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CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS REMOTE CHILD SAFETY SEAT INVESTIGATION

NASS/SCI COMBO CASE NO: 04-04-069B

VEHICLE: 1999 VOLKSWAGEN PASSAT

LOCATION: NEW JERSEY

CRASH DATE: JULY 2004

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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 are 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 remote investigative effort focused on the performance of the Belt Positioning Booster (BPB) seat and the resulting injury mechanisms of the child occupant of a 1999 Volkswagen Passat. The Volkswagen was involved in a head-on collision with a 1999 Dodge Ram pickup truck. The Volkswagen was occupied by a restrained 25-year-old female driver and a 3-year-old female positioned in a BPB and restrained by the vehicle's lap and shoulder safety belt in the rear left. The Dodge was occupied by a 39-year-old male driver. The driver of the Dodge initiated a left turn at a Y-intersection which resulted in the head-on collision with the Volkswagen. The impact resulted the frontal air bag deployment in the Passat and the firing of the safety belt pretensioners in the four outboard positions. The 25-year-old female driver of the Volkswagen sustained police reported internal abdominal bleeding and was transported to a trauma center. The medical records for the driver were not obtained due to lack of a medical release and cooperation by the driver. Therefore, the specific injuries and treatment were unknown. The 3-year-old female passenger of the Volkswagen sustained serious level injures and was transported to a local hospital where she was airlifted to a trauma center. The 3-year-old female expired prior to arrival at the trauma center. The driver of the Dodge sustained minor injuries and was transported to a hospital where he was treated and released.			
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NASS/SCI COMBO CASE NO.: 04-04-69B
LOCATION: STATE OF NEW JERSEY
VEHICLE: 1999 VOLKSWAGEN PASSAT
CRASH DATE: JULY 2004

BACKGROUND

This remote investigative effort focused on the performance of the Belt Positioning Booster (BPB) seat and the resulting injury mechanisms of the child occupant of a 1999 Volkswagen Passat **(Figure 1)**. The Volkswagen was involved in a head-on collision with a 1999 Dodge Ram pickup truck. The Volkswagen was occupied by a restrained 25-year-old female driver and a 3-year-old female positioned in a BPB and restrained by the vehicle's lap and shoulder safety belt in the rear left. The Dodge was occupied by a 39-year-old male driver. The driver of the Dodge initiated a left turn at a Y-intersection which resulted in the head-on collision with the Volkswagen. The impact resulted the frontal air bag deployment in the Passat and the firing of the safety belt pretensioners in the four outboard positions. The 25-year-old female driver of the Volkswagen sustained police reported internal abdominal bleeding and was transported to a trauma center. The medical records for the driver were not obtained due to lack of a medical release and cooperation by the driver. Therefore, the specific injuries and treatment were unknown. The 3-year-old female passenger of the Volkswagen sustained serious level injures and was transported to a local hospital where she was airlifted to a trauma center. The 3-year-old female expired prior to arrival at the trauma center. The driver of the Dodge sustained minor injuries and was transported to a hospital where he was treated and released.

Figure 1. Subject vehicle 1999 Volkswagen Passat.

This crash was identified by the National Automotive Sampling System (NASS) PSU 04 during the weekly sampling of Police Accident Reports (PARs). This crash was selected and researched as CDS Case No. 04-04-069B. The NASS PSU performed the vehicle, scene and child safety seat inspections. Due to the presence of the child safety seat and the fatal injuries sustained by the child occupant in the 1999 Volkswagen Passat, NHTSA assigned the tasks of case review and report preparation to the General Dynamics SCI team.

SUMMARY

Crash Site

This intersection crash occurred during the evening hours of July 2004. At the time of the crash, it was daylight and the asphalt road surface was dry. The crash occurred at an angled three-leg intersection. The east/westbound roadway was configured with one travel lane in each direction and was delineated by a double yellow centerline. A concrete barrier curb bordered the south road edge. The intersecting roadway was configured with two travel lanes that were not delineated. Traffic flow through the intersection was not controlled. The posted speed limit for

the east/westbound roadway was 80 km/h (50 mph). The NASS scene schematic is included as **(Figure 15)** of this report.

Vehicle Data – 1999 Volkswagen Passat

The 1999 Volkswagen Passat was identified by the Vehicle Identification Number (VIN): 3B7HC12YXX (production sequence omitted). The vehicle was a four-door sedan that was equipped with a 1.8-liter turbo, I4 engine linked to a four-speed automatic transmission, 4-wheel power disc brakes with antilock, power steering, and a tilt/telescoping steering wheel. At the time of the vehicle inspection, the odometer could not be read due to the lack of power to the vehicle. The manufacturers recommended tire pressure was unknown, the NASS researcher could not locate the vehicle placard. The Volkswagen was configured with Hercules tires size P195/65R15. The specific tire data was as follows:

Position	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kpa	6 mm (8/32)	Yes	Unknown
LR	200 kpa (29 psi)	7 mm (9/32)	No	None
RF	234 kpa (34 psi)	6 mm (8/32)	No	None
RR	200 kpa (29 psi)	7 mm (9/32)	No	None

The Volkswagen was configured with front bucket seats with height adjustable head restraints. The driver's head restraint was adjusted between the mid to full-down position. The front right head restraint was adjusted to the full-down position. The second row was configured with a three-passenger bench seat with a split, forward folding seatback (60/40). The outboard seats were equipped with height adjustable head restraints that were adjusted to the full-down position.

1999 Dodge Ram

The 1999 Dodge Ram was identified by the Vehicle Identification Number (VIN): 3B7HC12YXX (production sequence omitted). The vehicle was a two-door pickup truck that was equipped with a 5.2 liter, V8 engine linked to a four-speed automatic transmission, power brakes, power steering, and a tilt steering wheel. At the time of the vehicle inspection the odometer could not be read due to the lack of power to the vehicle. The Dodge was equipped with Goodyear tires in the front and General tires on the rear size P245/75R16. The vehicle manufacturers recommended tire size was P225/75R16 with a recommended tire pressure of 283.0 kPa (41.0 PSI) for the front and rear tires. The specific tire data was as follows:

Position	Measured Pressure	Tread Depth	Restricted	Damage
LF	296 kpa (43 psi)	7 mm (9/32)	Yes	None
LR	179 kpa (26 psi)	3 mm (4/32)	No	None
RF	324 kpa (47 psi)	5 mm (6/32)	No	None
RR	324kpa (47 psi)	3 mm (4/32)	No	None

Crash Sequence

Pre-Crash

The 25-year-old female driver of the Volkswagen was operating the vehicle in a westbound **(Figure 2)** direction on the two-lane roadway approaching a three-leg Y-intersection. The 39-year-old male driver of the Dodge was operating the vehicle eastbound **(Figure 3)** on the same roadway approaching the same intersection. As the driver of the Dodge continued his eastbound travel, he initiated a left turn prior to the intersection and entered the westbound travel lane.

Figure 2. Volkswagen's westbound approach.

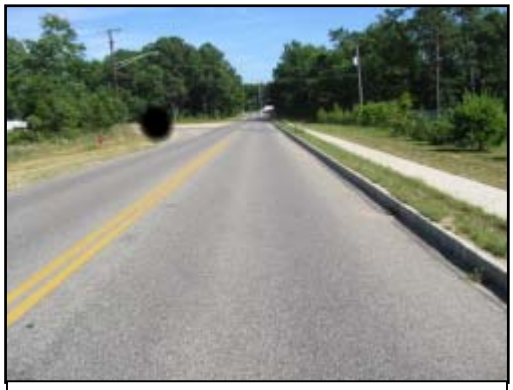

Figure 3. Dodge's eastbound approach.

Crash

The full frontal aspect of the Dodge impacted the full frontal aspect of the Volkswagen in the intersection. The impact resulted in severe frontal damage to the Volkswagen and the Dodge. The resultant directions of force were within 12 o'clock for both vehicles. The WINSMASH damage algorithm was used to calculate a delta for this impact. The total calculated delta V for the Volkswagen was 66.0 km/h (41.0 mph). The longitudinal and lateral components were -65.0 km/h (40.4 mph) and 11.5 km/h (7.1 mph), respectively. The total calculated delta V for the Dodge was 44.0 km/h (27.3 mph). The longitudinal and lateral components were -43.3 km/h (-26.9 mph) and -7.6 km/h (-4.7 mph), respectively. The impact resulted in the frontal air bag deployment and pretensioner firing in the Passat. The vehicles came to rest with the intersection.

Post-Crash

Police and EMS personnel responded to the crash site. The 25-year-old female driver of the Volkswagen sustained police reported internal abdominal bleeding and was transported by ambulance to a regional trauma center. The 3-year-old female passenger of the Volkswagen sustained serious level injures and was transported to a local hospital where she was airlifted to a trauma center. The 3-year-old female expired prior to arrival at the trauma center. The driver of the Dodge sustained minor injuries and was transported to a hospital where he was treated and released. Both vehicles sustained severe damage and were towed from the crash site.

Vehicle Damage

Exterior Damage – 1999 Volkswagen Passat

The 1999 Volkswagen Passat sustained severe severity frontal damage as a result of the impact with the Dodge **(Figure 4)**. The direct contact damage began at the front left bumper corner and extended 140.0 cm (55.1") to the front right bumper corner. The maximum crush was located at the front left bumper corner and measured 68.0 cm (26.8"). The damage resulted in the longitudinal displacement of the frontal components. The NASS researcher used six equidistant measurements to document the crush at the bumper level using a combined direct and induced damage width of 140.0 cm (55.5") and were as follows: C1 = 68.0 cm (26.8"), C2 = 53.0 cm (20.9"), C3 = 41.0 cm (16.1"), C4 = 30.0 cm (11.8"), C5 = 23.0 cm (9.1"), C6 = 27.0 cm (10.6"). The Collision Deformation Classification (CDC) for this impact was 12-FDEW-3.

Figure 4. Resultant frontal damage to the Volkswagen.

Interior Damage – 1999 Volkswagen Passat

The 1999 Volkswagen Passat sustained moderate damage as a result of occupant contacts. At impact with the Dodge, the frontal air bags deployed. The air bag deployment resulted in the displacement of the driver's left arm. As a result of this displacement, the driver's upper left arm contacted the front left window frame which was evidenced by hair. The driver's lower left arm contacted the door panel mounted power mirror control that was fractured. The NASS researcher noted a scuffmark to the knee bolster from contact with the driver's left knee. Also noted was stretching to the lap belt portion of the safety belt from the driver's abdomen loading the safety belt.

Figure 5. Overall view of the driver's area.

The 3-year-old female rear left passenger was seated in a belt-positioning booster at the time of the crash. At impact with the Dodge, she initiated a forward trajectory and loaded the shoulder portion of the manual 3-point lap and shoulder belt. The NASS researcher noted stretching and scratching to the safety belt webbing from the occupant contact/loading. **Figures 5 and 6** are overall views of the left side first and second rows.

Figure 6. Overall view of the second row left side.

The Volkswagen sustained moderate damage as a result of passenger compartment intrusion. The intrusions are listed in the following table:

Seat Position	Intruded Component	Magnitude	Direction
Front left	Windshield	9.0 cm (3.5”)	Longitudinal
Front left	Roof side rail	6.0 cm (2.4”)	Vertical
Front left	Roof	5.0 cm (1.9”)	Vertical
Front left	Toe pan	14.0 cm (5.5”)	Longitudinal
Front left	Left instrument panel	10.0 cm (3.9”)	Longitudinal
Front center	Windshield	17.0 cm (6.7”)	Longitudinal
Front center	Center instrument panel	6.0 cm (2.4”)	Lateral
Front right	Windshield	14.0 cm (5.5”)	Longitudinal
Front right	Toe pan	9.0 cm (3.5”)	Longitudinal
Rear left	B-pillar	3.0 cm (1.2”)	Lateral
Rear left	Floor	10.0 cm (3.9”)	Vertical
Rear right	Floor	10.0 cm (3.9”)	Vertical

Exterior – 1999 Dodge Ram

The 1999 Dodge Ram pickup truck sustained severe frontal damage as a result of the impact with the Volkswagen **(Figures 7)**. The direct damage began at the front left bumper corner and extended 185.0 cm (72.8”) to the right bumper corner. The maximum crush was located at the center of the frontal bumper and measured 65.0 cm (25.6”). Six crush measurements were used to document the crush along the frontal plane at the bumper level using a combined direct and induced damage width of 185.0 cm (72.8”) and were as follows: C1 = 53.0 cm (20.8”), C2 = 62.0 cm (24.4”), C3 = 65.0 cm (25.6”), C4 = 64.0 cm (25.2”), C5 = 49.0 cm (19.3”), C6 = 34.0 cm (13.4”). The CDC for this impact was 12-FDEW-3.

Figure 7. Crush profile for the 1999 Dodge Ram.

Manual Restraints Systems – 1999 Volkswagen Passat

The 1999 Volkswagen Passat was configured with manual 3-point lap and shoulder belts for the four outboard seating positions. The driver's safety belt **(Figure 8)** was configured with continuous loop webbing, sliding latch plate, height adjustable D-ring that was in the lower position at the time of the NASS inspection, Emergency Locking Retractor (ELR), and a retractor pretensioner that fired as a result of the crash. The stretching to the lap belt portion of the safety belt resulted from the driver's pelvic region loading the safety belt. Minimal occupant contacts and the fired status of the pretensioner supported the safety belt usage for the driver. The front right safety belt was configured with a sliding latch plate, height adjustable D-ring that was in the lower position at the time of the NASS inspection, switchable ELR/Automatic Locking Retractor (ALR), and a retractor pretensioner that did not fire.

Figure 8. Driver's safety belt.

The second row outboard safety belts were configured with sliding latch plates, switchable ELR/Automatic Locking Retractor (ALR), and retractor pretensioners that fired as a result of the crash. The rear left safety belt **(Figure 9)** was used with a high back belt-positioning booster seat which was supported by the stretching and scratching to the safety belt from the occupant contact/loading and fired retractor pretensioner. The rear right safety belt was used to restrain an unoccupied belt positioning booster seat at the time of the crash, which was evidenced by the fired retractor pretensioner. The rear center safety belt was a 2-point manual lap belt that was configured with a sliding latch plate and an ALR.

Figure 9. Rear left safety belt with fired pretensioner.

High-Back Belt Positioning Booster Child Safety Seat– Cosco Complete Voyager

The Cosco Complete Voyager high-back Belt-Positioning Booster (BPB) seat **(Figures 10 and 11)** was identified by the Model Number: 22-210-TIM. The date of manufacture was March 5, 2004. The BPB was configured with three shoulder belt positioning slots on the upper outboard aspects. It was not known what position the shoulder belt was placed. It should be noted that use of the shoulder belt positioners could not be confirmed. The NASS researcher noted a stress crease on the rear aspect of the right side panel of the of BPB. Also noted was a spot of body fluid on the upper right side of the seatback and a scuff to the lower right side of the cushion. The manual 3-point lap and shoulder belt was used to restrain the child in the rear left seat of the vehicle. The vehicle's safety belt system was equipped with a retractor pretensioner that fired as a result of the crash. The safety belt was found restricted in the used position which was as result of the fired pretensioner. The BPB was used to position the 3-year-old child to ensure a proper

fit with the vehicle's safety belt. A label on the BPB outlined the recommended use of the BPB as follows:

Belt-Positioning Booster

- Use only with children who weigh between 14-36 kg (30-80 lb) and height is between 73-132 cm (29-52") and over 1 year in age.

Do not use this child restraint if the midpoint of your child's head is above the top of the child restraints seatback.

- Use only the vehicle's lap and shoulder belt system when restraining the child in this booster seat.
- Do not use with lap belt only

Figure 10. BPB in the vehicle's rear left position.

Figure 11. Overall view of BPB.

Unoccupied High-Back Belt Positioning Booster Child Safety Seat – Cosco Complete Voyager

The NASS researcher noted a second BPB **(Figure 12)** in the rear right position of the Volkswagen. This BPB was not occupied at the time of the crash. The BPB was a Cosco Complete Voyager with a model number of 22-210-TM. The date of manufacture for this BPB was November 13, 2003. The BPB was found with the manual 3-point lap and shoulder belt in the used position. This was supported by the fired retractor pretensioner.

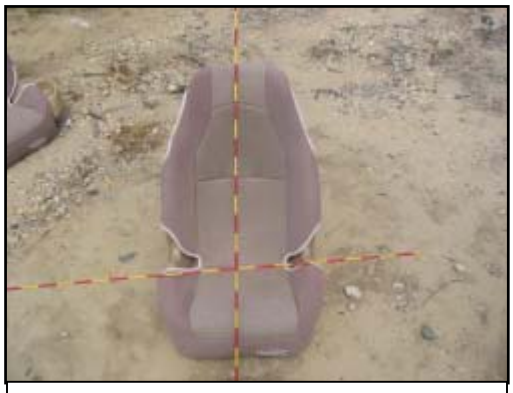

Figure 12. Unoccupied BPB.

Redesigned Frontal Air Bag System – 1999 Volkswagen Passat

The 1999 Volkswagen Passat was equipped with redesigned frontal air bags for the driver and front right passenger positions. The driver's air bag was conventionally located in the center of the steering wheel and the front right passenger's air bag was a top-mount module located on the right instrument panel. The redesigned frontal air bag system deployed as result of the subject crash.

Figure 13. Deployed driver's frontal air bag.

The driver's air bag module consisted of two H-configuration cover flaps. The top cover flap measured 17.0 cm (6.7") in width and 9.0 cm (3.5") in height. The lower cover flap measured 17.0 cm (6.7") in width and 7.0 cm (2.8") in height. The driver's air bag measured 72.0 cm (28.3") in diameter in its deflated state and contained two tethers. A single vent port that was located at the 12 o'clock position on the rear aspect vented the air bag. The NASS researcher noted no occupant contacts or failures to the driver's air bag. **Figure 13** is an overall view of the deployed driver's frontal air bag.

Figure 14. Deployed front right air bag.

The front right air bag **(Figure 14)** module consisted of a single cover flap configuration that measured 34.0 cm (13.4") in width and 20.0 cm (7.9") in height. The air bag membrane measured 70.0 cm (27.8") in width and 85.0 cm (33.5") in height and was not tethered. A single vent port that was located at the 11 o'clock position on the rear aspect of the top panel vented the air bag. No occupant contacts or failures were noted to the front right air bag.

Side impact Air Bags – 1999 Volkswagen Passat

The 1999 Volkswagen Passat was equipped with seatback mounted side impact air bags for the front seating positions. The side impact air bags did not deploy in the subject crash.

Occupant Demographics – 1999 Volkswagen Passat

Driver

Age/Sex:	25-year-old female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Forward track
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a regional trauma center, unknown type of treatment.

Driver Kinematics

The 25-year-old female driver of the Volkswagen was seated in a presumed upright posture with the seat track adjusted to a forward track position. At impact with the Dodge, the driver's frontal air bag deployed. The air bag expanded against her left anterior forearm which displaced driver's left arm from the steering wheel rim. As a result of this displacement, the driver's left forearm contacted the front left window frame which was evidenced by hair. The driver's left elbow contacted and fractured the door panel mounted power mirror control. The driver was displaced forward as result of the 12 o'clock impact force. The forward movement resulted in stretching to the lap belt portion of the safety belt from the driver's pelvic region loading the safety belt. Also noted was a scuff to the knee bolster from contact with the driver's left knee.

As a result of the crash, the driver sustained police reported internal abdominal bleeding and was transported by ambulance to a regional trauma center. The medical records for the driver were not obtained due to lack of a medical release and cooperation by the driver. Therefore, the specific injuries and treatment were unknown.

Rear Left Passenger

Age/Sex:	3-year-old female
Height:	99.0 cm (40.0”)
Weight:	17 kg (37 lb)
Seat Track Position:	Not adjustable
Manual Restraint Use:	Belt positioning booster seat Cosco Complete Voyager with vehicle’s lap and shoulder belt
Usage Source:	Vehicle inspection, CSS inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a hospital by ambulance and then was airlifted to a trauma center where she expired on route.

Rear Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Small cerebrum subarachnoid hemorrhage (posterior surfaces)	Serious (140684.3,9)	BPB seatback
Small cerebellum subarachnoid hemorrhage	Serious (140466.3,6)	BPB seatback
Mild cerebrum swelling	Serious (140662.3, 3)	Hyperflexion
Thoracic cavity injury with hemo-/pneumothorax	Serious (442202.3,2)	Shoulder belt
Upper cervical spine fracture with atlanto-occipital subluxation (dislocation)	Moderate (650216.2,6)	Hyperflexion
Jenjunum-ileum contusion (upper small intestines)	Moderate (541410.2,8)	Lap belt
Mesentery contusion	Moderate (542010.2,8)	Lap belt
Inferior abdomen contusion	Minor (590402.1,8)	Lap belt
12.7 x 3.8 cm (5.0 x 1.5”) contusion of the upper left chest and left anterior shoulder	Minor (490402.1,2), (790402.1,2)	Shoulder belt

Injury source: Autopsy

Rear Left Passenger Kinematics

The 3-year-old female passenger was restrained in a Cosco Complete Voyager high-back BPB on the left aspect of the second row bench seat. At impact with the Dodge, she initiated a forward trajectory and her upper body loaded the manual 3-point lap and shoulder belt. This loading resulted in the thoracic cavity injury with hemo-/pneumothorax, jenjunum-ileum contusion, mesentery contusion, inferior abdomen contusion, and a 12.7x3.8 cm (5.0x1.5”) contusion of the upper left chest and left anterior shoulder.

The loading of the safety belt restricted the movement of the passenger's torso which allowed her head to hyperflex over the shoulder belt portion of the safety belt. This hyperflexion resulted in the mild cerebrum swelling, upper cervical spine fracture with atlanto-occipital subluxation. The 3-year-old passenger rebounded into the BPB and her head contacted the upper aspect of the BPB seatback, which resulted in the small cerebrum subarachnoid hemorrhage and small cerebellum subarachnoid hemorrhage.

Medical Treatment

The 3-year-old passenger was transported by ambulance to a local hospital where she was airlifted to a trauma center. The 3-year-old female expired prior to the arrival at the trauma center. The medical records for the initial hospital were not obtained due to lack of a medical release and cooperation by the driver.

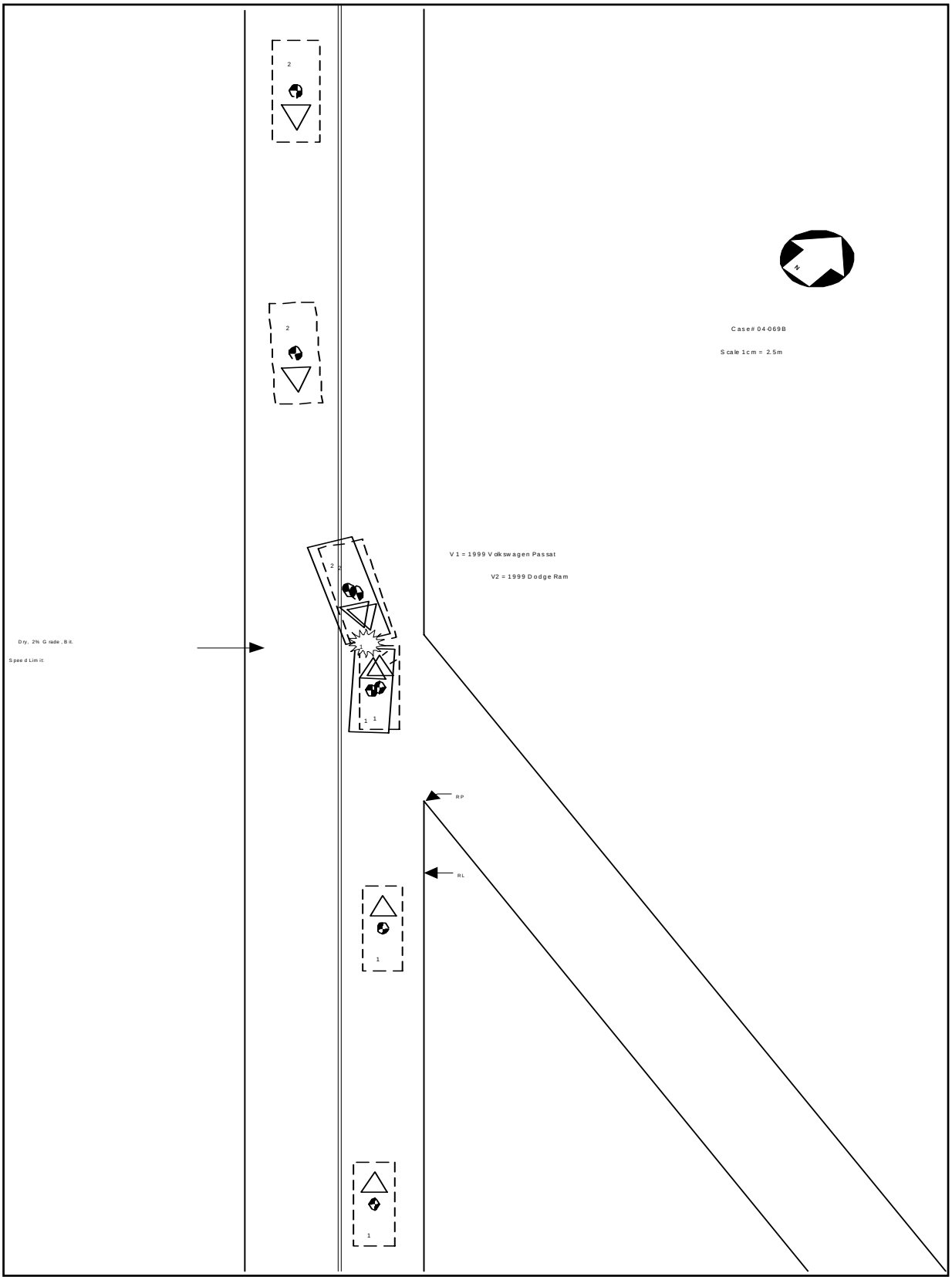

Figure 15. Scene Schematic