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ON-SITE SIDE INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN-06-029
LOCATION - TEXAS
VEHICLE - 2005 KIA SPECTRA EX
CRASH DATE - July 2006

Submitted:

March 20, 2007
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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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15. *Supplementary Notes* On-site side impact inflatable occupant protection investigation involving a 2005 Kia Spectra EX equipped with manual safety belts, manufacturer certified advanced 208-compliant front air bag system, side curtain air bags and front seat back-mounted side impact air bags.			
16. *Abstract* This report covers an on-site side impact inflatable occupant protection investigation involving a 2005 Kia Spectra (case vehicle) and a 2001 Nissan Maxima (other vehicle), which were involved in an intersection crash on a multi-lane city street. This crash is of special interest because the case vehicle was equipped with side curtain air bags and front seat back-mounted side impact air bags, and the case vehicle's driver (80-year-old, female) sustained a police reported “A” (incapacitating) injury as a result of the crash. The case vehicle was traveling westbound in the left through lane approaching a four-leg intersection. The Nissan was traveling northbound in the center through lane also approaching the intersection. As the vehicle’s entered the intersection, the front of the Nissan impacted the case vehicle’s left side causing the case vehicle driver’s seat back-mounted side impact air bag and left side curtain air bag to deploy. As a result of the impact, the case vehicle rotated counterclockwise, traveled northwest through the intersection, departed the northwest corner of the intersection and the back impacted a metal fence. The case vehicle came to final rest with the back of the vehicle against the metal fence heading southeast. The Nissan rotated counterclockwise and most likely traveled northwest through the intersection and came to rest in the northwest quadrant of the intersection heading northwest. The case vehicle’s driver’s was restrained by her three-point, lap-and-shoulder safety belt system. She was transported by ambulance to a hospital and treated and released for minor injuries.			
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This on-scene investigation was brought to NHTSA's attention on or before August 24, 2006 by NASS CDS/GES sampling activities. This crash involved a 2005 Kia Spectra EX (case vehicle) and a 2001 Nissan Maxima (other vehicle), which collided in the intersection of two multi-lane city streets. The crash occurred in July 2006, at 11:10 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with side curtain air bags and front seat back-mounted side impact air bags, and the case vehicle's driver [80-year-old, Black (non-Hispanic) female] sustained a police reported "A" (incapacitating) injury as a result of the crash. This contractor inspected the scene and both vehicles on September 7, 2006. No interview was conducted with the case vehicle's driver. This contractor was unable to contact her. This report is based on the police crash report, scene and vehicle inspections, case vehicle driver's medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling westbound in the left through lane approaching a four-leg intersection. The Nissan was traveling northbound in the center through lane also approaching the intersection. The police crash report indicated that the case vehicle entered the intersection on a red light as the Nissan was entering the intersection. The front of the Nissan impacted the case vehicle's left side (event 1) causing the case vehicle driver's seat back-mounted side impact air bag and left side curtain air bag to deploy. As both vehicles rotated counterclockwise, the right fender of the Nissan impacted the case vehicle's left rear bumper corner (event 2). The case vehicle continued to rotate counterclockwise, traveled northwest through the intersection, departed the northwest corner of the intersection with the back end leading and the back impacted a metal fence (event 3). The case vehicle came to final rest with the back of the vehicle against the metal fence heading southeast. The Nissan rotated counterclockwise and traveled northwest through the intersection and most likely came to rest in the northwest quadrant of the intersection heading southeast. At the time of the crash, the light condition was daylight, the atmospheric condition was clear and the roadway pavement was dry.

The case vehicle's CDCs were determined to be: **11-LPEW-2** (**320** degrees) for the left side impact with the front of the Nissan, **09-LBLU-1** (**270** degrees) for left rear bumper corner impact to the Nissan's right fender, and **06-BLLW-1** (**180** degrees) for the minor back impact with the metal fence. The case vehicle's maximum residual left side crush was 26 centimeters (10.2 inches) occurring at C_3. There was no residual damage due to the left rear bumper corner impact or no residual crush due to the back impact. The WinSMASH reconstruction program, damage only algorithm, calculated the case vehicle's Total, Longitudinal, and Lateral Delta Vs for the left side impact with the Nissan respectively as: 23 km.p.h. (13.7 m.p.h.), -17.6 km.p.h. (-10.9 m.p.h.), and 14.8 km.p.h. (9.2 m.p.h.). The collision fit the reconstruction model and the results appeared reasonable. The case vehicle was towed due to damage.

The CDCs for the Nissan were determined to be: **02-FDEW-1** (**50** degrees) for the front impact to the case vehicle's left side and **03-RFEN-1** (**90** degrees) for the right fender impact to the case vehicle's left rear bumper corner. The WinSMASH reconstruction program, damage

only algorithm, calculated the Nissan's Total, Longitudinal, and Lateral Delta Vs for the front impact respectively as: 20.0 km.p.h. (12.4 m.p.h.), -12.9 km.p.h. (-8.0 m.p.h.), and -15.3 km.p.h. (-9.5 m.p.h.). The collision fit the reconstruction model and the results appeared reasonable. The Nissan was towed due to damage.

The case vehicle's driver was restrained by her manual, three-point, lap-and-shoulder safety belt system. She was transported by ambulance to a hospital and treated and released for minor injuries. The case vehicle driver's use of her three-point, lap-and-shoulder safety belt system kept her restrained in her seat position during the impact and post-crash spinout. The deployment of the case vehicle driver's side curtain air bag and seat back mounted side impact air bag mitigated the case vehicle driver's impact with the left front door during the crash and reduced the driver's injury potential.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was a five-lane, undivided, city street, traversing in a westerly and easterly direction. The case vehicle was traveling westbound approaching a four-leg intersection. The trafficway on which the Nissan was traveling was a seven-lane, divided, city street, traversing in a northerly and southerly direction. The Nissan was traveling northbound approaching the same intersection. The east leg of the intersection had one westbound and one eastbound through lane. The roadway widened near the mouth of the intersection to accommodate two eastbound through lanes, two westbound through lanes and a left turn lane. The outside westbound through lane was 4 meters (13.1 feet) in width, while the inside westbound through lane and left turn lane were each approximately 3.1 meters (10.2 feet) in width. The south leg of the intersection had three southbound through lanes, three northbound through lanes, a left turn lane, and the trafficway was divided by a raised, grass median. Each northbound through lane was approximately 3.3 meters (10.8 feet) in width while the left turn lane was 3.9 meters (12.8 feet) in width. The median was approximately 14.7 meters (48 feet) in width and narrowed as it approached the intersection. The case vehicle's roadway pavement markings consisted of solid double yellow center lines, solid white lane lines near the intersection and solid white lines designating the pedestrian crosswalk. The Nissan's Roadway pavement markings consisted of solid white lane lines with "BOTS DOTS", solid white stop bar at the intersection and solid white lines designating the pedestrian crossing. The roadways were bordered by barrier curbs and the intersection was controlled by three-phase traffic signals. The speed limit for both trafficways was 48 km.p.h. (30 m.p.h.). There was no regulatory speed limit sign posted for either vehicle's approach to the intersection. At the time of the crash, the light condition was daylight, the atmospheric condition was clear and the roadway pavement was dry, level bituminous with an estimated coefficient of friction of 0.70. Traffic density is unknown, but given the location and time of the crash, traffic was most likely moderate to heavy. The site of the crash was urban commercial. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling westbound in the left through lane (**Figure 1** below) approaching the intersection. The driver was intending to continue straight through the intersection. The Nissan was traveling northbound in the center through lane also approaching

the intersection. The Nissan's driver was intending to continue straight through the intersection. It is unknown if the case vehicle's driver made any avoidance maneuvers prior to the crash. The crash occurred in the four-leg intersection of the two trafficways.

Figure 1: Approach of case vehicle to intersection in left through lane, red arrow shows area of initial impact, yellow arrow shows location of case vehicle's subsequent impact with fence, Nissan approached from left

Figure 2: Damage to front of Nissan from impact with left side of case vehicle

Figure 3: Damage to left side of case vehicle from impact with Nissan, vertical scale incremented in tenths of meter.

Figure 4: Damage to Nissan's right fender due to impact to case vehicle's left rear bumper corner

Crash: The police crash report indicated that the case vehicle entered the intersection on a red light as the Nissan was entering the intersection. The front of the Nissan (**Figure 2**) impacted the case vehicle's left side (event 1, **Figure 3**) causing the case vehicle driver's seat back-mounted side impact air bag and left side curtain air bag to deploy. The Nissan's driver and front right passenger air bags also deployed. As both vehicles rotated counterclockwise, the right fender of the Nissan (**Figure 4**) impacted the case vehicle's left rear bumper corner (event 2). The case vehicle continued to rotate counterclockwise and traveled northwest through the intersection and departed the northwest corner of the intersection with the back end leading. The back of the case vehicle then impacted a metal fence (event 3, **Figure 5** below).

Post-Crash: The case vehicle came to final rest with the back of the vehicle against the metal fence heading southeast (**Figure 5**). The police crash schematic did not depict the rest position of the Nissan, and no evidence of its rest position was found during the scene inspection. Given the crash dynamics, the Nissan rotated counterclockwise and most likely traveled northwest through the intersection and came to rest in the northwest quadrant of the intersection heading northwest.

Figure 5: Arrow shows case vehicle's impact location to metal fence at intersection's northwest quadrant

CASE VEHICLE

The 2005 Kia Spectra EX was a front wheel drive, four-door sedan (VIN: KNAFE121X55------). The manufacturer of this vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The case vehicle was equipped with dual stage driver and front right passenger air bags; driver and front right passenger manual, three-point, lap-and-shoulder safety belt systems with usage sensors, pretensioners and energy management features. In addition, the case vehicle was equipped with a front right passenger presence sensor, front seat back-mounted side impact air bags and right and left side curtain air bags protecting the outboard seating positions. Four wheel, anti-lock brakes were an option on some models, but it is unknown if case vehicle was so equipped.

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's impact with the Nissan involved the left side. The left front door and left rear door were directly damaged and crushed inward. Both doors were jammed shut. The direct damage ended 21 centimeters (8.3 inches) forward of the left rear axle and extended 201 centimeters (79.1 inches) forward along the left side. The residual maximum crush was measured as 26 centimeters (10.2 inches) occurring at C_3. The table below shows the case vehicle's left side crush profile.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	201	65	315	0	12	26	24	4	0	-13	5
in		79.1	25.6	124.0	0.0	4.7	10.2	9.4	1.6	0.0	-5.1	2.0

The case vehicle's wheelbase was unchanged. Induced damage involved the left fender, upper portions of the left side doors and the left quarter panel.

The case vehicle's recommended tire size was: P195/60R15, and the case vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	214	31	207	30	5	6	None	No	No
RF	207	30	207	30	5	6	None	No	No
LR	221	32	207	30	6	8	None	No	No
RR	221	32	207	30	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior (**Figures 6** and **7**) revealed an unidentified transfer on the driver's door adjacent to the door lock button. No other occupant contact evidence on any interior surfaces was observed. The vehicle sustained 5 centimeters (2 inches) of lateral driver's door intrusion into the driver's seat position and 14 centimeters (5.5 inches) of lateral left rear door intrusion into the back left seat position. There was no deformation to the steering wheel rim or compression of the energy absorbing steering column.

Figure 6: Case vehicle's steering wheel, instrument panel and windshield

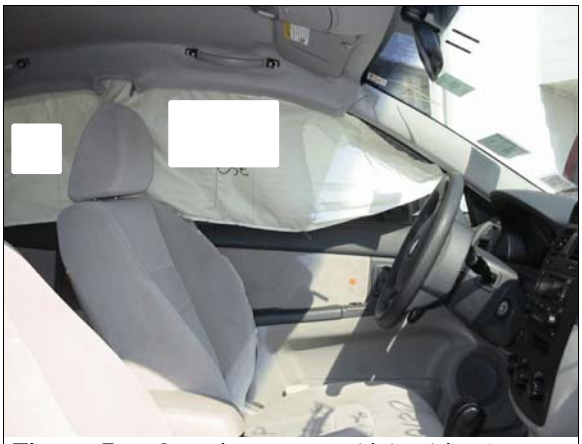


Figure 7: Overview case vehicle driver's seat position

Damage Classification: Based on the vehicle inspection, the CDCs were determined to be: **11-LPEW-2** (**320** degrees) for the left side impact with the Nissan, **09-LBLU-1** (**270** degrees) for the left rear bumper corner impact to the Nissan's right fender and: **06-BLLW-1** (**180** degrees) for the minor back impact with the metal fence. The WinSMASH reconstruction program, damage only algorithm was used to reconstruct the case

vehicle's Delta Vs for the left side impact with the Nissan. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23 km.p.h. (13.7 m.p.h.), -17.6 km.p.h. (-10.9 m.p.h.), and 14.8 km.p.h. (9.2 m.p.h.). The collision fit the reconstruction model and the results appeared reasonable. The case vehicle was towed due to damage.

Figure 8: Driver's seat back-mounted side impact air bag located in outboard side of driver's seat back

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with manufacturer certified advanced 208-compliant front air bags, side curtain air bags and front seat back mounted side impact air bags. The case vehicle's front air bags did not deploy in this crash. The case vehicle's advanced air bag system most likely determined that the case vehicle's longitudinal deceleration was not of sufficient magnitude to require their deployment. The case vehicle's left side curtain and left side impact air bags properly deployed in this crash due to the left side impact with the Nissan.

The case vehicle driver's seat back-mounted side impact air bag was located in the outboard side of her seat back (**Figure 8**). The air bag deployed through a tear seam in the seat back. There was no evidence of damage to the air bag due to deployment. The air bag was designed without tethers and was rectangular in shape. The air bag (**Figure 9**) was approximately 23 centimeters (9.1 inches) in length and approximately 32 centimeters (12.6 inches) in height. There was no evidence of occupant contact to the air bag.

Figure 9: Driver's seat back-mounted side impact air bag

The left side curtain air bag was located along the left roof side rail (**Figures 10** and **11** below) inside the headliner and extended along the driver and back left seat positions. The air bag was anchored to the left A-pillar. The cloth anchor was triangular-shaped, integral to the curtain air bag and was approximately 42 centimeters (16.5 inches) in length. The total length of the side curtain air bag was approximately 171 centimeters (67.3 inches) and was approximately 32 centimeters (12.6 inches) in height. It was designed without tethers and had a large inflation

chamber adjacent to the front left seat and a smaller inflation chamber adjacent to the back left seat back. There was no evidence of damage to the air bag due to deployment and no evidence of occupant contact.

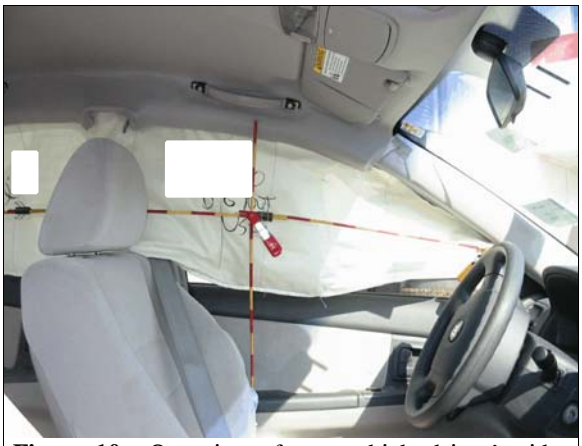


Figure 10: Overview of case vehicle driver's side curtain air bag

Figure 11: Overview of case vehicle's back left side curtain air bag

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [80-year-old, Black (unknown if Hispanic) female; unknown height and weight] was most likely seated in a nominal upright driving position. She most likely had her right foot on the accelerator her left foot on the floor and both hands on the steering wheel. Her seat was adjusted to between the middle and forward-most track position and her seat back was slightly reclined.

The driver was restrained by her manual, three-point, lap-and-shoulder safety belt system. There was slight loading evidence on the safety belt buckle.

The case vehicle's impact with the Nissan caused the driver to move forward and left along a path opposite the case vehicle's 320 degree direction of principal force as the case vehicle decelerated longitudinally and accelerated laterally to the right. The impact locked the driver's safety belt retractor and the left side of her thorax and her left upper arm impacted the deployed seat back-mounted side impact air bag and her head contacted the deployed side curtain air bag. The driver most likely rebounded off the air bags and moved to the right within her safety belt as the case vehicle rotated counterclockwise. The driver remained restrained in her seat and moved rearward and slightly loaded her seat back as the case vehicle traveled over the curb and the back of the case vehicle impacted the metal fence. It is not known how the driver exited the case vehicle. The case vehicle driver's use of her three-point, lap-and-shoulder safety belt system kept her restrained in her seat position during the impact and post-crash spinout. The deployment of the case vehicle driver's side curtain air bag and seat back mounted side impact air bag mitigated the case vehicle driver's impact with the left front door during the crash and reduced the driver's injury potential.

The police crash report indicated the driver sustained a "A" (incapacitating) injury and was transported by ambulance to a local hospital. The driver was treated in the emergency and released. The table below shows the case vehicle driver's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
	Pain and tenderness neck with multiple degenerative changes; myofascial pain, not further specified; chest pain on palpation, not further specified	not coded			Emergency room records
1	Contusion, not further specified	minor 990400.1,9	Unknown contact mechanism	Unknown	Emergency room records

OTHER VEHICLE

The 2001 Nissan Maxima was a front wheel drive, four-door sedan (VIN: JN1CA31D81T------). The Nissan was equipped with four wheel anti-lock brakes, front bucket seats with adjustable head restraints and driver and front right passenger, three point, lap-and-shoulder safety belt systems and redesigned driver and front right passenger air bags, which deployed as a result of the crash.

Figure 12: Top view of crush to front of Nissan from impact with left side of case vehicle

Exterior Damage: The Nissan's impact with the case vehicle involved the front plane. The front bumper, grille and hood were directly contacted, crushed rearward and displaced to the left [stubframe shift did not exceed 10 centimeters (4 inches)]. Direct damage began at the front right bumper corner and extended 151 centimeters (59.4 inches) along the front bumper. Crush measurements were taken at the bumper and the maximum residual crush (**Figure 12**) was measured as 11 centimeters (4.3 inches) occurring at C_2. The table below shows the Nissan's front crush profile.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	151	11	151	10	11	9	9	10	8	0	0
in		59.4	4.3	59.4	3.9	4.3	3.5	3.5	3.9	3.2	0.0	0.0

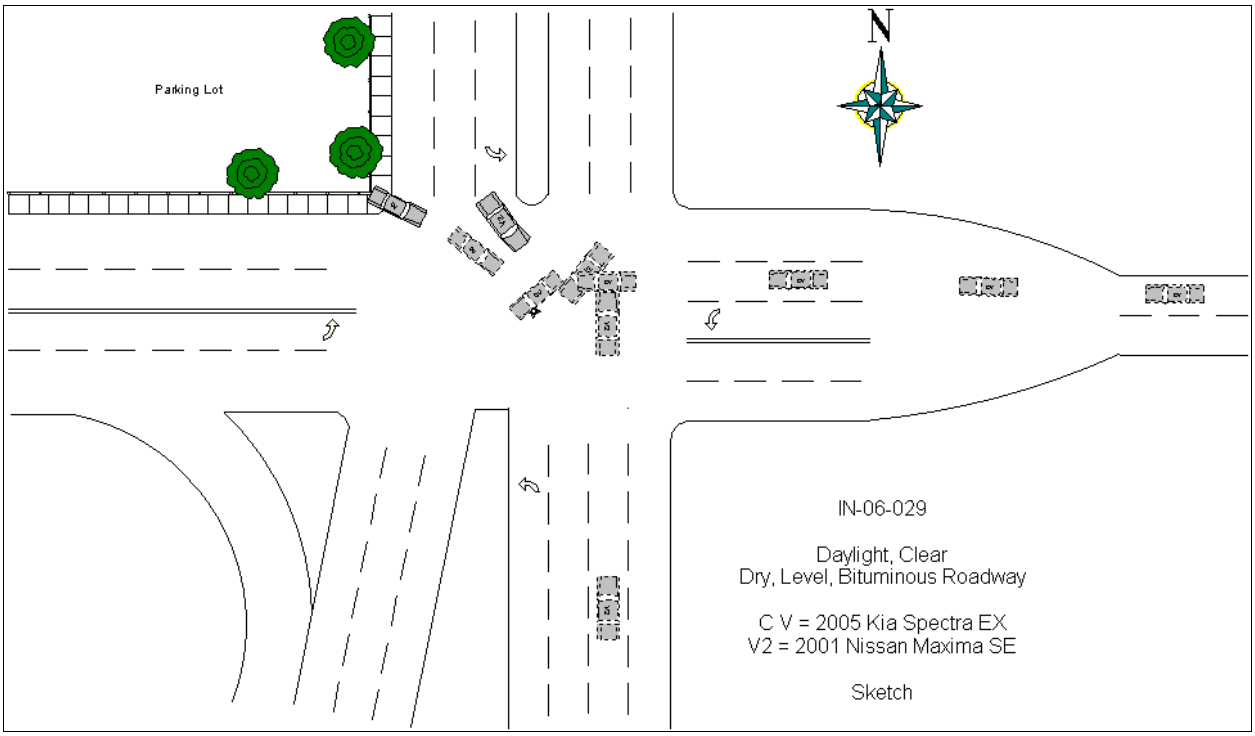
The Nissan's left side wheelbase was unchanged while the right side wheelbase was extended 1 centimeter (0.4 inch). Induced damage involved the hood and both fenders. In addition, what appeared to be sideswipe type damage was observed to a small area on the left rear door and left quarter panel. This damage was not consistent with the dynamics of the crash and appeared to be unrelated to this crash.

The Nissan's recommended tire size is unknown. The Nissan was equipped with P235/45R17 size tires. The Nissan's tire data are shown in the table below.

Tire	*Measured Pressure*		*Recommend Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kpa	psi	kpa	psi	milli-meters	32nd of an inch			
LF	186	27	207	30	7	9	None	No	No
RF	103	15	207	30	7	9	None	No	No
LR	186	27	207	30	5	6	None	No	No
RR	193	28	207	30	5	6	None	No	No

Damage Classification: Based on the vehicle inspection, the CDC for the Nissan's front impact to the left side of the case vehicle was determined to be: **02-FDEW-1** (**50** degrees). The CDC for the Nissan's right fender impact to the case vehicle's left rear bumper corner was determined to be: **03-RFEN-1** (**90** degrees) The WinSMASH reconstruction program, damage only algorithm, was used to reconstruct the Nissan's' front impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.0 km.p.h. (12.4 m.p.h.), -12.9 km.p.h. (-8.0 m.p.h.), and -15.3 km.p.h. (-9.5 m.p.h.) The collision fit the reconstruction model and the results appeared reasonable. The Nissan was towed due to damage.

Nissan's Occupants: According to the police crash report, the driver of the Nissan [25-year-old, White (unknown if Hispanic) male] was restrained by his manual, three-point, lap-and-shoulder, safety belt system. The police crash report indicated the driver was not injured in the crash and was not transported to a medical facility.


Parking Lot
N
IN-06-029
Daylight, Clear
Dry, Level, Bituminous Roadway
C V = 2005 Kia Spectra EX
V2 = 2001 Nissan Maxima SE
Sketch