CRASH DATA RESEARCH CENTER

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS CDS CASE NO. 1999-04-057J

RABSS VEHICLE - 1998 CHEVROLET S-10 PICKUP TRUCK

LOCATION - STATE OF NEW JERSEY

CRASH DATE - JULY, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. *Report No.* 99-04-057J	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Chevrolet S-10 pickup truck Location - State of New Jersey		5. *Report Date*: October, 2001 6. *Performing Organization Code*	
7. *Author(s)* Crash Data Research Center		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Crash Data Research Center Veridian Engineering Division P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0298.(0000-0009) 11. *Contract or Grant No.* DTNH22-94-D-07058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. *Type of Report and Period Covered* Technical Report Crash Date - July, 1999 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* NASS investigation of an offset frontal collision that involved a 1998 Chevrolet S-10 pickup truck equipped with redesigned frontal air bags.			
16. *Abstract* This investigation focused on a two vehicle crash involving a 1998 Chevrolet S-10 pickup truck (subject vehicle) and a 1995 Isuzu Trooper 4x4 sport utility vehicle. The Chevrolet S-10 was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with the Isuzu Trooper. The driver of the Chevrolet was operating the vehicle southbound and negotiating a left curve when she allowed the vehicle to cross the centerline into the path of the northbound Isuzu. As the Chevrolet entered the northbound lane, the front left area impacted the front left area of the Isuzu resulting in severe damage to both vehicles. The restrained 22 year old female driver of the 1998 Chevrolet S-10 initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Contact to the knee bolster resulted in a left knee abrasion and multiple fractures of the left femur. Venting driver air bag gases produced a 3rd degree burn to the left forearm. She loaded through the deployed driver air bag and struck the upper portion of the steering wheel rim which resulted in a contusion to the duodenum and lacerations of the spleen/liver. Contact to the steering wheel hub/spoke resulted in a forehead laceration, nose fracture and concussion. She also sustained a fractured right fibula and near amputation below the left ankle as a result of contact to the (intruded) toepan. The driver was transported to a local trauma center for treatment and admitted for 20 days. The restrained 22 year old male front right passenger of the Chevrolet also initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, glove compartment door and deployed redesigned passenger air bag. Loading of the manual restraint resulted in an abrasion to the right lateral abdomen while contact to the deployed passenger air bag resulted in abrasions to the right lateral chest. Loading of the glove compartment door resulted in bilateral knee abrasions. He also sustained a posterior scalp laceration and underlying concussion as a result of contact to the back light header. The passenger was transported to a local trauma center for treatment and admitted for 1 day.			
17. *Key Words* Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FDEW-6 Proper use of the manual belt system Near amputation below left ankle		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 8	22. *Price*

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BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Chevrolet S-10 pickup truck (subject vehicle) and a 1995 Isuzu Trooper 4x4 sport utility vehicle. The Chevrolet S-10 was equipped with redesigned frontal air bags for the driver and front right passenger positions which deployed as a result of an offset frontal collision with the Isuzu Trooper. The driver of the Chevrolet was operating the vehicle southbound and negotiating a left curve when she allowed the vehicle to cross the centerline into the path of the northbound Isuzu. As the Chevrolet entered the northbound lane, the front left area impacted the front left area of the Isuzu resulting in severe damage to both vehicles. The restrained 22 year old female driver of the 1998 Chevrolet S-10 initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Contact to the knee bolster resulted in a left knee abrasion and multiple fractures of the left femur. Venting driver air bag gases produced a 3rd degree burn to the left forearm. She loaded through the deployed driver air bag and struck the upper portion of the steering wheel rim which resulted in a contusion to the duodenum and lacerations of the spleen/liver. Contact to the steering wheel hub/spoke resulted in a forehead laceration, nose fracture and concussion. She also sustained a fractured right fibula and near amputation below the left ankle as a result of contact to the (intruded) toepan. The driver was transported to a local trauma center for treatment and admitted for 20 days. The restrained 22 year old male front right passenger of the Chevrolet also initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, glove compartment door and deployed redesigned passenger air bag. Loading of the manual restraint resulted in an abrasion to the right lateral abdomen while contact to the deployed passenger air bag resulted in abrasions to the right lateral chest. Loading of the glove compartment door resulted in bilateral knee abrasions. He also sustained a posterior scalp laceration and underlying concussion as a result of contact to the back light header. The passenger was transported to a local trauma center for treatment and admitted for 1 day.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 1999-04-057J and also included in the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the early morning hours of July, 1999. At the time of the crash, it was dark (street lighted) with no adverse conditions as the road was dry. The crash occurred in the northbound lane of a (level) two lane north/south roadway **(see Figure 8 - page 8)** along the straightaway of an "S" curve. The asphalt roadway was bordered by narrow paved shoulders and utility poles. No traffic control was present at the scene which had a posted speed limit of 80 km/h (50 mph).

Pre-Crash

The 22 year old female driver of the 1998 Chevrolet pickup truck was operating the vehicle southbound **(Figure 1)** and negotiating a left curve when she entered the straightaway and allowed the vehicle to cross the centerline into the path of the northbound Isuzu. The police reported no brake marks at the scene indicative of driver avoidance maneuvers.

The 45 year old female driver of the 1995 Isuzu Trooper 4x4 4-door sport utility vehicle was operating the vehicle northbound **(Figure 2)** and negotiating a left curve when she entered the straightaway and observed the southbound Chevrolet encroach into her lane of travel. The police reported no brake marks at the scene indicative of driver avoidance maneuvers. The front right passenger position was occupied by a 44 year old male.

Figure 1. Southbound approach for the 1998 Chevrolet S-10 pickup truck.

Figure 2. Northbound approach for the 1995 Isuzu Trooper sport utility vehicle.

Crash

As the Chevrolet pickup truck crossed the centerline into the path of the northbound Isuzu, the front left area impacted the front left area of the Isuzu which resulted in severe damage to both vehicles. Although the outputs were not coded into the NASS case file *(researcher stated the results were too high and beyond the scope of the program)*, the missing vehicle algorithm of the WinSMASH reconstruction program computed velocity changes of 84.5 km/h (52.5 mph) for the subject vehicle and 70.8 km/h (44.0 mph) for the struck Isuzu. Respective longitudinal components were -83.2 km/h (-51.7 mph) and -70.7 km/h (-43.9 mph). The impact induced deceleration was sufficient to deploy the Chevrolet's redesigned frontal air bag system. At this point, the Chevrolet rotated approximately 35 degrees counterclockwise and came to rest partially in the southbound lane facing southeast. The Isuzu Trooper rotated approximately 20 degrees counterclockwise and came to rest in the northbound lane facing northwest.

Post-Crash

The Chevrolet driver's lower extremities were pinned by the (intruded) toepan/instrument panel as she was subsequently extricated from the vehicle by rescue personnel due to perceived serious injury. The exit status of the Chevrolet passenger (and Isuzu occupants) were unknown. The driver and passenger of the Chevrolet were subsequently transported by ambulance to a local trauma center for treatment and admitted for 20 days and 1 day, respectively. The driver and front right passenger of the Isuzu were transported by ambulance to a local trauma center for treatment and admitted for 6 days and 10 days, respectively. Both vehicles were towed from the crash site due to disabling damage.

RABSS VEHICLE

The 1998 Chevrolet S-10 pickup truck was identified by the vehicle identification number (VIN): 1GCCS1441WK (production number deleted). The vehicle was a conventional cab pickup truck equipped with rear-wheel drive and a 2.2 liter, 4-cylinder engine. The police report listed the driver as the owner of the vehicle. The odometer reading was unknown at the time of the crash. The seating was configured with a split bench (with folding backs). The NASS interview was not obtained, therefore, previous crashes or maintenance on the Chevrolet's frontal air bag system were unknown.

VEHICLE DAMAGE

Exterior

The 1998 Chevrolet S-10 pickup truck sustained severe frontal damage as a result of the impact with the Isuzu Trooper sport utility vehicle **(Figures 3 & 4)**. The direct contact damage encompassed the entire front end width resulting in a combined direct and induced damage length (Field L) of 72.0 cm (28.3 in). Six crush measurements were documented at the level of the bumper: C1= 151.0 cm (59.4 in), C2= 129.0 cm (50.8 in), C3= 118.0 cm (46.5 in), C4= 76.0 cm (29.9 in), C5= 51.0 cm (20.1 in), C6= 32.0 cm (12.6 in). The Collision Deformation Classification (CDC) for this impact to the Chevrolet was 12-FDEW-6 with a principal direction of force of (+)10 degrees. *The crush seemed overstated, however, inadequate researcher field documentation prohibited further SCI analysis for correctional purposes.* The hood was deformed rearward from the impact force. The left fender was displaced rearward which restricted/deflated the left front wheel/tire and jammed the left door. Extensive (left and right side) bed to cab contact was noted which also jammed the right door. The right front wheel/tire was deflated (not restricted). The windshield was fractured from exterior impact forces. Reduction in the left side wheelbase measured 90.0 cm (35.4 in) while elongation in the right side wheelbase measured 3.0 cm (1.2 in). The pillars were cut as the roof and doors were removed by rescue personnel during occupant extrication activities post-crash.

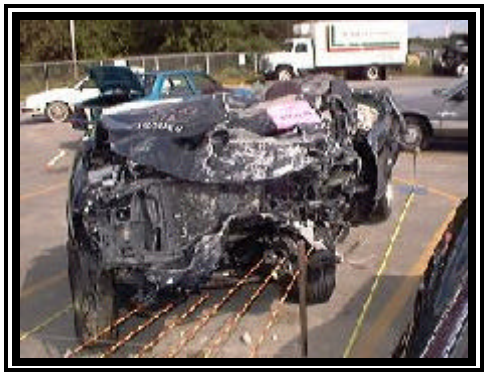

Figure 3. Frontal damage to the 1998 Chevrolet S-10 pickup truck.

Figure 4. Left side view.

Interior

Figure 5. Interior view.

Interior damage to the Chevrolet pickup truck identified through the vehicle inspection was severe and was attributed to occupant contact and component intrusion **(Figure 5)**. Scuff marks and indentations were documented on the left knee bolster, center instrument panel (at the junction with the right knee bolster), and glove compartment door. The left and right instrument panel were fractured and out-of-place. The upper portion of the steering wheel rim was deformed forward 14.0 cm (5.5 in). Deformation to the lower portion of the steering wheel rim was not identified as the hub/spokes were also deformed. Tissue transfers and blood pooling were noted to the left toepan area. Vertical floor buckling *(intrusion)* deformed the seat cushions upward while bed to cab contact produced extensive longitudinal (forward) buckling of the rear cab panel, which deformed the seat backs to an upright position. *SCI revised* longitudinal intrusions into the driver space involved 50.0 cm (19.7 in) of toepan, 39.0 cm (15.4 in) of instrument panel, and 37.0 cm (14.6 in) of steering wheel/column intrusion. 26.0 cm (10.2 in) of lateral sill intrusion was also documented to the driver space. Additional longitudinal intrusions into the front occupant space involved 25.0 cm (9.8 in) center instrument panel, 13.0 cm (5.1 in) of right instrument panel, 14.0 cm (5.5 in) of right toepan, 16.0 cm (6.3 in) of rear panel (left), 11.0 cm (4.3 in) of rear panel (center), and 13.0 cm (5.1 in) of rear panel (right) intrusion. Vertical intrusions into the front passenger space involved 4.0 cm (1.6 in) of left floor and 6.0 cm (2.4 in) of right floor intrusions. The rear panel intrusions (buckling) produced longitudinal seat back intrusions of 5.0 cm (2.0 in) to the left and 8.0 cm (3.1 in) to the right seat back.

REDESIGNED AIR BAG SYSTEM

The 1998 Chevrolet S-10 pickup truck was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The flaps were symmetrical in shape and measured 7.0 cm (2.8 in) in width and 10.0 cm (3.9 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted on the lower (centered) portion of the air bag face. The NASS researcher measured the diameter of the driver air bag at 68.0 cm (26.8 in) in its deflated state **(Figure 6)**. The bag was tethered by four internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. The cover flap was rectangular in shape and measured 32.0 cm (12.6 in) in width and 12.0 cm (4.7 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps. The NASS researcher measured the passenger air bag at 50.0 cm (19.7 in) square in its deflated state **(Figure 7)**. Blood spattering was noted on the upper left quadrant of the air bag face. No internal tether straps were present. The bag was vented by two ports located at the 9 o'clock and 3 o'clock sectors on the side aspect of the air bag. The vehicle was equipped with a passenger air bag cutoff switch which was set to the *"on"* position.

Figure 6. 1998 Chevrolet S-10 deployed redesigned driver air bag.

Figure 7. 1998 Chevrolet S-10 deployed redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	22 year old female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, police report
Eyeware:	None
Type of Medical Treatment:	Transported to a local trauma center and admitted (20 days)

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Laceration spleen (complex-multiple avulsions to superior, inferior, and hilar aspects of capsule)	Critical (544228.5,2)	Steering wheel rim
*3rd degree burn left arm (arm/hand/small and ring fingers)	Serious (792010.3,2)	Venting driver air bag gases
*Fracture left femur (distal shaft-comminuted)	Serious (851814.3,2)	Left knee bolster
*Fracture left femur (supra condylar-comminuted)	Serious (851822.3,2)	Left knee bolster
*Near amputation below left ankle	Serious (811002.3,2)	Toepan
*Contusion duodenum	Moderate (541010.2,7)	Steering wheel rim
*Laceration liver (minor-5cm)	Moderate (541822.2,1)	Steering wheel rim
*Fracture right fibula (lateral malleous-displaced/comminuted)	Moderate (851610.2,1)	Toepan
*Concussion	Minor (160499.1,0)	Steering wheel hub/spoke

Driver Injuries (con't.)

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Laceration forehead (7.6cm)	Minor (290602.1,7)	Steering wheel hub/spoke
*Fracture nose (NFS)	Minor (251000.1,4)	Steering wheel hub/spoke
+Abrasion left knee	Minor (890202.1,2)	Left knee bolster
+Contusion right toes	Minor (890402.1,1)	Foot controls

sources - discharge summary/ER report+*

Driver Kinematics

The 22 year old female driver of the 1998 Chevrolet S-10 pickup truck was restrained by the available 3-point manual lap and shoulder belt system and presumed to be seated in an upright posture with the seat track adjusted to the full rearward position. The police report stated she was belted, however, this could not be confirmed due to inadequate NASS researcher field documentation of the vehicle interior. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in a left knee abrasion and multiple fractures of the left femur, evidenced by the deformation documented to this component. Venting air bag gases resulted in a deep 3rd degree burn to the left posterior hand. She loaded through the deployed driver air bag and struck the steering wheel rim which resulted in a contusion to the duodenum and lacerations to the spleen/liver as evidenced by the 14.0 cm (5.5 in) of deformation documented to the upper portion of the rim. Counterclockwise rotation of the steering wheel rim at vehicle maximum engagement involved the upper portion of the rim during the subsequent occupant kinematic. The driver's face struck the steering wheel hub/spoke which resulted in a laceration to the forehead, nose fracture, and an underlying concussion. This injury mechanism was evidenced by the extensive deformation to the steering wheel hub/spokes relative to the kinematic response pattern. She also sustained a right fibula fracture and a near amputation below the left ankle which was a result of contact to the severely intruded toepan. This mechanism was evidenced by the blood pooling and skin tissue documented on the toepan in conjunction with the extent of this intruded component. This mechanism also entrapped the driver's lower extremities which required extensive extrication efforts by rescue personnel post-crash. She was subsequently transported by ambulance to a local trauma center for treatment and admitted for 20 days. It should be noted that although the driver loaded through the deployed driver air bag, the combination of restraint options provided her with a ride-down effect to the severe crash forces, thus reducing potentially fatal injuries.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	22 year old male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, police report
Eyeware:	None
Type of Medical Treatment:	Transported to a local trauma center and admitted (1 day)

Front Right Passenger Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Concussion	Moderate (160406.2,0)	Back light header
*Fracture left talus (foot)	Moderate (853200.2,2)	Toepan
*Laceration posterior scalp (14cm)	Minor (190602.1,6)	Back light header
+Abrasion right lateral chest	Minor (490202.1,1)	Passenger air bag
+Abrasion right lateral abdomen	Minor (590202.1,1)	Lap belt webbing
+Abrasion left knee	Minor (890202.1,2)	Center instrument panel
+Abrasion right knee	Minor (890202.1,1)	Glove compartment door

sources - discharge summary/ER report+*

Front Right Passenger Kinematics

The 22 year old male front right passenger of the 1998 Chevrolet S-10 pickup truck was restrained by the available 3-point manual lap and shoulder belt system and presumed to be seated in an upright posture with the seat track adjusted to the full rearward position. Belt usage was determined by the lack of significant interior contacts and injury in this high severity crash. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, glove compartment door and deployed redesigned passenger air bag. Loading of the manual restraint resulted in an abrasion to the right lateral aspect of the abdomen while contact to the deployed passenger air bag resulted in an abrasion to the right lateral chest. Contact to the glove compartment door and (lower) center instrument panel (at the junction with the right knee bolster) resulted in bilateral knee abrasions as evidenced by the deformation documented to these components. He also sustained a fracture of the left foot from contact to the (intruded) toepan. This injury mechanism was evidenced by the location of the injury relative to the placement of the feet on the floor pre-crash. The passenger rebounded into the seat back and subsequently struck the back light header which produced a large 14.0 cm (5.5 in) laceration to the rear scalp and an underlying concussion. Following the crash, he was transported by ambulance to a local trauma center for treatment and admitted for 1 day. The deployed redesigned passenger air bag provided additional protection against further contact to frontal components, and potential serious injury.

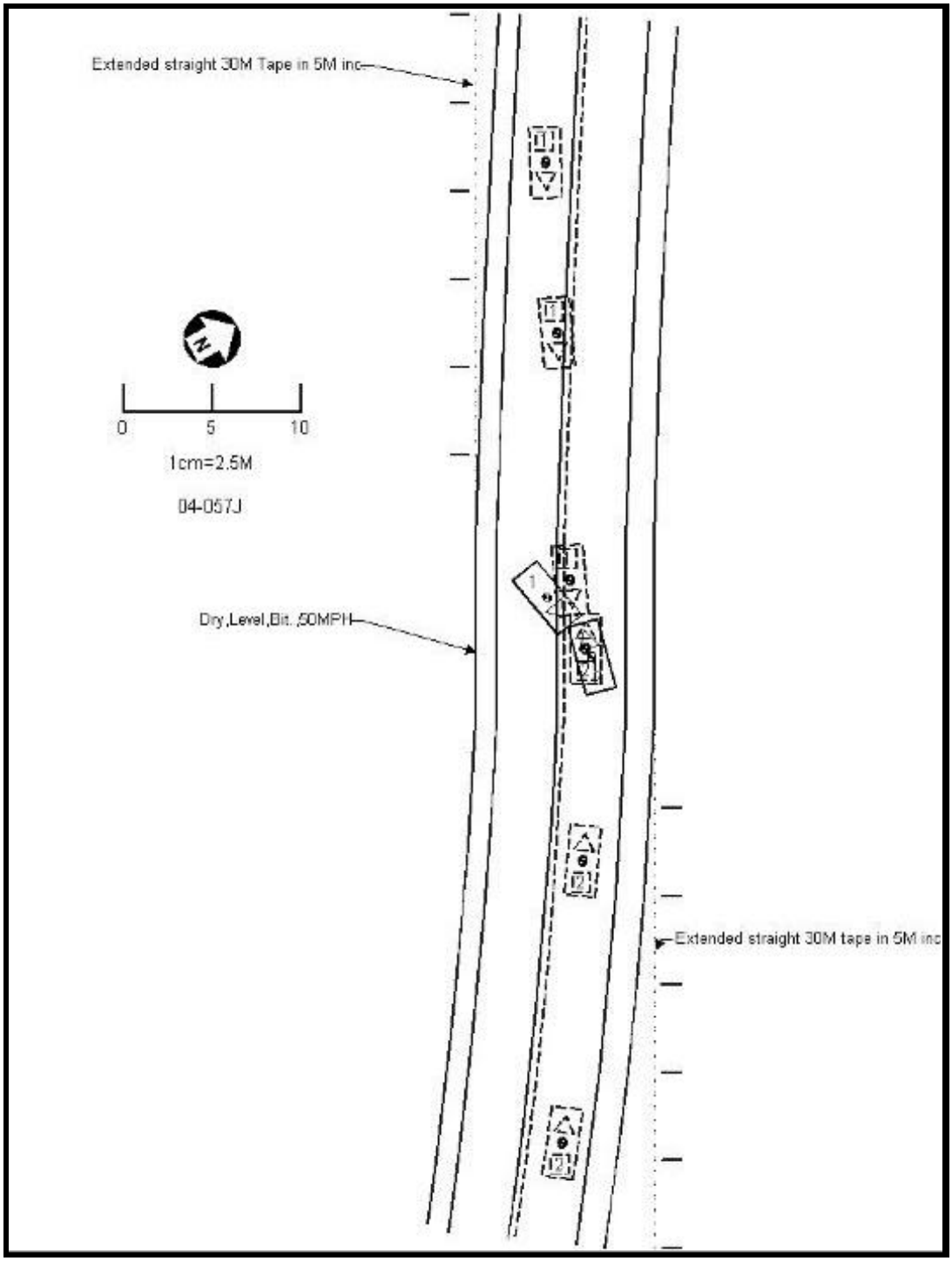

Figure 8. NASS Scene Diagram.