seating area viewed from left rear door showing blood stained area on interior roof surface, diagonally oriented above and leftward of second center seating position (case photo #51)

Figure 18: Closer-up view of diagonally oriented blood stained area above and to the left of case vehicle's second center seating position (case photo #52)

Figure 19: Century convertible child safety seat used in forward facing configuration by case vehicle's second seat center passenger (case photo #62)

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained redesigned frontal air bags at the driver and front right passenger positions. The case vehicle's driver air bag was located in the steering wheel hub (**Figure 13** above). The front right passenger's air bag was located in the middle of the instrument panel (**Figure 14** above). Neither front air bag deployed as a result of this crash.

CHILD SAFETY SEAT

The second seat center passenger was seated in a convertible child safety seat that was used in its forward facing configuration (**Figure 19**). The child safety seat was manufactured by Century but the label containing the date of manufacture was missing. The child seat was identified by Model name"3000 STE" and Model number **44331BEN**. The convertible seat was designed with a pullover tray-shield which attached between the child's legs into a recessed buckle. The seat had a top tether (**Figures 20** and **21** below) which was not in use, and there were three sets of slots to thread the harness through. The harness belts were threaded through the middle slots, which according to the manufacturer's instructions should only be used when the seat is in the rear facing configuration. The child seat was used in the forward facing configuration, in the upright position.

The convertible child safety seat consisted of a plastic one-piece shell and pullover shield. According to the case vehicle's inspection, the latch plate for this seating position's safety belt was the "sliding" type. The case vehicle's safety belt system had a switchable retractor. The case vehicle's driver indicated that she had read the child seat's instruction manual and the vehicle's manual on installation of a child safety seat using the vehicle's seat belts. The driver indicated that she had installed the child seat and had placed the child in the seat prior to the crash. The driver does not recall doing anything to lock the vehicle's seat belt while securing the child restraint. Therefore, it is unknown which mode the safety belt was in prior to the crash [i.e., **Automatic Locking Retractor** (ALR) mode versus **Emergency Locking Retractor** (ELR) mode]. The driver indicated that the child seat was "tight" and that no "locking clip" was used on this passenger's safety belt.

A close inspection of the child safety seat revealed no apparent damage or fractures to the base, shell, or shield (**Figure 20**). In addition, no damage or fractures were noted along the seat's path for the vehicle's safety belt (**Figure 21**). There was a manufacturer's label affixed to the left side (i.e., inboard side when used in the forward facing configuration) giving the child seat's weight limitations [i.e., up to 9-10 kilograms (20-22 pounds) for rear facing and 9-18 kilograms (20-40 pounds) for forward facing].

Figure 20: Back surface of Century convertible child safety seat used by case vehicle's second seat center passenger showing tray shield, top tether, and no apparent evidence of damage to back surface (case photo #70)

Figure 21: Case vehicle's Century convertible child safety seat laid on its left side in forward facing configuration showing tray shield, top tether, and warning labels (case photo #65)

Another manufacturer's label was affixed to the right side (i.e., outboard side when used in the forward facing configuration) of the child safety seat which explained the importance of securing the child restraint with a vehicle's safety belt as specified in the vehicle manufacturer's instructions (**Figure 21** above). The manufacturer's instructions for this child safety seat were not available on the back of the seat at the time of this contractor's inspection.

Both sides had labels that illustrated the proper way to install the vehicle's safety belts when the child safety seat was used in the forward facing configuration. None of the labels had any dates that were visible on the label.

CRASH DATA RECORDING

Permission was obtained to download the data from the **R**estraints **C**ontrol **M**odule, which houses the **EDR** technology. The RCM was located underneath the center console's carpeting (**Figure 22**). The download was attempted by this contractor's sponsor. Unfortunately, the data was either not able to be downloaded, or there was no data available from the **RCM**.

Figure 22: Case vehicle's Restraints Control Module which was located under the floor, below the center console, and between the front bucket seats–viewed from second seating area (case photo #48)

CASE VEHICLE SECOND SEAT CENTER PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's second seat center passenger [1-year-old, Black (non-Hispanic) female; 76 centimeters and 11 kilograms (30 inches, 24 pounds)] was restrained in a child safety seat and was seated in an upright posture with her back against the back of the child safety seat with her feet dangling over the front edge of the child safety seat's cushion, angled downward. In addition, the exact position of her hands is unknown but, according to the case vehicle's driver (i.e., mother), the child had a candy bar in her hands just prior to the crash. There was no seat track and, although the second seat had a 40/20/40 split/folding seat, the seat back was not adjustable.

Figure 23: Safety belt for case vehicle's second center seating position showing crease mark on webbing between arrows (case photo #58)

The child safety seat for the case vehicle's second seat center passenger (i.e., driver's daughter) was secured by her available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of bruising and/or abrasions from the child seat's harness belt to the second seat center passenger's body, but the inspection of the second seat center passenger's integrated (**Figure 17** above) seat belt webbing

(**Figure 23** above) and latch plate (**Figure 24**) showed trace evidence of loading on the webbing (i.e., a crease).

Figure 24: Latch plate for case vehicle's second seat center position showing no obvious evidence of loading (case photo #60)

Figure 25: Close-up of blood stains on harness straps of case vehicle's Century child safety seat used by second seat center passenger (case photo #64)

According to the case vehicle's driver, she steered to the left, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts in conjunction with her convertible child safety seat, the second seat center passenger most likely moved slightly forward and to her right just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's child passenger to continue slightly forward and rightward along a path opposite the case vehicle's **80** degree Direction of Principal Force as the case vehicle decelerated. As a result the child passenger loaded her harness straps and the right side of her tray shield, while simultaneously the occupied child seat loaded her safety belts which, taken together, enabled this child passenger to remain within her child seat. The case vehicle rolled over onto its left side as a result of its collision with the Chevrolet and continued to roll leftward coming to rest on its top. As a result of the rollover impact, the second seat center passenger's child safety seat, as well as the child passenger, most likely rebounded slightly forward and to the left as the vehicle began to roll about its longitudinal axis. As the case vehicle rolled onto its top, the child safety seat and passenger most likely moved back toward the right and eventually came to rest upside down, held in place by the safety belts of the second seat center's seating position. Because of her restraint use and the use of the vehicle's safety belts, the child passenger remained within the child safety seat where she came to rest with her head pointed downward. According to the interview with the case vehicle's driver, the child was removed from the vehicle with some assistance, most likely by the driver (i.e., her mother). Blood evidence was found on the harness straps of the child safety seat (**Figure 25**). In this contractor's opinion, this blood was most likely from the mother and was deposited by the mother when she removed the child safety seat and child from the vehicle. According to the child's medical records, she arrived at the hospital still strapped in the child safety seat.

The second seat center occupant was transported by ambulance to the hospital. She was examined for injuries and was released. The case vehicle's second seat center passenger did not sustain any injuries as a result of this crash.

CASE VEHICLE DRIVER KINEMATICS

According to the case vehicle's driver [28-year-old, Black (non-Hispanic) female; 170 centimeters and 70 kilograms (67 inches, 155 pounds)] she was seated in reclined posture with her back against the seat back, her left foot on the floor, her right foot on the accelerator, and both of her hands on the steering wheel. Her seat track was located in its middle position, the seat back was slightly reclined, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by her available, active, three-point, lap-and-shoulder, safety belt system; the belt system was equipped with a buckle-mounted pretensioner. On one hand there was no evidence of belt pattern bruising and/or abrasions to the driver's body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate revealed that the pretensioner had not actuated (**Figure 26**). On the other hand, there was blood evidence on the webbing (**Figure 27**) indicating that it was in use at the time of the crash.

Figure 26: Buckle-mounted pretensioner for case vehicle's driver showing pretensioner not actuated (case photo #45)

Figure 27: Case vehicle's driver safety belt showing blood stains on inboard side of belt's webbing (case photo #42)

According to the case vehicle's driver, she steered to the left, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts, she most likely moved slightly forward and to her right just prior to impact. The case vehicle's impact with the Chevrolet pickup enabled the case vehicle's driver to continue slightly forward and rightward along a path opposite the case vehicle's **80** degree Direction of Principal Force as the case vehicle decelerated. As a result the driver loaded her safety belts which enabled the driver to remain safely within her seat. The case vehicle rolled over onto its left side as a result of its collision with the Chevrolet. The case vehicle continued to roll leftward and came to rest on its top. As a result of the rollover impact, the driver most likely rebounded slightly forward and to the left as the vehicle began to roll about its longitudinal axis. As the case vehicle rolled onto its

top, the driver was partially ejected (i.e., at least the driver's left forearm) out the left front window glazing. The driver most likely moved back toward her right and eventually came to rest upside down, held in place by her safety belts. Because of her restraint use, the driver remained within her seating position where she came to rest. In this contractor's opinion, the driver who according to her interview exited the vehicle under her own power, removed her safety belts while the vehicle was upside down, allowing her to drop downward onto the vehicle's roof and move over her seat's head restraint and unbuckle the child safety seat. The case vehicle's driver has no recollection of exactly how she physically got out of the vehicle and/or whether she and her child were assisted by persons passing-by as opposed to being assisted by emergency medical technicians.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. She sustained a moderate injury and was treated and released. According to her interview and medical records, the case vehicle's driver sustained a 23 centimeter (9.1 inch) laceration to her left forearm when her arm contacted the roadway during the rollover. The medical records described the injury as macerated with foreign bodies present in the wound. In this contractor's opinion, the blood found on the driver's seat belt webbing, on the child safety seat harness, and along the vehicle's roof, diagonally oriented between the second seat left and center seating positions were all deposited post-crash during the driver's extrication efforts.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {wound}, 23 cm (9.1 in) left forearm from elbow toward wrist, macerated, with foreign bodies present	moderate 790604.2,2	Roadway	Probable	Emergency room records
	Trauma, multiple blunt, not further specified	Not coded			Emergency room records

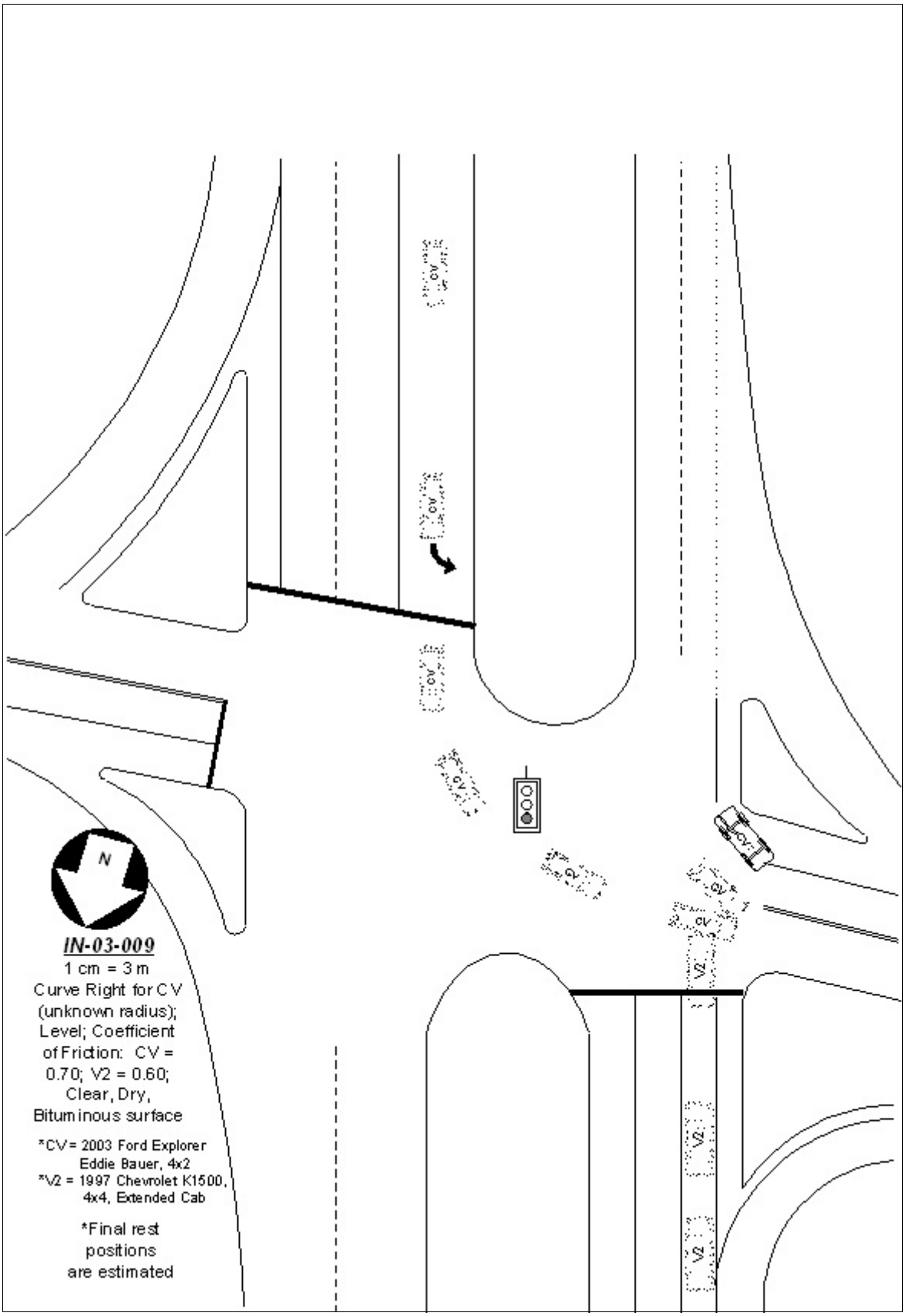
OTHER VEHICLE

Based on the VIN and manufacturer's specifications, the 1997 Chevrolet K1500 was a four wheel drive (4x4), five or six-passenger, extended cab pickup truck (VIN: 1GCEK19R1VE------) equipped with a 5.7L, V-8 engine and either the standard five-speed manual or the optional four-speed automatic transmission, both with overdrive. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The Chevrolet's wheelbase was 359 centimeters (141.5 inches), and the odometer reading is unknown because the Chevrolet was not inspected. Furthermore, the vehicle was equipped with driver and front right passenger supplemental restraints (air bags) and manual, three-point, lap-and-shoulder, safety belt systems for at least the front and back outboard seating positions. The back center seat most likely had a manual, two-point, lap belt. Standard equipment included a front split bench seat and a non-

adjustable, back fold-down bench seat; however, front bucket seats for the driver and front right passenger were optional.

Exterior Damage: With no available vehicle photographs, the CDC for the Chevrolet is not estimable. The WinSMASH reconstruction program, missing vehicle algorithm, was used on the Chevrolet's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 15.0 km.p.h. (9.3 m.p.h.), -14.8 km.p.h. (-9.2 m.p.h.), and +2.6 km.p.h. (+1.6 m.p.h.). The Chevrolet were was towed due to damage.

Chevrolet's Occupants: According to the Police Crash Report, the Chevrolet's driver [47-year-old, (unknown race and/or ethnic origin) male] was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The driver was not transported by ambulance to the hospital, and he did not sustain any injuries as a result of this crash.


N
IN-03-009
1 cm = 3 m
Curve Right for CV (unknown radius); Level; Coefficient of Friction: CV = 0.70; V2 = 0.60; Clear, Dry, Bituminous surface
*CV = 2003 Ford Explorer Eddie Bauer, 4x2
*V2 = 1997 Chevrolet K1500, 4x4, Extended Cab
*Final rest positions are estimated
CV
V2