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ON-SITE CHILD RESTRAINT SYSTEM INVESTIGATION

CASE NUMBER - IN10027
LOCATION - MICHIGAN
VEHICLE - 1997 DODGE INTREPID
CRASH DATE - July 2010

Submitted:

December 15, 2010

Contract Number: DTNH22-07-C-00044

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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16. *Abstract* This on-site investigation focused on the 4-year-old male second row left passenger of a 1997 Dodge Intrepid and the Gerry Double Guard booster Child Restraint System (CRS) in which he was seated. The Dodge was occupied by an unrestrained 28-year-old male driver, an unrestrained 28-year-old female front row right passenger, the second row left passenger, and a restrained 5-year-old male second row right passenger seated in a Graco Turbo Booster belt-positioning booster CRS. The Dodge was traveling north on a 2-lane rural highway during daylight hours and clear weather conditions. The vehicle departed the left side of the roadway and the front plane impacted a small sapling and a large tree (events 1 and 2). The vehicle then rolled over right side leading 3 quarter turns and came to final rest on its left side. The second row left passenger's CRS was not properly secured by the lap-and-shoulder safety belt and the passenger was partially ejected through the partially open left rear window. His head and right arm were entrapped between the ground and the window. He sustained a fatal head injury. The remaining occupants were transported to medical facilities and admitted. The vehicle was towed from the crash scene due to damage.			
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This on-site investigation focused on the 4-year-old male second row left passenger of a 1997 Dodge Intrepid (**Figure 1**) and the Gerry Double Guard booster Child Restraint System (CRS) in which he was seated. This crash was brought to the National Highway Traffic Safety Administration's (NHTSA) attention on July 27, 2010 through an on-line news article. The investigation was assigned on August 17, 2010. The crash involved the Dodge, which departed the roadway and impacted a tree and then rolled over. The crash occurred in July, 2010, at 1346 hours, in Michigan and was investigated by the Michigan State Police. The Dodge, the CRS, and the crash scene were inspected on August 26, 2010. The front right passenger was interviewed on October 10, 2010. This report is based on the police crash report, police on-scene photographs, vehicle inspection, CRS inspection, crash scene inspection, occupant medical records, occupant kinematic principles, and evaluation of the evidence.

Figure 1: The damaged 1997 Dodge Intrepid

CRASH CIRCUMSTANCES

Crash Environment: This crash occurred on a 2-lane, undivided, rural roadway during daylight hours and clear weather conditions. The roadway traversed in a north-south direction. The northbound lane was 3.5 m (11.5 ft) in width, while the southbound lane was 3.3 m (10.8 ft) in width. The roadway was bordered by gravel shoulders 1.7 m (5.6 ft) in width, and there was a line of large trees on the west side of the roadway located approximately 6.1 m (20 ft) from the west edge line. The roadway pavement markings consisted of solid white edge lines and broken yellow center line. The roadway surface was dry bituminous and the grade was level. The speed limit was 86 km/h (55 mph). The Crash Diagram is on page 15 of this report.

Pre-Crash: The Dodge was occupied by an unrestrained 28-year-old male driver, an unrestrained 28-year-old female front row right passenger, a restrained 4-year-old male second row left passenger, and a restrained 5-year-old male second row right passenger. The second row left passenger was seated in a booster CRS with a shield, while the second row right passenger was seated in a belt-positioning booster CRS. The driver was traveling north (**Figure 2**) and intended to continue northbound. He told police that the front end of the vehicle suddenly started to shake violently and he lost control of the vehicle. He told police that he had recently replaced a tie rod

Figure 2: Approach of the Dodge; the arrow shows the location of the crash

on one of the front wheels and the tie rod on the other front wheel needed to be replaced as well. The driver was given a blood test for alcohol and drugs. His blood alcohol content was 0.02 mg/dl and the drug test was positive for opiates, amphetamine, and cannabinoids

Figure 3: Approach of the Dodge to impact

Crash: The vehicle departed the west side of the roadway (**Figure 3**) and traveled approximately 39 m (127.9 ft) through the grass where the left portion of the front plane impacted and broke a 6 cm (2.4 in) diameter sapling (event 1). The vehicle traveled an additional 5.8 m (19 ft) and the front plane (**Figure 4**) impacted a 130 cm (51.2 in) diameter Sycamore tree (**Figure 5**). During this impact, the vehicle rode up the base of the tree and there was significant front undercarriage engagement with tree, which shifted the front end structure upward (**Figure 5**). The vehicle deflected off the tree and rolled over right side leading three quarter turns. During the rollover, the second row left passenger was partially ejected out of the partially open left rear window glazing. His head and right arm were entrapped between the ground and the glazing causing a fatal head injury. The second row right passenger was completely displaced out of his CRS during the crash. The vehicle came to final rest on the left side plane heading north located 4.9 m (16.1 ft) north and 5.3 m (17.4 ft) east of the tree.

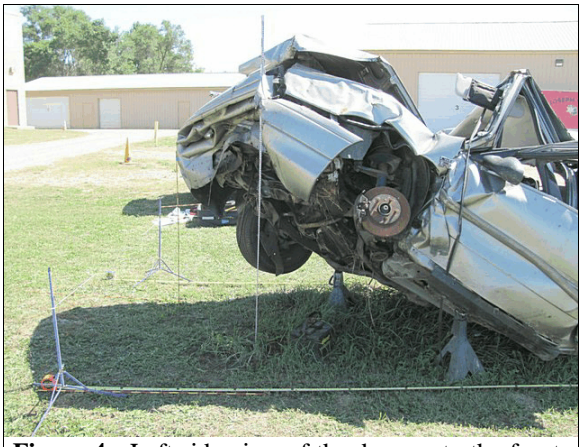

Figure 4: Left side view of the damage to the front plane of the Dodge from the impact with the 130 cm (51.2 in) diameter tree

Figure 5: The impacted Sycamore tree

Post-Crash: The sheriff's department, Michigan State Police, township fire department, and emergency medical service responded to the crash scene. The front right passenger and second row right passenger came to rest in the second row left seating position on top of the second row left passenger. The driver remained in the front row. The driver, front right passenger, and second row right passenger were all unconscious upon arrival of the emergency responders. Rescue personnel removed all the occupants from the vehicle. The front right passenger and second row right passenger were transported by air ambulance to a trauma center. The driver was transported by ground ambulance to a hospital. The second row left passenger was pronounced deceased at the crash scene and transported to a hospital for a post-mortem examination. The vehicle was towed due to damage.

The rollover of the Dodge was initiated by the impact with the 130 cm (51.2 in) diameter tree. As the left front wheel rode up the base of the tree, the front plane and front undercarriage engaged the tree and the vehicle was deflected upward and to the right, which initiated a right side leading rollover. The vehicle deflected off the tree becoming airborne in a northeast direction and rolled over three quarter turns touching down to final rest on its left side. The vehicle traversed a distance of approximately 10 m (32.8 ft) during the rollover.

CASE VEHICLE

The 1997 Dodge Intrepid was a front wheel drive, 5-passenger, 4-door sedan (VIN: 2B3HD46T6VH------) equipped with a 3.3-liter, I-6 engine, and an automatic transmission. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder safety belts, and driver and front right passenger frontal air bags. The second row was equipped with a bench seat, lap-and-shoulder safety belts at the outboard seating positions and a lap belt for the center seating position. The vehicle's odometer reading at the SCI inspection was 268,302 kilometers (166,715 miles). The specified wheelbase was 287 cm (113 in).

CASE VEHICLE DAMAGE

Exterior Damage Event 1: The Dodge sustained minor damage on the left portion of the front bumper from the impact with the 6 cm (2.4 in) diameter sapling. The damage was masked by the impact with the large. Based on the location of the sapling relative to the path of the left side tires leading to the impact, the direct damage from the sapling resided approximately 22 cm (8.7 in) right of the front left bumper corner.

Damage Classification Event 1: The Collision Deformation Classification for the impact with the sapling was estimated to be 12FLEN1 (0 degrees). The severity of the damage was minor.

Exterior Damage Event 2: The Dodge sustained damage on the front bumper, hood, and the front undercarriage (**Figure 6**) from the impact with the 130 cm (51.1 in) diameter tree. The damage on the bumper began at the front left bumper corner and extended 93 cm (36.6 in) across the bumper. Crush measurements were taken on the front bumper and the maximum residual crush was 94 cm (37 in) occurring at C_1. The damage on the undercarriage began on the bottom of the bumper at the front left corner and extended 132 cm (52 in) to the right. The tree directly engaged the bottom of the engine and front frame members and deposits of tree bark and wood extended rearward

Figure 6: Damage on the front plane and undercarriage of the Dodge from the impact with the 130 cm (51.2 in) tree; scale on right in 10^{ths} of meter; each increment on left scale is 5 cm (2 in)

approximately 201 cm (79.1). The end structure of the vehicle was shifted vertically upward 107 cm (42.2 in). The table below presents the crush that was measured on the bumper.

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	2	93	94	138	94	84	76	61	41	16	-28	0
in		36.6	37.0	54.3	37.0	33.1	29.9	24.0	16.1	6.3	-11.0	0.0

Damage Classification Event 2: The CDC for the impact with the 130 cm (51.1 in) diameter tree was 20FYEW4. The non-horizontal direction of force was incremented for the vertical shift of the front end structure. The WinSMASH program could not be used on this impact since an impact resulting in a non-horizontal direction of force is out of scope for the program. Based on the extent of the damage on the front plane and undercarriage, the severity of the damage was severe.

Exterior Damage Event 3: The damage from the rollover involved the entire left side of the vehicle. The direct damage consisted primarily of scratches and minor dents. There was no vertical or lateral crush to the roof structure from the rollover.

Damage Classification Event 3: The CDC for the rollover was 00LDAO2. The WinSMASH program could not be used on this impact since a rollover is out of scope for the program. The severity of the damage was minor based on the extent of damage on the left side plane.

The vehicle manufacturer's recommended tire size was P225/60R16. The vehicle was equipped with a P215/65R16 size tire on the left front. The remaining tires were of the recommended size. The Dodge's tire data are presented in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	241	35	2	2	Debeaded	No	Yes
LR	193	28	241	35	2	3	None	No	No
RR	138	20	241	35	1	1	None	No	No
RF	221	32	241	35	4	5	None	Yes	No

Vehicle Interior: The inspection of the Dodge's interior revealed scuff marks on the right portion of the center instrument panel, the right instrument panel, and the glove box door from contact

by the front right passenger's knees. The upper half of the steering wheel rim was deformed forward 8 cm (3.1 in) from the driver loading through the frontal air bag and contacting the steering wheel. While there was probably compression of the energy absorbing steering column, this could not be confirmed since the front seat was not accessible due to jammed front doors and instrument panel intrusion. The front right passenger's seat back was displaced rearward from the upright position to the mid-rear position from occupant loading during rebound.

Both front doors were jammed shut during the crash. Both rear doors remained closed and operational. Prior to the crash, the glazing in the right front and left rear windows were partially open. The right rear window glazing was closed and the driver's window glazing was open. The glazing in the backlight, left front, right front, and right rear windows was disintegrated from impact forces. The windshield was cracked and out of place.

The Dodge sustained intrusions in the front row that involved the instrument panel, steering wheel, windshield header, both A-pillars, and the driver and front right passenger's toe pans. The most severe intrusions in the driver space involved the instrument panel and steering wheel, which intruded an estimated 30 cm (11.8 in). The most severe intrusions in the front right passenger's space involved the instrument panel and toe pan, which intruded and estimated 20 cm (7.9 in) and 8 cm (3.1 in), respectively.

AUTOMATIC RESTRAINT SYSTEM

The Dodge was equipped with driver and front right passenger frontal air bags. Both air bags deployed as a result of the impact with the large tree (event 2).

The driver's frontal air bag was located in the steering wheel hub and the module cover was a two flap configuration constructed of pliable vinyl. Each flap was 16 cm (6.3 in) in length and 6.5 cm (2.6 in) in height. The module cover flaps opened at the designated tear points and were undamaged. The deployed air bag was 48 cm (18.9 in) in diameter. It sustained no damage and there were no discernable occupant contact scuffs or transfers present on the air bag.

The front right passenger's frontal air bag was located within the top of the instrument panel and the module cover was a single flap constructed of pliable vinyl with a plastic backing. The cover flap was 36 cm (14.1 in) in width at the front, 34 cm (13.4 in) in width at the back, and 14 cm (5.6 in) in height. It opened at the designated tear points and was undamaged. The deployed air bag was 50 cm (19.7 in) in width and 61 cm (24.0) in height. There were no external vent ports. The air bag sustained no damage and there was no discernable evidence of occupant contact.

MANUAL RESTRAINT SYSTEM

The Dodge was equipped with lap-and-shoulder safety belts in the front row and the outboard second row seating positions. The second row center position had a lap belt. The driver's safety belt was equipped with continuous loop belt webbing, a sliding latch plate, an Emergency Locking Retractor (ELR), and an adjustable upper anchor that was in the full down

position. The front right safety belt was similarly equipped but had a locking latch plate and the upper anchor was in the full up position. The second row outboard safety belts were equipped with continuous loop belt webbing, lightweight locking latch plates, ELRs, and fixed upper anchors. The second row center lap belt was equipped with a locking latch plate.

The inspection of the driver's safety belt assembly revealed no evidence of loading on the latch plate belt guide, D-ring, or safety belt webbing. This evidence indicated that the driver was not restrained in this crash.

The inspection of the front right passenger's safety belt revealed no evidence of loading on the latch plate belt guide, D-ring, or safety belt webbing. The passenger stated during the SCI interview that she was not wearing the safety belt.

The second row left and right safety belts were found in the buckled position during the SCI inspection. The plastic belt guide on each latch plate was broken, but the plastic cinch bar was intact. The police on-scene photographs showed that the second row right passenger's safety belt was still buckled immediately following the crash. The police photographs also showed the second row left passenger's safety belt in the buckled position prior to the removal of the second row left passenger from the vehicle. This evidence indicated that both the second row left and right safety belts were in use at the time of the crash.

CHILD RESTRAINT SYSTEM

The second row left passenger of the Dodge [4-year-old male, 117 cm (46 in) and 21 kg (47 lbs)] was seated in a Gerry Double Guard booster CRS (**Figure 7**). The CRS had no label identifying the model number or year of manufacture. This model CRS was manufactured between 1990 and 1995. The CRS was equipped with a removable shield and had an integral lap belt within the shield assembly (**Figure 8**). A safety belt path was located on the seat bottom for securing the CRS with a vehicle's safety belt when the CRS was used with the shield. There was no label present that listed the height and weight restrictions for the CRS. A CRS of this type is typically intended for use by children over 1-year-old who weigh between 9 kg and 18 kg (20 and 40 lbs). The CRS was designed to convert to a belt-positioning booster by removing the shield. When used as a belt-positioning booster, the CRS is intended for children who weigh 18 kg (40 pounds) or more.

Figure 7: The Gerry Double Guard CRS used by the second row left passenger of the Dodge

The CRS was constructed of a plastic shell and the plastic removable shield. The integral lap belt within the shield assembly was designed to extend when the shield was opened. The length of the lap belt with the shield in the open position was 43 cm (16.9 in). With the shield in its closed position, the belt retracted to a length of 34 cm (13.4 in). When the shield is latched, a plastic tab closes and locks the lap belt retractor. The CRS and shield was covered with a padded fabric cover 1 cm (0.4 in) thick. At the time of the crash, the second row left passenger was seated in the CRS with the shield latched. The vehicle's lap-and-shoulder safety belt was not routed through the belt path on the CRS. The police on-scene photographs of the CRS and the child prior to their removal from the vehicle indicated that the lap belt was possibly positioned under the CRS and the shoulder belt was positioned across the child's chest.

Figure 8: The shield and lap belt on the Gerry Double Guard CRS

Figure 9: The Graco Turbo Booster used by the second row right passenger of the Dodge

Inspection of the CRS revealed no crash related damage. The shield and integral lap belt assembly functioned normally. The latch on the hinge side of the removable shield was jammed and the shield could not be removed from the CRS.

The second row right passenger [5-year-old male, 122 cm (48 in) and 22 kg (49 lbs)] was seated in a Graco Turbo Booster belt-positioning booster CRS (**Figure 9**). The CRS was manufactured on June 22, 2007 and the model number was 8491QNY. The CRS was designed to be used with or without a back support. The back support was not in use at the time of the crash and was not with the CRS. When used without the back support, the CRS was designed for children whose height was 102 to 145 cm (40 to 57 in). When used with the back support, the CRS was designed for children whose height was 97 cm to 145 cm (38 to57 in).

The CRS was constructed of plastic and was equipped with height adjustable arm rests. It had a 1 cm (0.4 in) thick cushion on the seat. The CRS sustained no damage during this crash. The second row right passenger was seated in the CRS at the time of the crash. While, the safety belt was in use, it is not known how it was positioned on the passenger.

CASE VEHICLE DRIVER KINEMATICS

The unrestrained driver of the Dodge [28-year-old male, 160 cm (63 in) and 64 kg (140 lbs)] was seated in an upright posture. The driver's seat track was located between the middle and rear

positions and the seat back was slightly reclined. The tilt steering column was located in the center position. The driver was not wearing glasses.

The initial impact with the 6 cm (2.4 in) diameter sapling was minor and probably had little effect on the seated position of the driver. The frontal impact with the 130 cm (51.2 in) diameter tree displaced the driver forward. The driver loaded through the deployed frontal air bag and his chest contacted and deformed the upper half of the steering wheel rim 8 cm (3.1 in). He contacted his left foot on the toe pan and right knee on the center instrument panel causing a fracture of the left medial malleolus and a comminuted fracture of the right patella. As the vehicle deflected to the right off the tree and rolled over right side leading, the driver was redirected toward the roof. He contacted his head on the roof during the rollover and sustained a concussion. He also sustained multiple abrasions during the crash. He remained in the vehicle throughout the crash and came to final rest in the front row. He was removed from the vehicle by rescue personnel.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ground ambulance to a hospital and admitted for treatment of his injuries. He was hospitalized for four days and had three follow-up visits to a medical facility. He was not working at the time of the crash. The table presents the driver's injuries and injury sources.

Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Concussion with less than 30 minutes of loss of consciousness and amnesia for event	moderate 161004.2,0	Roof	Probable	Hospitalization records
2	Fracture, closed, comminuted, right patella with displacement of fracture fragments, 2 cm (0.8 in) and ORIF[1]	moderate 854500.2,1	Center lower instrument panel	Certain	Hospitalization records
3	Fracture, oblique, left medial malleolus, non-displaced; no dislocation (syndesmosis widening) with ORIF[1]	moderate 854361.2,2	Floor, including toe pan	Certain	Hospitalization records
4	Abrasion right occipital region of scalp, not further specified	minor 110202.1,6	Roof	Probable	Hospitalization records
5	Abrasions face, not further specified with dried blood on lips	minor 210202.1,9	Air bag, driver's	Probable	Hospitalization records
6	Injury to nose with epistaxis (dried blood in nares)	minor 251004.1,4	Air bag, driver's	Probable	Hospitalization records

[1] ORIF=surgically--Open Reduction and Internal Fixation, was required for this lesion.

Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
7	Abrasion right axilla, not further specified	minor 410202.1,1	Air bag, driver's	Possible	Hospitalization records
8	Abrasion right knee with swelling, not further specified	minor 810202.1,1	Center lower instrument panel	Probable	Hospitalization records
9	Abrasion, mild, medial left ankle with swelling	minor 810202.1,2	Floor, foot controls	Probable	Hospitalization records

CASE VEHICLE FRONT ROW RIGHT PASSENGER KINEMATICS

The unrestrained front row right passenger [28-year-old female, 157 cm (62 in) and 54 kg (120 lbs) was asleep and leaning to the left. The passenger's seat track was located between the middle and forward positions and the seat back was slightly reclined. The passenger was not wearing glasses.

The frontal impact with the 130 cm (51.2 in) diameter tree displaced the front right passenger forward. She contacted her knees on the glove box door and loaded through the deployed frontal air bag contacting her chest on the right instrument panel, which caused a contusion of the left lung and fractures of left ribs 3, 5 and 6. She contacted her right foot on the toe pan and sustained a comminuted displaced fracture of the right distal tibia and fracture of the right medial malleolus. She also sustained a comminuted displaced fracture of the talus and calcaneus from the toe pan contact. The passenger rebounded into her seat and as the vehicle rolled over right side leading, she was redirected toward the roof and then into the second row. As the vehicle touched down to final rest on the left side, she contacted her head on the left roof side rail and came to final rest on top of the second row left passenger. She sustained a concussion with loss of consciousness from the roof side rail contact.

CASE VEHICLE FRONT ROW RIGHT PASSENGER INJURIES

The front row right passenger was transported by air ambulance to a trauma center and admitted for treatment of her injuries. She was hospitalized for four days and had three follow-up visits to a medical facility. She did not know when she would be able to return to work. The table below presents the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Concussion with loss of consciousness greater than 6 hours but less than 24 hours; GCS=7 initially, then became unresponsive at scene with seizure activity at scene noted by EMS	serious 161006.3,0	Roof, left rear side rail	Probable	Hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
2	Contusion left lung (pulmonary) at apex, not further specified	moderate 441407.2,2	Right instrument panel	Probable	Hospitalization records
3	Fracture, nondisplaced, left ribs: 3rd, 5th, and 6th–the 6th rib was fractured posteriorly, not further specified for 3rd and 5th ribs	serious 450203.3,2	Right instrument panel	Probable	Hospitalization records
4	Fracture, comminuted, displaced, intra-articular, right distal tibia including shear-type (vertical medial) fracture right medial malleolus; tibial impaction	moderate 854371.2,1	Floor, including toe pan *(indirect injury)*	Certain	Hospitalization records
5	Fracture, comminuted, displaced, talus including body, talar neck, and dome with 2 fragments separated and displaced from body and neck by 2 cm (0.8 in); involvement of tibial and posterior facet articular surfaces[2]; impaction of talus on calcaneus	moderate 857271.2,1	Floor, including toe pan *(indirect injury)*	Certain	Hospitalization records
6	Fracture calcaneus, posterior aspect of sustentaculum tali[3]	moderate 857351.2,1	Floor, including toe pan	Certain	Hospitalization records
7	Hematoma, auricular, left, requiring surgical intervention	minor 210402.1,2	Roof, left side rail	Probable	Hospitalization records
8	Laceration left ear, not further specified	minor 210600.1,2	Roof, left side rail	Probable	Hospitalization records
9	Abrasion over right eye, not further specified	minor 210202.1,7	Air bag, front right passenger's	Probable	Emergency room records
10	Abrasions face, including left cheek, not further specified	minor 210202.1,2	Air bag, front right passenger's	Probable	Hospitalization records
11	Abrasions bilateral upper extremities, not further specified	minor 710202.1,3	Air bag, front right passenger's	Probable	Hospitalization records
12	Abrasions, small, multiple, left leg in ankle area, not further specified	minor 810202.1,2	Right lower instrument panel (includes knee bolster)	Probable	Hospitalization records

[2] Talar dome was depressed 1 cm (0.8 in) relative to distal talus; significant deformity of medial talar articular surface with fragment displacement and significant deformity to both talar dome and talar articular surface of posterior facet.

[3] From Wikipedia: at the upper and forepart of the medial surface of the calcaneus is a horizontal eminence, the sustentaculum tali (alternatively, the talar shelf), which gives attachment to … ligaments.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
13	Abrasions anterolateral right distal lower leg and ankle	minor 810202.1,1	Right lower instrument panel (includes knee bolster)	Probable	Hospitalization records
14	Lacerations anterolateral right distal lower leg and ankle	minor 810602.1,1	Right lower instrument panel (includes knee bolster)	Probable	Hospitalization records
15	Contusion (ecchymosis) around right calcaneus	minor 810402.1,1	Floor, including toe pan	Probable	Hospitalization records

CASE VEHICLE SECOND ROW LEFT PASSENGER KINEMATICS

The second row left passenger [4-year-old male, 117 cm (46 in) and 21 kg (47 lbs)] was seated in an unknown posture in the CRS. The shield of the CRS was latched to keep the child within the CRS; however, instead of using the lap-and-shoulder belt to secure the CRS to the vehicle's seat, the safety belt was used unconventionally around the child similar to how a safety belt is used to secure a child in a booster seat. The shield was latched over the belt and the child.

During the crash sequence, the CRS and the passenger were displaced off the seat and out of the lap-and-shoulder safety belt. The CRS rode up the seat back of the vehicle and the passenger was redirected to the left and toward the roof during the rollover. As the vehicle rolled over onto its left side, the passenger was partially ejected out of the partially open left rear window glazing. When the vehicle touched down on its left side at final rest, the passenger's head and right hand were entrapped between the glazing and the ground. The passenger sustained a crushed skull with exposure of the brain.

CASE VEHICLE SECOND ROW LEFT PASSENGER INJURIES

The passenger was pronounced deceased at the crash scene. He was transported to a hospital where a post-mortem examination was conducted. The table below presents the passenger's injuries and injury sources based on the post-mortem exam[4] and the on-scene photos.

[4] There were no images obtained of the post-mortem exam.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Crushed skull, maxilla to vertex with brain exposed and partially missing with minimal injury elsewhere, not further specified	maximal 113000.6,0	Ground[5]	Probable	Post-mortem examination
2	Abrasions, multiple, right arm	minor 710202.1,1	Ground	Probable	Other: on-scene photos
3	Contusions, multiple, right arm	710402.1,1	Ground	Probable	Other: on-scene photos

CASE VEHICLE SECOND ROW RIGHT PASSENGER KINEMATICS

The second row right passenger [5-year-old male, 122 cm (48 in) and 22 kg (49 lbs)] was seated in an unknown posture in the CRS. He was restrained by the lap portion of the safety belt, but it could not be determined if the shoulder portion was also in use.

During the crash sequence, the CRS and the passenger were displaced off the seat and out of the lap-and-shoulder safety belt. Following the crash, the passenger and the CRS were found in the second row left seating position on top of the second row left passenger. The position of the safety belt on the second row right passenger and whether it was tightly secured could not be determined. It is possible that there was slack in the lap belt and the shoulder belt was not in use, which allowed the passenger and the CRS to separate from the safety belt during the crash sequence. The passenger's injuries, which included a hematoma of the duodenum, lacerations of the small bowel, lacerations of the colon and cecum, and a fracture of the L_2 vertebra were consistent with loading the lap portion of the safety belt during the crash.

CASE VEHICLE SECOND ROW RIGHT PASSENGER INJURIES

The second row right passenger was removed from the vehicle by rescue personnel and transported by air ambulance to a trauma center where he was hospitalized for 17 days. The table below presents the passenger's injuries and injury sources.

[5] Passenger was partially ejected out of the partially open LR window and the on-scene photos show that the child's head was entrapped between the ground and glazing.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
1	Hematoma, duodenum, requiring evacuation and ischemic serosa resection[6]	moderate 541010.2,7	Lap portion of safety belt system	Certain	Hospitalization records
2	Lacerations (perforations) x 4 in small bowel, focal, 1-2 cm (0.4 -0.8 in), well separated from each other requiring repair	serious 541424.3,8	Lap portion of safety belt system	Certain	Hospitalization records
3	Laceration (perforations) mid-descending colon and cecum requiring 2 large bowel resections with anastomoses[3]; 1 liter of blood loss and stool within belly	severe 540826.4,8	Lap portion of safety belt system	Certain	Hospitalization records
4	Fracture, Chance[7], L_2 vertebra, mostly horizontal extending through posterior elements into body of vertebra–with disruption of posterior ligament	moderate 650617.2,8	Lap portion of safety belt system	Certain	Hospitalization records
5	Abrasion forehead, not further specified	minor 210202.1,7	Seat back, front right passenger's	Probable	Hospitalization records
6	Contusion with hematoma, large, 5.1 cm (2 in) in diameter, raised about 0.6 cm (0.25 in) on forehead over left eye	minor 210402.1,7	Seat back, front right passenger's	Probable	Hospitalization records
7 8	Abrasions left cheek and nose, not further specified	minor 210202.1,2 210202.1,4	Seat back, front right passenger's	Probable	Hospitalization records
9 10	Contusion (bruise) left cheek and nose, not further specified	minor 210402.1,2 210402.1,4	Seat back, front right passenger's	Probable	Emergency room records

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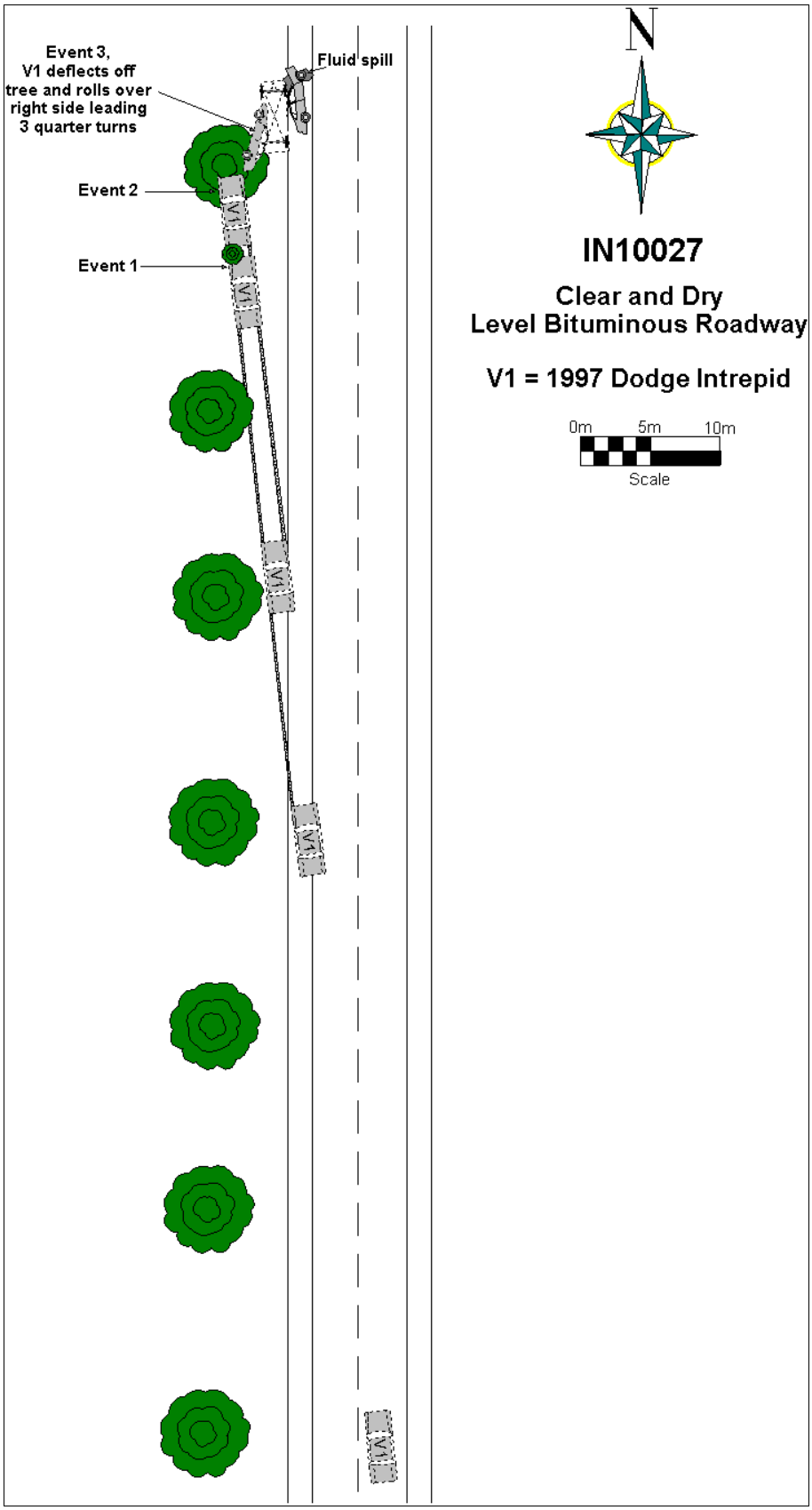
[6] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
anastomosis (a-nas″to-mo′sis): 1. a connection between two vessels. 2. an opening created by surgical, traumatic, or pathological means between two normally separate spaces or organs.
excision (ek-sizh′n) **[L. excisio, from ex out + caedere to cut]**: removal of a portion or all of an organ or other structure. Called also resection and ectomy.
ischemia (is-ke′me-a): deficiency of blood in a part, usually due to functional constriction or actual obstruction of a blood vessel.
ischemic (is-kem′ik): pertaining to, or affected with, ischemia.
resection (re-sek′shn) **[L. resectio]**: excision.

[7] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
fracture (frak′cher): 1. the breaking of a part, especially a bone. 2. a break or rupture in a bone.
Chance f.: horizontal splitting of the neural arch and body of a vertebra, usually in the lumbar region, caused by a flexion-distraction force; called also *seat belt f.*
There was 6-7 mm (0.1 in) of separation to the posterior elements with significant widening between spinous processes L1 & L2 (splaying). There was no cord or disc involvement.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 2005	Injury Source	Source Confidence	Source of Injury Data
11	Abrasions across abdomen at seat belt area[8]	minor 510202.1,8	Lap portion of safety belt system	Certain	Hospitalization records
12	Contusion, 4 cm (1.6 in) across lower abdomen[5]	minor 510402.1,8	Lap portion of safety belt system	Certain	Hospitalization records
13	Contusion (hematoma), mid to left back at upper lumbar area	minor 410402.1,6	Lap portion of safety belt system	Probable	Hospitalization records

[8] Lesions are flank-to-flank, above iliac crest, below umbilicus. Abdomen is rigid and painful to palpation.


Event 3,
V1 deflects off
tree and rolls over
right side leading
3 quarter turns
Fluid spill
Event 2
Event 1
V1
N
IN10027
Clear and Dry
Level Bituminous Roadway
V1 = 1997 Dodge Intrepid
0m
5m
10m
Scale