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REDESIGNED AIR BAG REPORT

CASE NUMBER - IN97-050
LOCATION - TEXAS
VEHICLE - 1998 CHEVROLET CAVALIER LS
CRASH DATE - November, 1997

Submitted:

February 28, 2000

Revised Submission:

March 27, 2000

Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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 air bag deployment investigation involving a 1998 Chevrolet Cavalier LS, four-door sedan, with manual safety belts and dual front redesigned air bags, and a 1994 Pontiac Firebird, two-door liftback

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1998 Chevrolet Cavalier LS (case vehicle) and a 1994 Pontiac Firebird (vehicle #2). This crash is of special interest because the case vehicle was equipped with redesigned air bags, and the case vehicle's driver (22-year-old male) most likely sustained only minor injuries from his deploying driver air bag. The case vehicle was traveling northwest in the center, northwestbound, through lane of a six-lane, divided, state trafficway and was approaching a controlled, four-leg intersection (i.e., both the northwest and southeastbound roadways had three through lanes and were separated by a raised concrete median). Vehicle #2 was traveling northeast in the right lane of a three-lane, one-way roadway, which was a service road for an elevated, limited-access highway. The crash occurred in the intersection of the two trafficways, and the intersection was within an interchange area. The left front fender of the case vehicle was impacted by the front right of vehicle #2, causing the case vehicle's driver and front right passenger air bags to deploy. Vehicle #2 was also equipped with dual front air bags, but they did not deploy. The case vehicle rotated clockwise and vehicle #2 rotated counterclockwise, resulting in a "sideslap" impact between the left quarter panel of the case vehicle and the right quarter panel of vehicle #2. The two vehicles proceeded in a north-northwesterly direction before coming to rest near the north corner of the intersection, both headed somewhat north of northwest. The case vehicle's driver was seated with his seat track located in the rearmost position. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and declined treatment at the scene, and it is not known if he sought treatment at a later time. The Police Crash Report indicates that he sustained "C" (possible) injuries. The exact injuries sustained by the case vehicle's driver are unknown.

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BACKGROUND

IN97-050

This on-site investigation was brought to the NHTSA's attention by NASS/CDS sampling activities in December, 1997. The crash involved a 1998 Chevrolet Cavalier LS (case vehicle) and a 1994 Pontiac Firebird (vehicle #2). The crash occurred in November, 1997, at 8:53 p.m., in Texas and was investigated by the applicable municipal police agency. This crash is of special interest because the case vehicle was equipped with redesigned air bags, and the case vehicle's driver [22-year-old, White (unknown if Hispanic) male] most likely sustained only minor injuries from his deploying driver air bag. This contractor's subcontractor inspected the case vehicle on December 21, 1997; vehicle #2 was inspected on December 22, 1997, and the scene was inspected on March 3, 1998. The driver of the case vehicle was contacted several times and finally refused to cooperate with this contractor on May 11, 1998. This report is based on the Police Crash Report, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling northwest in the center, northwestbound, through lane of a six-lane, divided, state trafficway (**Figure 1**) and was approaching a controlled, four-leg intersection, intending to continue traveling northwestward (i.e., both the northwest and southeastbound roadways had three through lanes and were separated by a raised concrete median). Vehicle #2 was traveling northeast in the right lane of a three-lane, one-way roadway, which was a service road for an elevated, limited-access highway (**Figure 2**). Vehicle #2 intended to cross the intersection and continue straight ahead on the service road. It is not known if either driver attempted any avoidance action. The crash occurred in the intersection of the two trafficways, and the intersection was within an interchange area.

Figure 1: Case vehicle's westward path of travel in center lane of westbound roadway, which was part of a divided trafficway; Note: case vehicle was approaching a controlled, four-leg intersection inside an interchange area (case photo #02)

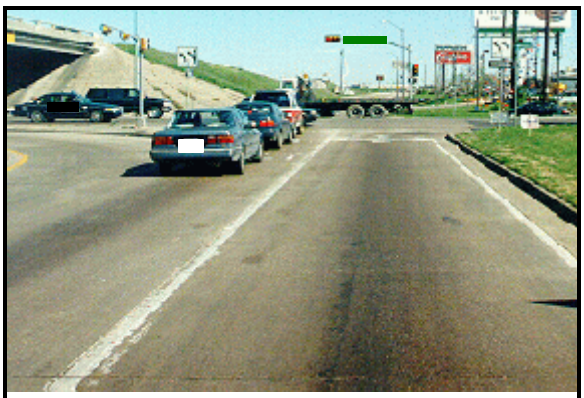


Figure 2: Vehicle #2's northbound travel path in right lane of service road; Note: vehicle #2 was approaching a controlled, four-leg intersection in an interchange area (case photo #06)

The state highway was straight and level at the area of impact. The pavement was concrete and the width of the center, northwestbound lane was 3.2 meters (10.5 feet). The roadway was bordered by mountable curbs. Pavement markings consisted of single, broken, white, lane lines to separate the three through lanes for northwestbound traffic, augmented by a single solid yellow "no passing" line on the

southwest side of the roadway just prior to the raised concrete median. The local access roadway was straight and level at the area of impact. The pavement was concrete and the width of the right northeastbound lane was 3.5 meters (11.5 feet). Pavement markings consisted of a single solid white lane line for the right, northeastbound lane vehicle #2 was in. The other two northeastbound lanes were for left-hand turns only. In addition, a solid white edge line was also present on the southeast side of the roadway (**Figure 2** above). The estimated coefficient of friction was 0.65 for both roadways. Both roadways were controlled by on-colors, horizontally-mounted, traffic control signals. The speed limit for both vehicles was 56 km.p.h. (35 m.p.h.). The case vehicle was traveling approximately 56 km.p.h. (35 m.p.h.), and vehicle #2 was traveling approximately 24-32 km.p.h. (15-20 m.p.h.). The Police Crash Report indicates that the signal pole that controlled northwestbound traffic had been damaged in a previous crash, and it was difficult to see the signal. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear, and the road pavement was dry. Traffic density at the time of the crash is unknown, and the site of the crash was urban commercial.

The left front fender of the case vehicle (**Figures 3** through **5**) was impacted by the front right of vehicle #2 (**Figures 6** and **7** below), causing the case vehicle's driver and front right passenger air bags to deploy. Vehicle #2 was also equipped with dual front air bags, but they did not deploy. The case vehicle rotated clockwise and vehicle #2 rotated counterclockwise, resulting in a "sideslap" impact between the left quarter panel of the case vehicle (**Figure 8** below) and the right quarter panel of vehicle #2 (**Figure 9** below). The two vehicles proceeded in a north-northwesterly direction before coming to rest near the north corner of the intersection, both headed somewhat north of northwest.

Figure 3: Case vehicle's damaged left front with contour gauge present (case photo #10)

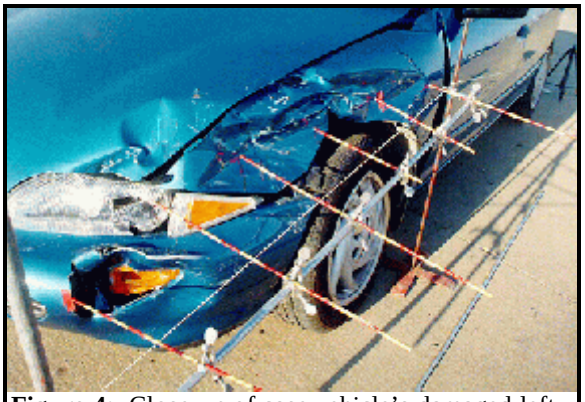


Figure 4: Close-up of case vehicle's damaged left front viewed from left of front; Note: direct damage involves bumper, left headlight assembly and fender, and hood (case photo #11)

Figure 5: Close-up of case vehicle's left front damage viewed from left of back; Note: induced damage to left fender (case photo #15)

Figure 6: Vehicle #2's frontal damage with contour gauge present at bumper level; Note: damage was primarily to front right corner (case photo #36)

Figure 7: Close-up of vehicle #2's front right damage viewed from right of front; Note: contour gauge present above bumper level (case photo #45)

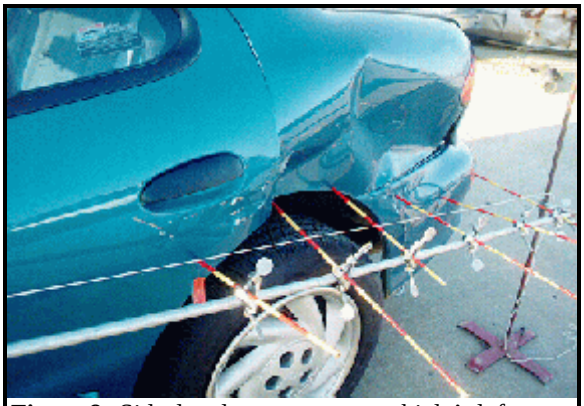


Figure 8: Sideslap damage to case vehicle's left rear door and quarter panel (case photo #17)

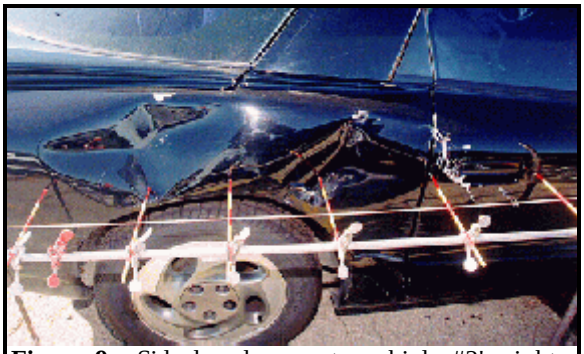


Figure 9: Sideslap damage to vehicle #2's right quarter panel and right rear door (case photo #43)

CASE VEHICLE

The case vehicle was a front wheel drive, 1998 Chevrolet Cavalier LS, five-passenger, four-door sedan (VIN: 1G1JF52T9W7------) equipped with a 2.4L, DOHC-SFI, I-4 engine and a four-speed automatic transmission. The case vehicle was equipped with four-wheel, anti-lock brakes. The case vehicle's wheelbase was 264 centimeters (104.1 inches), and the odometer reading at inspection was 4,733 kilometers (2,941 miles). The case vehicle was equipped with driver and front right passenger redesigned air bags which deployed during the crash (**Figure 10**).

Figure 10: Case vehicle's front seating area showing deployed driver and front right air bags and floor-mounted automatic transmission (case photo #28)

Based on the case vehicle's inspection, direct contact extended from the bumper corner to the axle (i.e., the front overhang; **Figures 4** and **5** above), with induced damage causing the entire left fender to be deformed. The front bumper cover was folded inward at the apex of the corner, the front left turn signal and headlight assembly were shattered, and the left side of the engine cover was buckled inward. Maximum crush was 12 centimeters (4.7 inches). The CDC for the first (deployment) impact was determined to be: **11-LFEW-2 (-20)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 10.9 km.p.h. (6.8 m.p.h.), -10.3 km.p.h. (-6.4 m.p.h.), and +3.7 km.p.h. (+2.3 m.p.h.). The case vehicle's second (nondeployment) impact involved the left quarter panel, with direct contact restricted to the rear overhang, and the maximum crush was 9 centimeters (3.5 inches). The CDC for the second impact (**Figure 8** above) was determined to be: **09-LBEW-1 (-90)**. The case vehicle was towed from the scene due to disabling damage.

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of "I"-configuration cover flaps made of thick vinyl with overall dimensions of 24 centimeters (9.4 inches) at the upper and lower horizontal seams and 10 centimeters (3.9 inches) vertically. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps (**Figure 11**). The driver's air bag was designed without any tethers. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 6 and 12 o'clock positions. The deployed driver's air bag was round with a diameter of 61 centimeters (24.0 inches). There was contact evidence (i.e., scuffs) apparent just left of center and near the bottom (i.e., 6:30 o'clock position) of the driver's air bag (**Figure 12**). The steering wheel rim was not deformed, and there was no evidence that the steering column had moved.

Figure 11: Case vehicle's deployed driver air bag showing "I"-type cover flaps without evidence of damage or occupant contact (case photo #25)

Figure 12: Case vehicle's deployed driver air bag showing some scuff marks just left of center and near the 6:30 o'clock position (case photo #27)

The front right air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 32 centimeters (12.6 inches) at the lower horizontal seam and 18 centimeters (7.1 inches) along both vertical seams. The profile of the case vehicle's instrument panel/dash

resulted in a 12 centimeter (4.7 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points and, while there was no evidence of damage during the deployment to the air bag, there were scuffs on the front right air bag module's cover flap from its impact with the windshield. The front right air bag was designed with two tethers, but the front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 40 centimeters (15.7 inches) and a width of approximately 50 centimeters (19.7 inches). There was no contact evidence readily apparent on the front of the air bag (**Figure 13**), but there were some scuffs on the backside of the air bag from contact with the windshield.

Figure 13: Case vehicle's deployed front right passenger air bag (case photo #30)

Figure 14: Crack to case vehicle's right windshield caused by front right passenger air bag module's cover flap (case photo #32)

There was a small scuff on the knee bolster to the left of the steering column, indicating probable contact by the driver's left knee, and there was no other evidence of contact anywhere in the vehicle. There was a horizontal area of spiderweb cracking in the windshield directly above the cover flap (**Figure 14**).

CASE VEHICLE OCCUPANT

The case vehicle's driver declined to cooperate in this research, and there was no other occupant in the case vehicle. As a result, there is no knowledge of his pre-crash posture or avoidance actions. Presumably, immediately prior to the crash, the case vehicle's driver was seated in a slightly reclined posture, with his back against the seat back, his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel. Post-crash, the driver's seat track was located in the rearmost position, the seat back was slightly reclined, and there was no evidence of seat or track failure.

According to the Police Crash Report, the case vehicle's driver (unknown height and weight) was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The vehicle inspection indicated that the upper anchorage adjustment was in the middle position; however, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate, while showing evidence of usage, did not show any evidence of loading.

Based on the available evidence, the case vehicle's driver made no known pre-crash avoidance

maneuvers. As a result and independent of the use of his available safety belts, the driver's pre-impact body position did not change just prior to impact. The case vehicle's primary impact with vehicle #2 enabled the case vehicle's driver to continue forward and slightly leftward toward the -20 degree Direction of Principal Force as the case vehicle decelerated. The initial impact also caused the case vehicle to rotate clockwise, causing the driver to move further to the left. Because he was using his lap-and-shoulder, safety belt system, his forward motion was restricted, and he encountered the deployed air bag in a left-of-center alignment, most likely with his face and chest. The second (sideslap) impact served to arrest the case vehicle's clockwise rotation and caused the driver to move leftward toward the -90 degree PDOF and into the driver's door. The driver then rebounded back into his seat as the case vehicle came to rest.

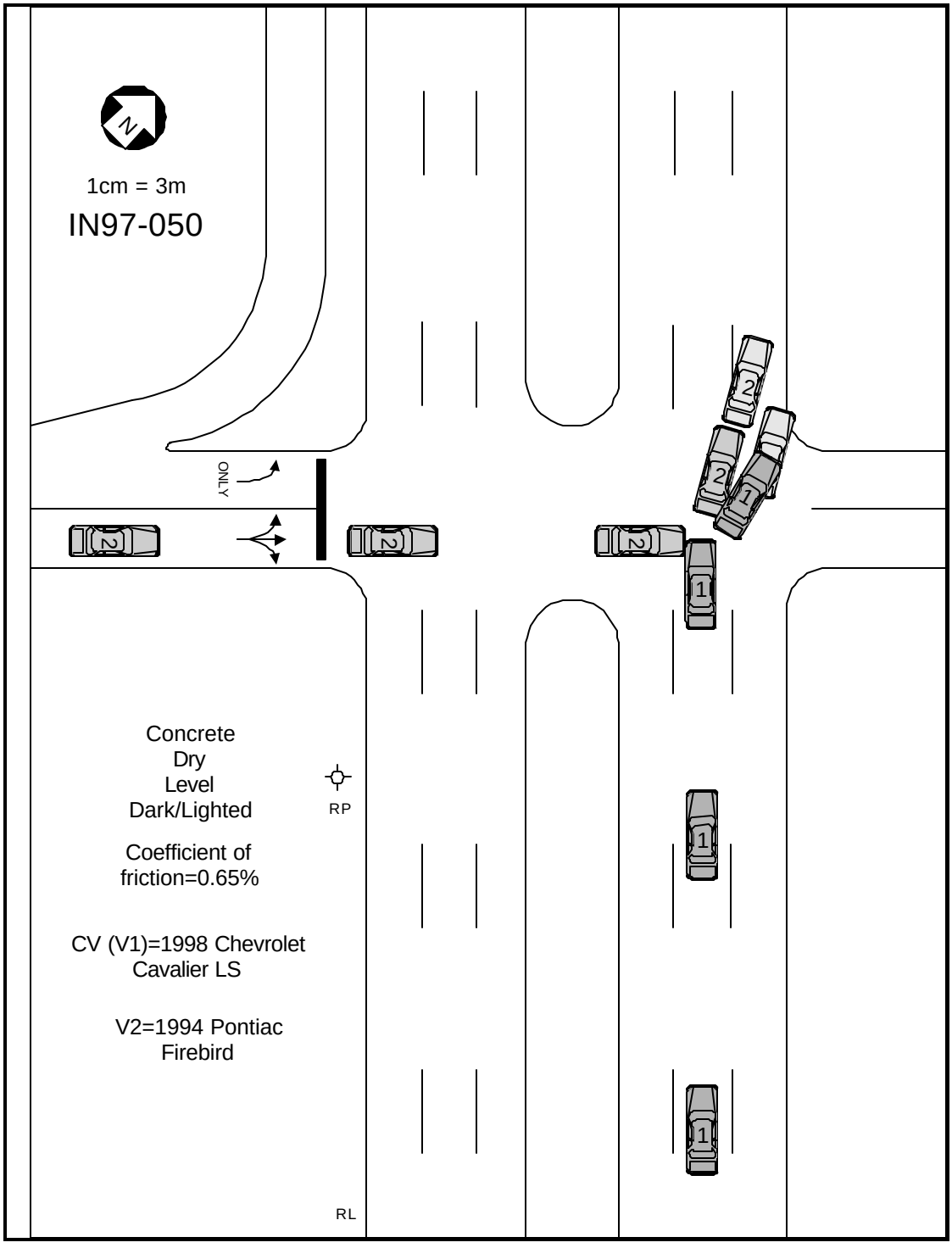
DRIVER INJURIES

The driver declined treatment at the scene, and it is not known if he sought treatment at a later time. The Police Crash Report indicates that he sustained "C" (possible) injuries. The exact injuries sustained by the case vehicle's driver are unknown.

VEHICLE #2

Vehicle #2 was a rear wheel drive, 1994 Pontiac Firebird, four-passenger, two door coupe (VIN: 2G2FS22S2R2------) equipped with a 3.4L, EFI-OHV, V-6 engine and a five-speed manual transmission. Vehicle #2 was also equipped with four-wheel, anti-lock brakes. The case vehicle's wheelbase was 257 centimeters (101.1 inches), and the odometer reading is unknown. Vehicle #2 was equipped with driver and front right passenger air bags; however, neither air bag deployed in this crash.

The inspection of vehicle #2 indicated that this vehicle's front was equipped with a markedly rounded (**Figure 6** above) bumper cover [i.e., 33 centimeters (13 inches) free space at the bumper corners] composed of flexible plastic and rigid plastic fenders. The first impact caused substantial tearing of the bumper cover and shattering/cracking of the right fender at the front right corner. In addition, the right headlight and turn signal assemblies were shattered, and there was minor bending of the engine cover (**Figure 7** above). Crush was measured at the metallic bumper under the plastic bumper cover, indicating a maximum crush of 7 centimeters (2.8 inches) at the front right bumper corner. The CDC for the first impact (nondeployment) was determined to be: **02-FREE-1 (+70)**. The WinSMASH reconstruction program, damage only algorithm, was used on vehicle #2's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 8.6 km.p.h. (5.3 m.p.h.), -2.9 km.p.h. (-1.8 m.p.h.), and -8.1 km.p.h. (-5.0 m.p.h.). Vehicle #2's second impact involved the area of the right rear wheel, "C"-pillar, and quarterpanel, and the maximum crush was 5 centimeters (2.0 inches). The CDC for the second impact (**Figure 9** above) was determined to be: **03-RZEW-1 (+90)**. Vehicle #2 was towed from the scene due to disabling damage.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1cm = 3m
IN97-050
ONLY
2
2
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2
1
1
1
Concrete
Dry
Level
Dark/Lighted
RP
Coefficient of
friction=0.65%
CV (V1)=1998 Chevrolet
Cavalier LS
V2=1994 Pontiac
Firebird
RL