TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

Veridian Engineering
Buffalo, NY 14225

REMOTE AIR BAG RELATED CHILD PASSENGER FATALITY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA01-003

SUBJECT VEHICLE - 1996 NISSAN QUEST

LOCATION - STATE OF CALIFORNIA

CRASH DATE - JANUARY 1998

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.* CA01-003	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Veridian Remote Air Bag Related Child Passenger Fatality Investigation Vehicle: 1998 Nissan Quest Location: State of California		5. *Report Date*: June 2001 6. *Performing Organization Code*	
7. *Author(s)* Crash Data Research Center		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0327.(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: January 1998 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* Remote investigation of an intersection crash that resulted in the frontal air bag deployment and the death of the 4-year-old male front right passenger.			
16. *Abstract* This remote investigation focused on a two-vehicle intersection crash that involved a 1996 Nissan Quest minivan that was equipped with frontal air bags for the driver and front right positions. The front of the Quest struck the rear of a stopped 1990 Nissan Pathfinder in a front-to-rear configuration. The frontal impact was sufficient to deploy the frontal air bag system in the Quest. The Quest was occupied by a 26-year-old female driver and a 4-year-old male front right passenger. Both occupants were unrestrained. Pre-crash braking caused the 4-year-old to initiate a forward trajectory which placed him in the path of the front right passenger's air bag. Both occupants of the Quest continued the forward trajectory. The driver loaded the deployed driver's air bag which offered protection from the frontal crash forces. She refused treatment at the scene. The 4-year-old child was struck by the air bag and was projected vertically into the windshield header by the expansion of the air bag. He struck his head on the windshield header and rebounded rearward. He sustained a cerebral hemorrhage, diastatic and basal skull fractures, fracture of the right humerus, laceration of the liver, and contusions of the lungs and heart. He was transported by ambulance to a regional trauma center where he expired the next day.			
17. *Key Words* Frontal air bag deployment Air bags Air bag related child passenger fatality		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 10	22. *Price*

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BACKGROUND

Figure 1. 1996 Nissan Quest

This remote investigation focused on a two-vehicle intersection crash that involved a 1996 Nissan Quest minivan **(Figure 1)** that was equipped with frontal air bags for the driver and front right positions. The front of the Quest struck the rear of a stopped 1990 Nissan Pathfinder in a front-to-rear configuration. The frontal impact was sufficient to deploy the frontal air bag system in the Quest. The Quest was occupied by a 26-year-old female driver and a 4-year-old male front right passenger. Both occupants were unrestrained. Pre-crash braking caused the 4-year-old to initiate a forward trajectory which placed him in the path of the front right passenger's air bag. Both occupants of the Quest continued the forward trajectory. The driver loaded the deployed driver's air bag which offered protection from the frontal crash forces. She refused treatment at the scene. The 4-year-old child was struck by the air bag and was projected vertically into the windshield header by the expansion of the air bag. He struck his head on the windshield header and rebounded rearward. He sustained a cerebral hemorrhage, diastatic and basal skull fractures, fracture of the right humerus, laceration of the liver, and contusions of the lungs and heart. He was transported by ambulance to a regional trauma center where he expired the next day.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for child fatalities that occurred in vehicles equipped frontal with air bags. The crash occurred in January 1998 and was assigned to the Veridian Special Crash Investigations Team on January 8, 2001 as a remote investigation effort. A police report, police photographs and an postmortem examination report were obtained, which provided the basis for this narrative report.

SUMMARY

Crash Site

This crash occurred at a four-leg intersection of two arterial roadways. At the time of the crash, it was raining and the asphalt road surface was wet. Police reported the weather to be cool and cloudy with moderate visibility. The north/south roadway consisted of one travel lane for northbound traffic and two travel lanes for southbound traffic. The south leg was configured with two left turn lanes and one right turn lane. The north leg was configured with two left turn lanes. The east/west roadway consisted of three travel lanes in each direction separated by raised concrete dividers. The east leg of the intersection was configured with a left turn lane, and the west leg configured with a left turn lane. Both roadways were

bordered by bicycle lanes and concrete curbs. The roadside environment consisted of residential lawn areas, concrete sidewalks, and trees. A filling station was located on the southeast corner of the intersection. Traffic control for the intersection consisted of three-phase traffic signals for each leg of the intersection with separate signals for the left turn lanes. Police reported that the traffic signals were functioning properly at the time of the crash.

Pre-Crash

The 26-year-old female driver of the 1996 Nissan Quest was operating the vehicle northbound on approach to the four-leg intersection **(Figure 2)** when she became inattentive. The traffic signal for northbound traffic was in the green phase, however, northbound and southbound traffic was stopped at the intersection to yield the right of way to a westbound emergency vehicle. The driver of the Quest failed to detect the stopped 1990 Nissan Pathfinder in the northbound lane. According to the witness statement from the driver of the Pathfinder, there were also two uninvolved vehicles stopped in the intersection in front of the Pathfinder. When the driver of the Quest realized the impending harmful event, she applied the brakes in an attempt to avoid the collision. Due to the wet road surface, the investigating officer did not document any skid marks in the Quest's trajectory.

Figure 2. Northbound approach for the Nissan Quest

Crash

As the Nissan Quest entered the intersection, the front area impacted the rear area of the Nissan Pathfinder **(Figure 3)**. The Quest underrode the bottom edge of the spare tire which caused the spare tire to engage the area above the bumper. The spare tire was centered on the rear of the Pathfinder on a bracket that was hinged on the right side, and protruded approximately 30 cm (12") rear of the bumper. Impact resulted in moderate damage to the Quest and minor damage to the Pathfinder. The resultant directions of force were in the 12 o'clock and 6 o'clock sectors for the Quest and the Pathfinder, respectively. The damage algorithm of the WinSMASH program was used to calculate the Delta-V of the Quest based on estimated crush profiles. Due to the spare tire on the rear of the Pathfinder, the Delta-V for the Quest was computed twice, using the Barrier and Missing Vehicle routines. The Barrier routine computed a total velocity change of 19.5 km/h (12.1 mph). The Missing Vehicle routine computed a total velocity change of 20.4 km/h (12.7 mph). These results appeared reasonable.

Figure 3. Point of impact and marked final rest position

The Pathfinder was redirected forward and came to rest in the center of the intersection. The Quest traveled forward approximately 2 m (5') and came to final rest facing north in the southeast quadrant of the intersection **(Figure 4)**.

Figure 4. On-scene photograph looking northwest showing final rest position

Post-Crash

The driver of the Nissan Pathfinder drove the vehicle through the intersection and parked it in the bike lane in the north leg of the intersection. She remained in the vehicle until police arrived on-scene, at which time she exited the vehicle under her own power. The driver of the Nissan Quest exited the vehicle under her own power and removed the unconscious front right child passenger from the vehicle. According to a witness, the driver attempted to revive the child by shaking him. The child was placed on the roadway next to the vehicle and temporarily immobilized until rescue personnel arrived. The driver of the Nissan Quest refused treatment at the scene and was driven to the regional trauma center by police to be with the front right passenger. The front right child passenger was transported by ambulance to a regional trauma center where he expired the next day. The driver of the Nissan Pathfinder refused treatment/transportation at the scene and drove the Pathfinder from the scene. The Nissan Quest was towed from the scene.

VEHICLE DATA - 1996 Nissan Quest

The 1996 Nissan Quest was identified by the Vehicle Identification Number (VIN): 4N2DN11W5TD (production sequence omitted). The Quest minivan was equipped with front wheel drive, automatic transmission, front disc and rear drum brakes, and a 3.0 liter V-6 engine. At the time of the police vehicle inspection, the odometer read 100,663 km (62,551 miles). The Quest was also equipped with the XE trim package which included the following standard equipment: air conditioner, tilt steering column, intermittent windshield and rear window wipers, cargo net, sliding right side passenger door, rear lift-gate, and tinted glazing.

The seating was configured with front bucket seats with adjustable head restraints. Both front head restraints were in the fully lowered position. The second and third rows were equipped with bench seats with folding backs and adjustable head restraints for the outboard positions.

VEHICLE DAMAGE

Exterior Damage - *1996 Nissan Quest*

Figure 5. Damage to the Nissan Quest

The 1996 Nissan Quest sustained moderate frontal damage as a result of the impact with the Nissan Pathfinder **(Figure 5)**. The direct contact damage began approximately 41 cm (16") left of center on the bumper fascia and extended laterally to the right bumper corner. The combined direct and induced damage involved the entire frontal width of the vehicle. The bumper fascia was deformed and fractured approximately 41 cm (16") left of center from engagement with the left rear bumper corner of the Pathfinder. The bumper fascia and bottom right corner of the front license plate were fractured from contact with the Pathfinder's rear trailer hitch. The grille was fractured approximately 5 cm (2") to the left of center, and the top aspect of the grille was displaced forward onto the top aspect of the bumper fascia. The upper radiator support and radiator core were crushed rearward, and maximum crush was approximated at C4 and was estimated to be 15 cm (6"). The leading edge of the hood was crushed rearward and the hood was buckled at the designated fold points. Semi-circular damage from the Pathfinder's spare tire was noted on the hood which measured 64 cm (25") in diameter **(Figure 6)** based on measurements in police photographs. The center of the semi-circular damage was located approximately 15 cm (6") to the right of center. The Collision Deformation Classification (CDC) for this impact to the Quest was 12-FDEW-1. Six crush measurements were estimated at the level of the upper radiator support, and were as follows: C1 = 5 cm (2"), C2 = 8 cm (3"), C3 = 11 cm (4"), C4 = 15 cm (6"), C5 = 10 cm (4"), C6 = 5 cm (2").

Figure 6. Frontal damage showing damage from the Pathfinder's spare tire

Previous unrelated damage was noted on the right side aft of the A-pillar along the sill. It was approximately 40 cm (16") in length.

Interior Damage - ***1996 Nissan Quest***

Interior damage to the 1996 Nissan Quest appeared to be moderate and was attributed to occupant contact. There appeared to be no intrusion of the passenger compartment **(Figure 7)**. The windshield was cracked in a spider-web pattern directly over the center of the front right passenger's air bag cover flap from occupant contact **(Figure 8)**. The windshield fracture also exhibited an outward deflection. The center of the windshield strike was located 35 cm (14") vertically from the windshield header and 35 cm (14") inboard of the right A-pillar, based on measurements in the police photographs. There was no hair noted in the fractured glass. The leading edge of the head liner had longitudinal abrasions and contained hair strands from the 4-year-old child. The leading edge of the front right sun visor had longitudinal abrasions and also contained hair strands from the child **(Figure 9)**. The front right sun visor was displaced rearward out of its clasp.

Figure 7. Interior view from right side

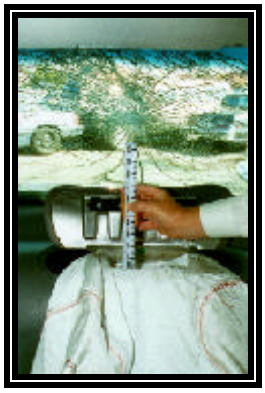

Figure 8. Interior view showing windshield strike

Figure 9. Leading edge of right front sun visor showing abrasions and hair strands

Exterior Damage- ***1990 Nissan Pathfinder***

The 1990 Nissan Pathfinder sustained minor rear damage as a result of the impact with the Nissan Quest **(Figure 10)**. The rear bumper was displaced slightly rearward and downward. The left side of the rear bumper was deformed and scuffed approximately 66 cm (26") left of center from contact with the front bumper fascia of the Quest. The spare tire cover had a semi-circular gouge mark that followed the contour of the spare tire rim. It measured 30 cm (12") from corner to corner based on police photographs, and was located approximately 14 cm (6") above the bottom edge of the spare tire.

Figure 10. Damage to Nissan Pathfinder

AIR BAG SYSTEM - 1996 Nissan Quest

The 1996 Nissan Quest was equipped with air bags for the driver and front right passenger positions that deployed as a result of the impact with the Nissan Pathfinder **(Figure 11)**. The driver's air bag was housed in the center of the steering wheel with asymmetrical H-configuration module cover flaps. A vent port was visible in the 11 o'clock position in the police photographs.

Figure 11. Frontal air bag system in the Nissan Quest

The front right passenger's air bag deployed from the right upper-instrument panel with a single cover flap design hinged at the top aspect. The cover flap was rectangular in shape with a slight contour along the leading edge. The front right passenger's air bag had two vent ports located at the 10 and 2 o'clock positions in the police photographs.

OCCUPANT DEMOGRAPHICS - 1996 Nissan Quest

Driver

Age/Sex:	26-year-old female driver
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Estimated at mid-track in police photographs
Manual Restraint Use:	Unrestrained
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Refused treatment at the scene

Driver Kinematics

The 26-year-old female driver of the 1996 Nissan Quest was presumed to be seated in an upright posture with the seat back slightly reclined. She was not restrained by the available 3-point lap and shoulder belt system. At impact, the frontal air bag system deployed. She initiated a forward trajectory in response to the frontal crash force and loaded the deployed driver's air bag which offered protection from the frontal crash forces. She rebounded rearward into the driver's seat back and came to rest slumped over the steering wheel, according to a witness. The police indicated that the driver complained of minor pain, but could not be specific as to the location. She refused any medical treatment at the scene and was driven to the regional trauma center by police to be with the front right child passenger.

Front Right Passenger

Age/Sex:	4-year-old male
Height:	107 cm (42")
Weight:	17 kg (38 lb)
Seat Track Position:	Estimated at mid-track in police photographs
Manual Restraint Use:	Unrestrained
Usage Source:	Injury data, occupant contacts, police report
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a regional trauma center where he expired the following day

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Contusions of the right basal ganglion posteriorly	Critical (140204.5,8)	Indirect - windshield header
Focal areas of cortical contusions on undersurface of temporal areas, contusions of centrum ovale bilaterally, contusions of temporal cortex	Serious (140620.3,3)	Windshield header
Subarachnoid hemorrhage, NFS	Serious (140684.3,9)	Windshield header
Marked cerebral edema	Serious (140660.3,9)	Windshield header
Basilar skull fracture, NFS	Serious (150200.3,8)	Indirect - windshield header
Lung contusions, NFS	Serious (441402.3,9)	Front right passenger's air bag
Bilateral diastatic calvarium fracture involving the frontal, sagittal, and lambdoid sutures which extended into the base of the skull	Moderate (150402.2,3)	Windshield header
Liver contusion	Moderate (541810.2,1)	Front right passenger's air bag
Liver laceration	Moderate (541820.2,1)	Front right passenger's air bag

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Fracture of the distal right humerus	Moderate (752602.2,1)	Front right passenger's air bag
Extensive subaponeurotic hemorrhage in the right frontal area	Minor (190402.1,5)	Windshield glazing
Extensive subaponeurotic hemorrhage in the right occipital area	Minor (190402.1,6)	Right B-pillar (probable rebound)
1.3 cm (0.5") laceration of the right frontal scalp	Minor (190602.1,1)	Windshield glazing
7.6 cm (3.0") long deep abrasion on the undersurface of the chin	Minor (290202.1,8)	Front right passenger's air bag membrane
Heart contusion, NFS	Minor (441002.1,4)	Front right passenger's air bag
Punctate abrasions on the dorsal surface of the right hand	Minor (790202.1,1)	Windshield glazing

Injury source: Autopsy report

Front Right Passenger Kinematics

The 4-year-old male front right child passenger was presumed to be seated in an upright posture. It was unknown if he was seated with his back against the seat back or if he was forward to allow his lower legs to clear the leading edge of the seat cushion. The child passenger was displaced forward by pre-crash braking. This displacement placed him in close proximity to the top-mounted front right passenger's air bag module at impact. He probably extended his right arm forward in an effort to brace. At impact, the frontal air bag system deployed. The front right passenger's air bag expanded against the underside of his chin and right arm, which projected his extended right arm into the windshield glazing and projected his head vertically into the windshield glazing. He sustained punctate abrasions on the dorsal surface of the right hand and a fracture of the distal right humerus from the hand/arm strike to the windshield glazing and air bag expansion against the proximal area of the arm. He sustained a 7.6 cm (3.0") long, deep abrasion on the undersurface of the chin from the expansion of the air bag. The head strike to the windshield resulted in extensive subaponeurotic hemorrhage in the right frontal areas, and a 1.3 cm (0.5") laceration of the right frontal scalp. The windshield glazing was fractured in a spider-web fashion with an outward deflection, typical of a head strike. He continued the vertical trajectory and struck the top aspect of his head on the windshield header. The windshield header and leading edge of the sun visor sustained longitudinal abrasions

from the occupant contact and probable contact with the expanding air bag. Strands of the child's hair were visible on both the windshield header and forward aspect of the sun visor. The contact with the windshield header produced a diastatic fracture of the calvarium involving the frontal, sagittal and lambdoid sutures and extending into the base of the skull, subarachnoid hemorrhage, cerebral edema, a basilar skull fracture, contusions of the right basal ganglion posteriorly, focal areas of cortical contusions on the undersurface of the temporal areas, contusions of the centrum ovale bilaterally, and contusions of the temporal cortex. The air bag expansion against the 4-year-old's chest and abdomen resulted in a heart contusion, lung contusions, a liver contusion, and a liver laceration. The continued expansion of the air bag displaced the child rearward, possibly into the right B-pillar. Although there was no interior contact evidence visible in the police photographs to support this head strike, the extensive subaponeurotic hemorhage in the right occipital area suggests an impact to the rear aspect of the child's head.

The 4-year-old child was removed from the vehicle by the driver. Witness statements indicated the driver attempted to revive the unconscious child by shaking him. The child was placed on the road surface next to the vehicle until rescue personnel arrived. Police reported the child to be unconscious at the scene and had difficulty breathing and was bleeding from the head. He was transported by ambulance to a regional trauma center where he expired the following day.

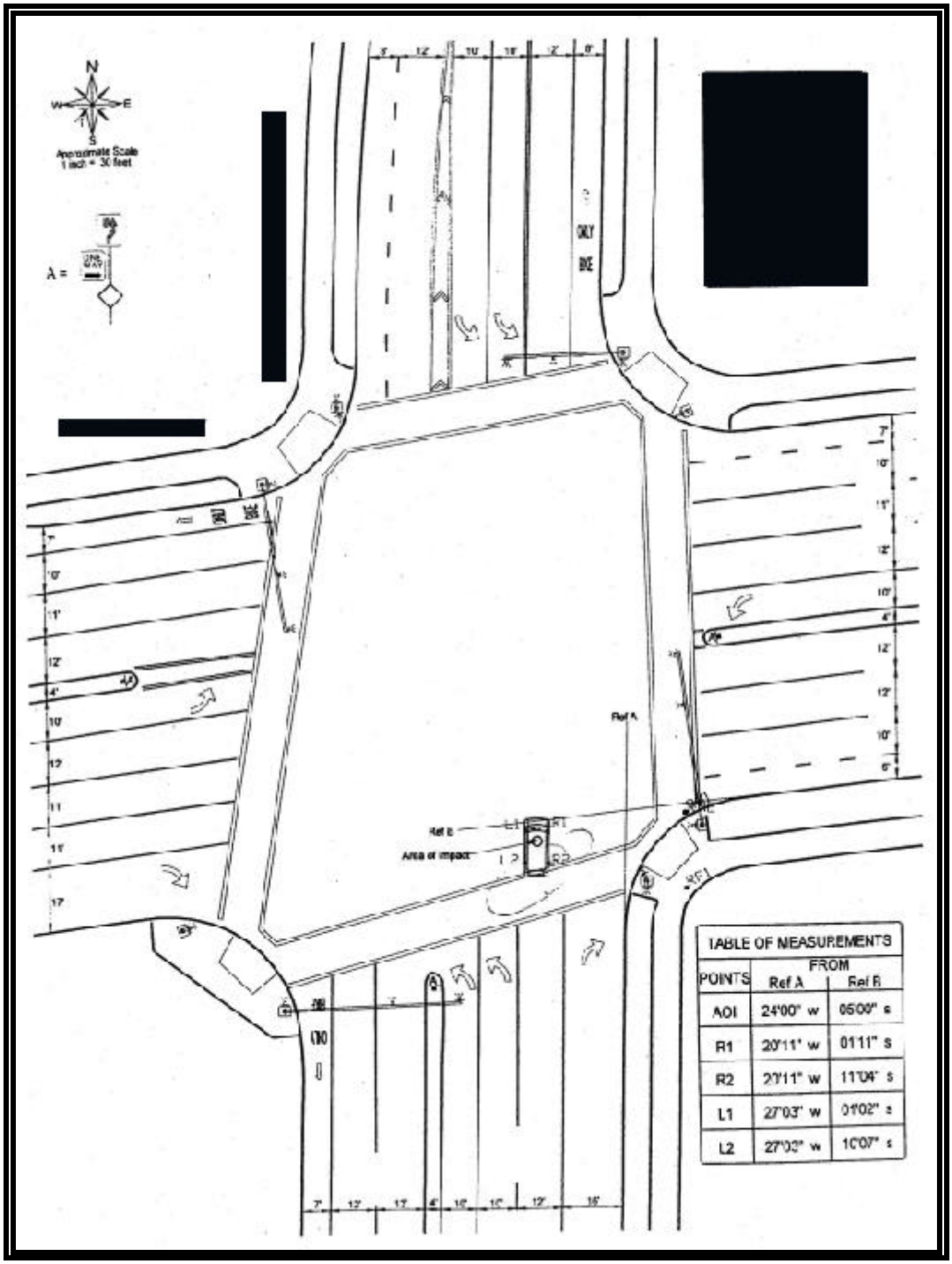

Figure 12. Police scene schematic