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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-016
LOCATION - TEXAS
VEHICLE - 2004 DODGE DURANGO LIMITED
CRASH DATE - April 2004

Submitted:

July 26, 2005
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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points 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 investigation involving a 2004 Dodge Durango Limited with manual safety belts and dual front advanced air bag system.			
16. *Abstract* This report covers an on-site investigation of an air bag deployment crash that involved a 2004 Dodge Durango Limited (case vehicle),which ran-off-road and impacted a wooden fence, a utility pole and rolled over. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, the driver's air bag deployed, and the driver (45-year-old male) sustained a police reported "B" (non-incapacitating-evident) injury as a result of the crash. The case vehicle was traveling north in the center northbound lane of a six-lane, divided city street and was approaching a left curve. The case vehicle did not negotiate the curve, but continued straight ahead and departed the east side of the roadway. The front right portion of the case vehicle impacted a wooden, split rail fence. The front of the vehicle then immediately impacted a wooden utility pole causing the driver's air bag to deploy. The front right passenger air bag was suppressed because there was no front right passenger in the vehicle. The impact fractured the utility pole and caused the case vehicle to rotate counterclockwise, and the right side impacted the wooden fence. As the case vehicle continued to rotate counterclockwise, it tripped and rolled over, passenger side leading, two quarter turns and came to final rest on its roof facing west. At the time of the crash, it was daylight, the weather was clear, the roadway was dry and traffic density was light. Prior to the crash, the case vehicle's driver was seated in an upright posture with his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel. His seat track was located between its forward and middle positions, and the adjustable pedals were located between the rear-most and middle position. His seat back was slightly reclined, the tilt steering wheel was located between the center and full-down position, and the driver was restrained by his manual, lap-and-shoulder, safety belt system. The impact with the utility pole caused the driver to move forward, load his safety belt and contact his deployed air bag. The driver moved to the right and off his seat to some degree as the case vehicle rolled over. He remained restrained as the vehicle came to rest on its roof. The driver released himself from his safety belt and exited the case vehicle under his own power. He was not transported from the scene and reported no injuries.			
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IN-04-005

This on-site investigation was brought to NHTSA's attention on or about May 21, 2004 by NASS GES sampling activities. This crash involved a 2004 Dodge Durango Limited sport utility vehicle (case vehicle). The crash occurred in April, 2004, at 10:11 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with certified advanced 208 compliant air bags, and the case vehicle's driver [45-year-old, White (non-Hispanic) male] sustained a police reported "B" (non-incapacitating-evident) injury as a result of the crash. The manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This contractor inspected the case vehicle on May 25, 2004, the crash scene on May 26, 2004 and interviewed the case vehicle driver on June 8, 2004. This report is based on the police crash report, scene and vehicle inspections, interviews with the case vehicle driver and owners of the property where the crash occurred; occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in the center northbound lane of a six-lane, divided city street and was approaching a left curve. The case vehicle did not negotiate the curve, but continued straight ahead and departed the east side of the roadway. The front right portion of the case vehicle impacted a wooden, split rail fence. The front of the vehicle then immediately impacted a wooden utility pole causing the driver's air bag to deploy. The front right passenger air bag was suppressed because there was no front right passenger in the vehicle. The impact fractured the utility pole and caused the case vehicle to rotate counterclockwise, and the right side impacted the wooden fence. As the case vehicle continued to rotate counterclockwise, it tripped and rolled over, passenger side leading, two quarter turns and came to final rest on its roof facing west. The weather at the time of the crash was clear, the roadway was dry and traffic density was light.

The vehicle's front, top and right side sustained direct and induced damage as a result of the crash. The left side was damaged when the vehicle was pulled back over onto its wheels during removal from the scene. The CDCs for the case vehicle were determined to be: **12-FRLE-1** (**0** degrees) for the front impact to the wooden fence, **12-FYEW-3** (**0** degrees) for the front impact to the wooden utility pole, **03-RPEW-1** (**90** degrees) for the right side impact to the wooden fence and **00-TZDO-2** for the rollover. The WinSMASH reconstruction program was used to determine a barrier equivalent speed of 48.1 km.p.h (29.9 m.p. h.) for the utility pole impact based on the crush to the front of the case vehicle.

Immediately prior to the crash, the case vehicle's driver was seated in an upright posture with his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel. His seat track was located between its forward and middle positions and the adjustable pedals were located between the rear-most and middle position. His seat back was slightly reclined, the tilt steering wheel was located between the center and full-down position, and the driver was restrained by his manual, lap-and-shoulder, safety belt system.

The was no evidence the driver took any actions to avoid the crash. He stated to investigating police, as well as this contractor's investigator, that he steered right to avoid a vehicle that cut into his lane; however, witnesses stated there was no other vehicle near the case vehicle prior to the crash. It is not known why the case vehicle left the roadway.

It is likely the driver remained in an upright driving position and may have moved slightly forward as the case vehicle impacted the curb and wooden fence just prior to the utility pole impact. The case vehicle's impact with the utility pole caused the driver to move forward as the case vehicle decelerated, and he loaded his seat belt and his face and chest contacted his deployed air bag. Following the utility pole impact, the case vehicle rotated counterclockwise and the driver continued to load his seat belt and move forward and to the right. The driver then most likely continued to move to the right and off his seat to some degree as the case vehicle rolled over, passenger side leading, two quarter turns and came to rest on its top. The driver remained in his seat following the crash and indicated in his interview that he was able to release himself from his safety belt and exit the case vehicle without assistance. The driver's use of his safety belt system and the deployment of his air bag mitigated his interaction with the case vehicle's frontal interior components.

The police crash report indicated the driver sustained a "B" (non-incapacitating-evident) injury and was not transported from the scene for medical treatment. The driver stated in his interview that he was not injured and sought no treatment subsequent to the crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a two-way, six-lane, divided, city street traversing in a north and south direction. Each direction of the trafficway contained three travel lanes, and the roadway began to curve to the northwest just prior to the crash location. The trafficway was divided by a raised, curbed median containing grass, luminaires and trees. There were also cuts in the median to allow access to adjacent residential and commercial properties. Each lane of the case vehicle's roadway was approximately 3.2 meters (10.5 feet) wide, and the roadway was bordered by barrier curbs. The case vehicle's roadway had a slight positive grade of 0.9%. Roadway pavement markings consisted of broken white lane lines. The speed limit was 56 km.p.h. (35 m.p.h.), and there were no regulatory speed limit sign or warning signs posted near the crash scene. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry, traveled concrete with an estimated coefficient of friction of 0.72. Traffic density was light and the site of the crash was urban with a combination of commercial and residential. See the Crash Diagram at the end of this report.

Figure 1: Approach of the case vehicle northbound in the center lane, arrow shows location of struck utility pole

Pre-Crash: The case vehicle was traveling north in the center lane approaching the curve, and the driver was intending to continue northwest bound (**Figure 1** above). The case vehicle did not negotiate the curve, but continued straight ahead and departed the east side of the roadway. There was no indication in the police report or during this contractor's scene inspection that the case vehicle's driver took any actions to avoid the crash. The pre-crash motion of the case vehicle relative to its travel lane and area where it departed the roadway (**Figure 2**) shows the case vehicle essentially traveled straight ahead in the curve indicating the driver may have fallen asleep; however, it is unknown why the case vehicle departed the roadway. The case vehicle's driver stated to police, and to this contractor's investigator, that he steered right to avoid a vehicle that cut into his lane from the outside lane, which caused him to depart the roadway. The police crash report listed two witnesses that stated there were no other vehicles near the case vehicle prior to the crash. The crash occurred on the east side of the roadway.

Figure 2: Approach of case vehicle to utility pole impact, arrow shows case vehicle tire mark on curb

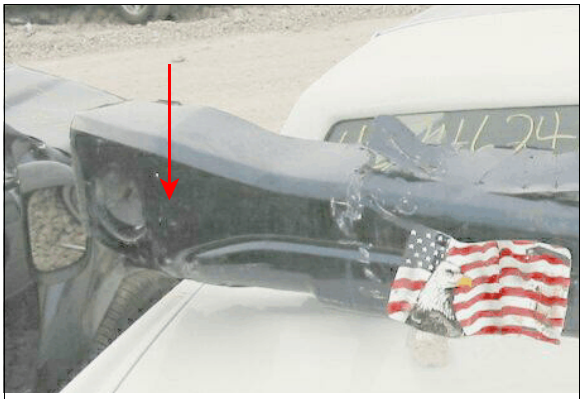


Figure 3: Arrow shows direct damage from wooden fence impact to right corner of front bumper cover

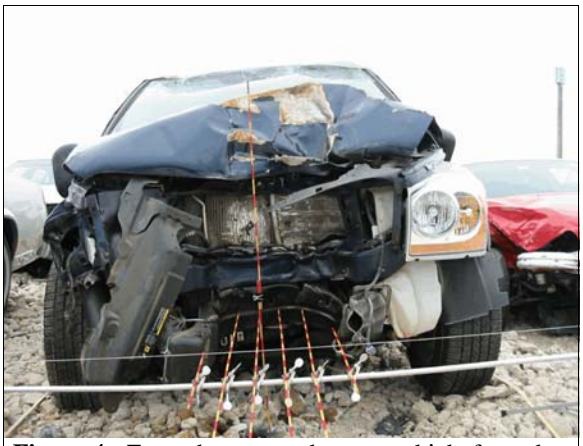


Figure 4: Front damage to the case vehicle from the impact with the utility pole, each stripe on rods is 5 cm (2 in)

Crash: The impacts to the case vehicle involved a decorative, split-rail, wooden fence and a utility pole (**Figure 2**) followed by a passenger side leading rollover. The utility pole was wooden and bolted onto the east side of the pole was a large, metal conduit pipe housing electrical cable that connected to three transformers mounted on top of the pole. This contractor's investigation and information in the police crash report indicated that the wooden fence extended up to the utility pole, and a section of it was broken out by the case vehicle during the impact sequence. However, there was little evidence on the case vehicle of the apparent contacts with the wooden fence. This is most likely due to the materials and construction of the wooden fence. Fences of this type are made of soft wood and the support posts are not buried deep in the ground and offer little resistance to an impact by a motor vehicle. The front right portion of the case vehicle appears to have first impacted the wooden fence (**Figure 3**), and then the front (**Figure 4**) immediately

impacted the utility pole. The impact fractured the utility pole and caused the case vehicle to rotate counterclockwise, and the right side impacted the wooden fence. The case vehicle continued to rotate counterclockwise and initiated a passenger side leading rollover and rolled over two quarter turns onto its roof (**Figure 5**). The utility pole impact caused the case vehicle's driver air bag to deploy. The case vehicle's front right air bag did not deploy because there was no front right occupant seated in the case vehicle. The weight sensor in the front right seat properly determined the absence of an occupant and suppressed deployment of the front right air bag.

Figure 5: Rollover damage to the top

Post-Crash: The case vehicle came to rest on its top facing west about five meters (16.4 feet) from the roadway (**Figure 6**). Following the utility pole impact, the broken section of the utility pole impacted and damaged a section of woven wire fence north of the base of the utility pole (**Figure 6**). In addition, the police crash report indicates a "water main" located a short distance north of the utility pole was also damaged. There was no indication on the police crash report or during this contractor's scene inspection that a fire hydrant located a short distance northwest of the utility pole was also impacted. Also, there was no damage apparent on the case vehicle indicating an impact with the woven wire fence, a water main (or water main cover) or the fire hydrant. This contractor therefore concludes that the damage to these objects resulted from contact by the broken section of the utility pole.

Figure 6: View to southwest showing damage to woven wire fence, missing section of wooden fence, water main cover (arrow), fire hydrant and area of rest of case vehicle (near bottom of photo)

Figure 7: Overview of front and left side of case vehicle and damage to front of vehicle from impact with the utility pole

CASE VEHICLE

The 2004 Dodge Durango Limited (**Figure 7**) was a four wheel drive, five-door sport utility vehicle (VIN: 1HGCM82604A------) equipped with a 5.7 L, V-8 engine and a four-speed automatic transmission. Braking was achieved by power, four wheel, anti-lock disc brakes. The vehicle was also equipped with electronic traction control, adjustable pedals and multi-stage driver and front right passenger air bags. The front seat row was equipped with driver and passenger

bucket seats with height adjustable head restraints, knee bolsters and three-point, lap-and shoulder safety belts with pretensioners, constant force retractors and height adjustable D-rings. The front right seat was also equipped with an occupant classification system that suppresses or deploys the front right air bag based upon the severity of the crash and the weight of the occupant. The second and third seat rows were equipped with split bench seats with height adjustable head restraints for each seat position as well as three-point, lap-and-shoulder safety belt systems. In addition, the vehicle was equipped with a LATCH system for securing child safety seats. Side curtain air bags were an option, but the case vehicle was not so equipped. The case vehicle's wheelbase was 303 centimeters (119.3 inches). Lastly, the case vehicle's electronic odometer reading was unknown due to no power during the inspection. However, the driver estimated the vehicle had approximately 1,786 kilometers (1,110 miles) on it at the time of the crash.

Figure 8: Top view of front crush

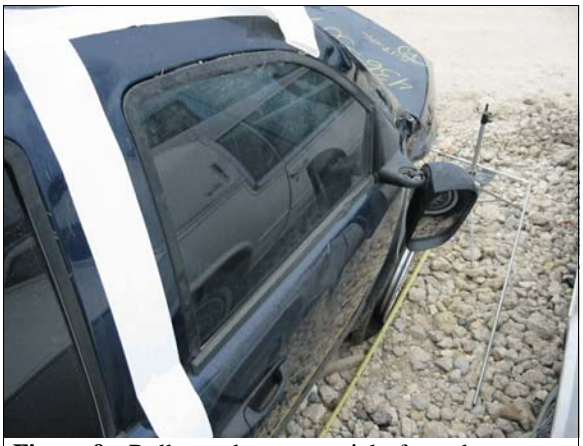


Figure 9: Rollover damage to right front door


Figure 10: Rollover damage to right roof side rail and roof

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the utility pole involved the front bumper, grille and hood (**Figure 7** above). The center of the direct damage was offset to the left of the centerline of the case vehicle 8 centimeters (3.2 inches). The direct damage began 16 centimeters (6.3 inches) left of the front right bumper corner and extended 43 centimeters (17.9 inches) along the bumper. The crush pocket approximated the shape of the utility pole. Crush measurements were taken at the front bumper bar because the front bumper cover was off the vehicle. The maximum crush to the front bumper bar occurred at C_2 (**Figure 8**) and was measured as 58 centimeters (22.8 inches). There was a small area of direct damage scratches on the front bumper cover (**Figure 3** above) about 20 centimeters in length beginning at the right corner of the bumper cover. This appeared to be the result of the impact with the wooden fence. In addition, there were several small areas of direct damage to the right side of the case vehicle that also appeared to be due to impact with the wooden fence. Direct and induced damage from the rollover involved the right side, top and windshield of the case vehicle

(**Figure 5** above and **Figures 9** and **10)**. In addition, the left side had a few dents and some scratches, the left side view mirror was broken off its mount and the driver's door window was cracked. This damage appeared to be related to rolling the vehicle back onto its wheels in order to tow the vehicle from the crash scene. The table below shows the case vehicle's front crush profile

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	43	58	43	13	58	57	54	51	0	-8	0
in		16.9	22.8	16.9	5.1	22.8	22.4	21.3	20.1	0.0	-3.2	0.0

The case vehicle's wheelbase was unchanged on the left side and extended 1 centimeter (0.4 inch) on the right side. Induced damage involved the hood, both front fenders, the roof and right side.

The recommended tire size was: P265/65R17 and the 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	32nd of an inch			
LF	234	34	228	33	9	11	None	No	No
RF	0	0	228	33	9	11	Bead Separation	No	Yes
LR	228	33	228	33	9	11	None	No	No
RR	0	0	228	33	9	11	Bead Separation	No	Yes

Vehicle Interior: Inspection of the case vehicle's interior (**Figure 11**) revealed no evidence of occupant contact to any interior surfaces or components. The case vehicle sustained eight occupant compartment intrusions, all occurring in the front seat row. The most severe intrusions were 14 centimeters (5.5 inches) of vertical roof intrusion into the front right seat area, 12 centimeters (4.7 inches) of vertical windshield intrusion into the front right seat area, and 10 centimeters (3.9 inches) of vertical windshield intrusion into the driver's seat area. There was no

Figure 11: Overview of the case vehicle's instrument panel, windshield and steering wheel

apparent compression of the energy absorbing steering column, and no deformation of the steering wheel rim was observed (**Figure 12**)

Figure 12: Overview of case vehicle's steering wheel and steering column; Note, spots on steering wheel rim are from adhesive tape

Damage Classification: Based on the vehicle inspection the CDCs for the damage to the case vehicle were determined to be: **12-FRLE-1** (**0** degrees)for the front impact to the wooden fence, **12-FYEW-3** (**0** degrees) for the front impact to the utility pole, **03-RPEW-1** (**90** degrees) for the right side impact to the wooden fence and, **00-TZDO-2** for the rollover.

The WinSMASH reconstruction program could not be used on the case vehicle's impact with the utility pole because the pole fractured. However, the WinSMASH program was used to determine a barrier equivalent speed of 48.1 km.p.h (29.9 m.p. h.) based on the damage to the front of the case vehicle.

Figure 13: Case vehicle's driver air bag

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with certified advanced 208-compliant frontal air bags at the driver and front right passenger positions. The driver's air bag deployed as a result of the case vehicle's front impact with the wooden utility pole. The front right air bag did not deploy because there was no front right occupant seated in the vehicle at the time of the crash. It is not known which stage or stages of the multi-stage driver's air bag deployed because no event data recorder data was available. It is not known if the case vehicle was equipped with an event data recorder.

Figure 14: One of case vehicle's two driver air bag vent ports

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the module cover flaps, but the air bag had a few scuffs on it that appeared related to the deployment. The deployed driver's air bag **(Figure 13)** was round with a diameter of approximately 63 centimeters (24.8 inches)**.** The air bag was designed with two

tethers, each approximately 4.5 centimeters (1.8 inches) in width, and had two X-shaped vent ports located at the 11 and 1 o'clock positions. The vent ports were 4.5 centimeters (1.8 inches) in width with a 0.5 centimeter (0.2 inch) hole at each corner (**Figure 14** above). The two air bag module flaps (**Figure 15**) were constructed of pliable vinyl with a cloth backing . The top of each flap was straight while the bottom was rounded. The tear seams ran across the top, down the middle and along the bottom of the flaps. There was a Dodge emblem on the left flap and a cut-out on the right flap that mated with the emblem. Each flap was 13.5 centimeters (5.3 inches) in height along the vertical tear seam and 7.5 centimeters (3 inches) in width at its widest point. The distance between the mid center of the driver's seat back, as positioned at the time of the inspection, and the front surface of the air bag at full excursion was 29 centimeters (11.4 inches).

Figure 15: Case vehicle's driver air bag module flaps

Figure 16: Overview of case vehicle's right instrument panel and location of front right air bag (arrow)

The front right passenger's air bag was located in the middle of the instrument panel (**Figure 16**). The deployment of the front right air bag was properly suppressed by the case vehicle's advanced occupant protection system because there was no front right passenger in the case vehicle at the time of the crash.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [45-year-old, White (non-Hispanic) male; 180 centimeters and 81.6 kilograms (71 inches, 180 pounds)] was seated in an upright posture. His left foot was on the floor, his right foot on the accelerator, and both hands were on the steering wheel. His seat track was located between its forward and middle positions and the adjustable pedals were located between the rear-most and middle position (**Figure 17**). The driver's seat back was slightly reclined, and the tilt steering wheel was located between the center

Figure 17: Case vehicle's adjustable brake and accelerator foot pedals

and full-down position. The driver was wearing glasses at the time of the crash.

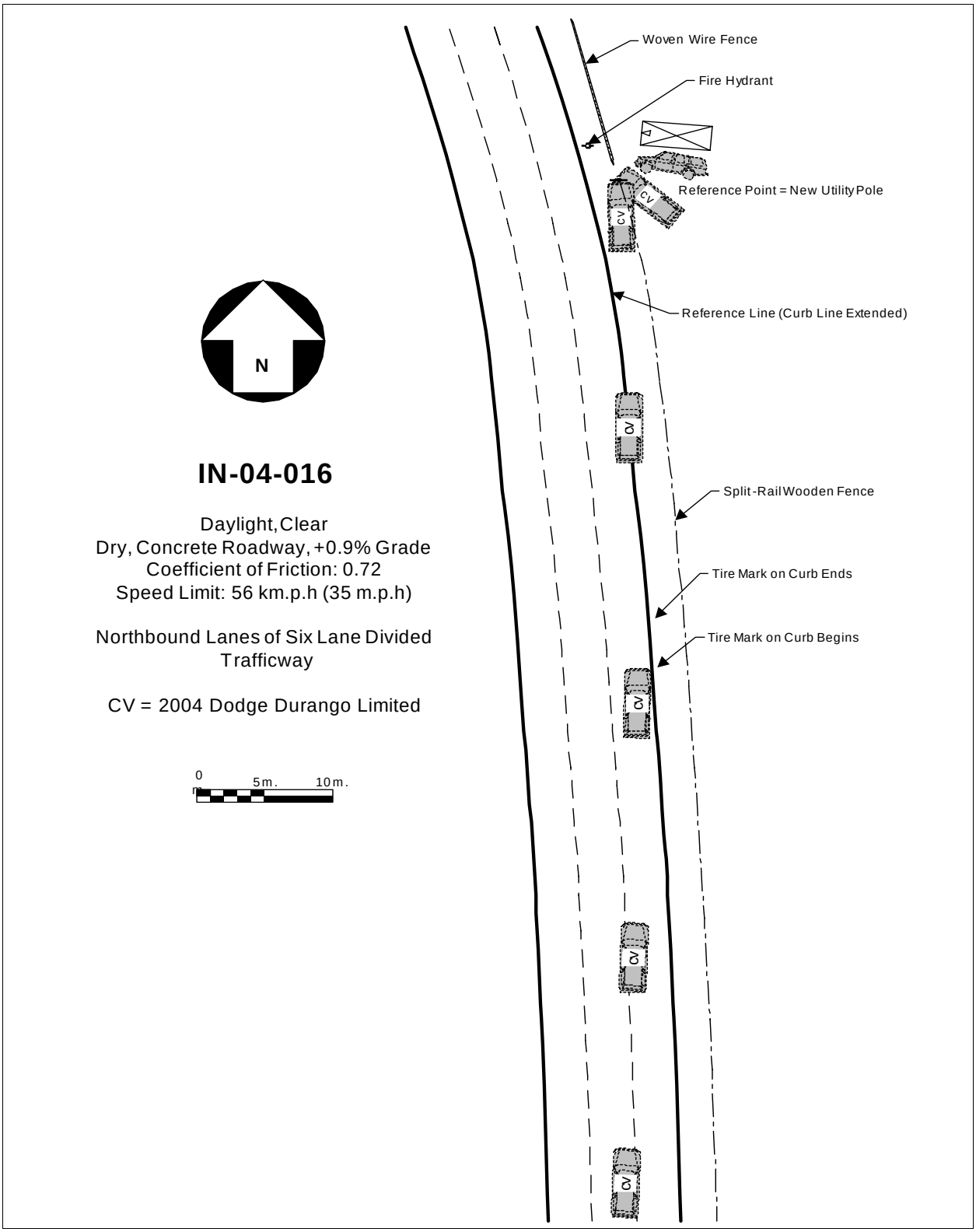
The case vehicle's driver was restrained by his manual, three-point, lap-and-shoulder, safety belt system. The safety belt system was equipped with a belt pretensioner and load limiting retractor. These components were housed within the B-pillar. Inspection of the seat belt assembly revealed load marks on the shoulder belt webbing (**Figure 18**). The driver also stated in his interview that he was wearing the lap and shoulder belt.

Figure 18: Load marks on driver's shoulder belt, between the yellow tapes

The evidence at the crash site and reported in the police crash report indicated the driver made no pre-crash braking or steering actions. It is likely the driver remained in an upright driving position and may have moved slightly forward as the case vehicle impacted the curb and wooden fence just prior to the utility pole impact. The case vehicle's impact with the utility pole caused the driver to move forward along a path opposite the case vehicle's 0 degree direction of principal force as the case vehicle decelerated, and he loaded his seat belt and his face and chest most likely contacted his deployed air bag. There was no evidence on the lower instrument panel that the driver's knees contacted the knee bolster. Following the utility pole impact, the case vehicle rotated counterclockwise and the driver most likely continued to load his seat belt and move forward and to the right. The driver then continued to move to the right and off his seat to some degree as the case vehicle rolled over, passenger side leading, two quarter turns and came to rest on its top. The driver remained in his seat following the crash and indicated in his interview that he was able to release himself from his safety belt and exit the case vehicle without assistance. The driver's use of his safety belt system and the deployment of his air bag mitigated his interaction with the case vehicle's frontal interior components.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated the driver sustained a "B" (non-incapacitating-evident) injury and was not transported from the scene for medical treatment. The driver stated in his interview that he was not injured and sought no treatment subsequent to the crash.


Woven Wire Fence
Fire Hydrant
Reference Point = New Utility Pole
Reference Line (Curb Line Extended)
Split-Rail Wooden Fence
Tire Mark on Curb Ends
Tire Mark on Curb Begins
CV
N
IN-04-016
Daylight, Clear
Dry, Concrete Roadway, +0.9% Grade
Coefficient of Friction: 0.72
Speed Limit: 56 km.p.h (35 m.p.h)
Northbound Lanes of Six Lane Divided Trafficway
CV = 2004 Dodge Durango Limited
0
5m.
10m.