TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

Advanced Information Engineering Services
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GENERAL DYNAMICS ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM
CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

CASE NO. CA02-039

VEHICLE – 2002 CADILLAC DEVILLE

LOCATION - STATE OF MICHIGAN

CRASH DATE – AUGUST 2002

Contract No. DTNH22-01-C-17002

Prepared for:

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Washington, D.C. 20590

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| 16. Abstract
This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) features that were present in a 2002 Cadillac Deville. The AOPS consisted of dual-stage frontal air bags, seat belt buckle pretensioners, and an Event Data Recorder (EDR). The Cadillac Deville was involved in an intersection collision with a 1998 Saturn that resulted in the deployment of the dual-stage frontal air bag system and seat belt pretensioners in the Cadillac. The 49-year-old female driver was restrained by the integrated manual 3-point lap and shoulder belt and initiated a forward trajectory in response to the frontal crash force. She loaded the seat belt webbing and contacted the deployed driver's air bag. The driver sustained minor hand and neck injuries and was not transported to a medical facility. | | | |

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BACKGROUND

This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) features that were present in a 2002 Cadillac Deville. The AOPS consisted of dual-stage frontal air bags, seat belt buckle pretensioners, and an Event Data Recorder (EDR). The Cadillac Deville was involved in an intersection collision with a 1998 Saturn that resulted in the deployment of the dual-stage frontal air bag system and seat belt pretensioners in the Cadillac (**Figure 1**). The 49-year-old female driver was restrained by the integrated manual 3-point lap and shoulder belt and initiated a forward trajectory in response to the frontal crash force. She loaded the seat belt webbing and contacted the deployed driver's air bag. The driver sustained minor hand and neck injuries and was not transported to a medical facility.

Figure 1. View of damaged 2002 Cadillac Deville

This crash was identified by the National Automotive Sampling System (NASS) PSU 12 during the weekly sampling of Police Accident Reports (PAR's). This crash was not selected as a CDS case, however, the PAR was forwarded to the General Dynamics SCI team. The PAR was then forwarded to NHTSA and was assigned as an on-site investigation that was initiated on September 25, 2002 due to the presence of the Advanced Occupant Protection System (AOPS) in the 2002 Cadillac Deville. The Saturn was also equipped with an EDR, and the EDR's from both vehicles were downloaded during the vehicle inspections. The EDR summaries for the Cadillac Deville and Saturn SL2 are included as **Attachments A and B** of this report, respectively.

CRASH SITE

This two-vehicle crash occurred during daylight hours of August 2002 at a four-leg intersection of a four-lane undivided roadway and a two-lane undivided roadway. At the time of the crash the weather was clear and the asphalt roadway surface was dry. Both roadway surfaces were straight and level. The north/south roadway was configured with two travel lanes in each direction that were separated by a double-yellow centerline and bordered by asphalt shoulders. The east/west roadway was configured with one travel lane in each direction separated by a broken yellow centerline on the west leg and a broken/solid no-passing centerline for westbound traffic on the east leg. The east/west roadway was bordered by gravel shoulders. The four corners of the intersection were configured with concrete curbs. The roadside environment consisted primarily of wooded areas and industry. Traffic control at the intersection consisted of stop signs on both sides of the roadway for eastbound and westbound traffic approaching the intersection. The

posted speed limit for the north/south roadway was 89 km/h (55 mph) and the posted speed limit for the east/west roadway was 72 km/h (45 mph). The scene schematic is included as **Figure 14** of this report.

CRASH SEQUENCE
 Pre-Crash
The 49-year-old female driver was operating the 2002 Cadillac Deville in a southbound direction in the outboard lane of the four-lane roadway **(Figure 2)**. The data summary from the Event Data Recorder (EDR) indicated the Cadillac was traveling at a speed of 97 km/h (60 mph) five seconds prior Algorithm Enable. The 39-year-old driver of the 1998 Saturn was operating the vehicle in a westbound direction on the two-lane roadway on approach to the four-leg intersection **(Figure 3)**. The driver of the Saturn disregarded the stop sign and proceeded into the intersection across the path of the Cadillac Deville. There was no evidence of attempted avoidance maneuvers by the driver of the Saturn. The driver of the Cadillac stated that she applied the brakes, but this avoidance was not supported by the EDR or physical evidence at the scene.

Figure 2. Southbound approach for the Cadillac

 Crash
The front aspect of the 2002 Cadillac Deville impacted the 1998 Saturn in the right rear side aspect. The EDR maximum-recorded velocity change was -18.36 km/h (-11.41 mph) for the Cadillac DeVille. The impact resulted in the deployment of both stages of the Cadillac's dual stage frontal air bag system and the actuation of both front seat belt buckle pretensioners. The longitudinal velocity change for the 1998 Saturn

Figure 3. Westbound approach for the Saturn

was sufficient to deploy the redesigned frontal air bag system, however, the Saturn's EDR only recorded a near-event with a maximum EDR recorded velocity change of -3.17 km/h (-1.97 mph). The damage algorithm of the WinSMASH program calculated total delta-V's of 16.0 km/h (9.9 mph) for the Cadillac and 27.0 km/h (16.8 mph) for the Saturn, based on the respective crush profiles. The calculated longitudinal components for the Cadillac and Saturn were –15.0 km/h (-9.3 mph) and –9.2 km/h (-5.7 mph), respectively. It should be noted that due to the composition of the Saturn's exterior door panels, the WinSMASH crush profile was based on measurements documented along the sill of the Saturn. This was not fully representative of the damage to the composite body panels and space frame of the vehicle. The Cadillac Deville rotated approximately 180 degrees in a clockwise (CW) direction and came to rest on the southbound shoulder adjacent to the southwest corner of the intersection. The Saturn rotated approximately 120 degrees in a CW direction and departed the roadway at the southwest corner of the intersection. Delineator posts were present near the Saturn's post-crash trajectory.

Although damage to the Saturn suggested a frontal impact with a narrow object, the crash dynamics suggest that there was no contact with the delineator posts in this crash. The Saturn traveled in a rearward direction and rolled into heavy brush and down a shallow embankment to final rest.

Post-Crash
The 49-year-old female driver of the 2002 Cadillac Deville stated that although the vehicle was equipped with OnStar, the system did not activate as a result of the crash. The driver stated that after the vehicle came to rest, she placed the steering column-mounted transmission selector to the "park" position, unlocked the driver's door, and turned the ignition off. She was not transported to a medical facility. The 39-year-old driver of the Saturn sustained B-type non-incapacitating injuries and was transported by ambulance to a local hospital. Her admission status was not known.

VEHICLE DATA – 2002 CADILLAC DEVILLE
The 2002 Cadillac Deville was identified by the Vehicle Identification Number (VIN): 1G6KD54Y42U (production sequence omitted). The driver reported that the vehicle's odometer read 25,379 km (15,770 miles) prior to the crash. The vehicle was a four-door sedan equipped with a 4.6 liter V-8 engine, a four-speed automatic transmission with front wheel drive, power steering, four-wheel disc brakes with anti-lock, all-speed traction control, power sunroof, and power and heated exterior mirrors. It was not equipped with Stabilitrak, which operated with the anti-lock brake system and traction control system to selectively apply any one of the four brakes to help the driver counteract dangerous handling situations. The system monitored yaw rate, lateral acceleration, and steer angle. The DeVille was also equipped with OnStar communications system, wiper-activated headlamps, ten-way power seat adjustment, four-way adjustable front head restraints, electronic climate controls, a tilt steering wheel with audio, climate, and cruise controls, four-way power lumbar support, and headed front and rear leather seats. The Cadillac Deville was equipped with Michelin Symmetry P225/60R16 tires. The manufacturer's recommended tire pressure was 207 kpa (30 psi) and the specific tire data is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	203.4 kpa (29.5 psi)	5.6 mm (7/32")	No	None
LR	203.4 kpa (29.5 psi)	7.0 mm (9/32")	No	None
RF	199.9 kpa (29.0 psi)	5.6 mm (7/32")	No	None
RR	206.8 kpa (30.0 psi)	7.0 mm (9/32")	No	None

The front seating positions in the 2002 Cadillac Deville were configured with a split bench seat with a folding center arm rest. Both outboard front seating positions were configured with four-way adjustable head restraints. The rear seating positions were configured with a bench seat with fixed head restraints and a folding center armrest. The center seat back was configured with a pass-through to the trunk behind the folding arm rest.

VEHICLE DAMAGE

Exterior Damage – 2002 Cadillac Deville

The 2002 Cadillac Deville sustained moderate damage as a result of the frontal impact with the 1998 Saturn (**Figure 4**). The direct contact damage along the leading edge of the hood began 14.0 cm (5.5") inboard of the left front corner of the hood and extended 118.1 cm (46.5") laterally along the hood. The lateral abrasions and contact deformation measured 26.7 cm (10.5") in depth from the leading edge of the hood rearward. The combined direct and induced damage involved the entire frontal width of the vehicle. The Field L measured 143.5 cm (56.5") across the width of the front bumper beam. The bumper fascia was separated and was not located with the vehicle at the time of the inspection. The grille was fractured and partially separated on the left side. The hood was buckled rearward. The left front fender was displaced inward at the forward aspect and outward at the rear aspect. The right front fender was displaced outward at the forward aspect as a result of the end shift (**Figure 5**). Both head lamp assemblies were separated. The bumper beam was crushed rearward and the maximum crush was located on the front left corner of the beam. Abrasions 24.9 cm (9.8") to the left of the hood's centerline were present on the hood from direct contact with the spring and suspension components of the right rear wheel of the Saturn. The right front wheel was displaced rearward which resulted in the shortening of the right wheelbase by 5.5 cm (2.2"). The left front wheel sustained minor abrasions from probable post-impact contact with the curbed roadside corner. The Collision Deformation Classification (CDC) for the impact with the Saturn was 71-FDEW-2. The CDC was incremented by 60 to reflect the lateral end shift to the right. Six crush measurements were documented along the front bumper beam and were as follows: C1 = 4.4 cm (1.8"), C2 = 21.1 cm (8.3"), C3 = 27.3 cm (10.8"), C4 = 27.3 cm (10.8"), C5 = 34.5 cm (13.6"), C6 = 32.4 cm (12.8").

Figure 4. Frontal view of damage to the 2002 Cadillac Deville

Figure 5. 45 degree view of the 2002 Cadillac Deville

Interior Damage – 2002 Cadillac Deville

Interior damage to the 2002 Cadillac Deville was minor (**Figure 6**) and attributed to passenger compartment intrusion. All doors were operational. The windshield laminate was fractured on the right aspect from contact with the deployed front right passenger's air bag. The remaining glazing was undamaged. There were no

Figure 6. Interior view of 2002 Cadillac Deville

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intrusions into the passenger compartment. The tilt steering column was found in the fourth position from the top (6 total positions) and was undamaged. The knee bolster was undamaged and did not exhibit contact evidence.

Exterior Damage – 1998 Saturn

The 1998 Saturn sustained moderate right side damage as a result of the impact with the Cadillac Deville. The direct contact damage began at the leading edge of the right rear door and extended 182.9 cm (72.0") rearward along the right side plane (**Figures 7 and 8**). The combined direct and induced damage began at the leading edge of the right front door and extended 295.9 cm (116.5") rearward along the right side plane to the right rear bumper corner. The maximum crush measured 22.9 cm (9.0") and was located 96.5 cm (38.0") aft of the leading edge of the right rear door on the right rear quarter panel. The composite exterior surface of the right rear door had fractured and was

Figure 7. View of right side damage to the 1998 Saturn

completely separated. The composite right rear quarter panel was also fractured in multiple locations and partially separated. The right aspect of the rear bumper fascia was abraded and displaced. The lower aspect of the right front door was fractured in multiple locations, and a large diagonal fracture that extended vertically from the bottom aspect to the door handle was present on the rear aspect of the door. The roof was buckled slightly and the sunroof was displaced but not fractured. The right rear wheel was displaced laterally against the suspension components. The right rear wheel was abraded and minor scuff marks were present on the sidewall of the tire. Both rear tires remained inflated and both front tires were deflated. The left rear wheel was displaced outward, and the rear track width was reduced by 13.7 cm (5.4"). The front bumper fascia exhibited abrasions consistent with an impact to a narrow object. Although delineator posts were present near the Saturn's post-crash trajectory, the crash dynamics suggest that there was no contact with the delineator posts in this crash. The CDC for the impact

Figure 8. Longitudinal view of right side damage

with the Cadillac Deville was 02-RZEW-2. Six crush measurements were documented along the right side at the mid-door level and were as follows: C1 = 0.0 cm, C2 = 0.0 cm, C3 = 8.3 cm (3.3"), C4 = 12.7 cm (5.0"), C5 = 14.0 cm (5.5"), C6 = 3.8 cm (1.5"). Based on the composite body panels, this crush profile was not an accurate representation of the resultant damage. A second crush profile was documented at the right sill which was used for the WinSMASH reconstruction model. These measurements and were as follows: C1 = 2.5 cm (1.0"), C2 = 6.4 cm (2.5"), C3 = 11.4 cm (4.5"), C4 = 15.2 cm (6.0"), C5 = 17.8 cm (7.0"), C6 = 3.8 cm (1.5").

MANUAL RESTRAINT SYSTEMS – 2002 CADILLAC DEVILLE

The 2002 Cadillac Deville was equipped with integrated manual 3-point lap and shoulder belts for the driver **(Figure 9)** and front right passenger positions and a lap belt for the front center position. The outboard seat belts were configured with sewn-on latch plates and electric shoulder belt height adjusters that were located on the outboard aspects of the front seat backs. The driver's restraint was configured with emergency locking retractors (ELR's) for the shoulder belt and lap belt. The front right restraint was configured with an ELR in the shoulder belt and a switchable/automatic locking retractor (ALR) for the lap belt. A label was present on the front right lap belt which stated, "With Active Air Bag: Move seat fully rearward. Pull belt out completely, then secure child seat." The shoulder belt height adjusters were electronically controlled by vertical motion of the seat back recline switch that was located on the outboard aspects of the front seat cushions. The height adjuster measured 11.4 cm (4.5") in depth and the front aspect consisted of a circular cover that measured 7.0 cm (2.8") in diameter with a diagonal opening through which the shoulder belt webbing passed. The top aspect of the driver's shoulder belt height adjuster was positioned 9.5 cm (3.8") above the seat back and the shoulder belt webbing was positioned 5.7 cm (2.3") above the seat back **(Figure 10)**. The front right shoulder belt height adjuster appeared to be in the full-down position and the top aspect measured 7.6 cm (3.0") above the front right seat back.

Figure 9. View of driver's integrated 3-point lap and shoulder belt

Figure 10. Close-up of the driver's shoulder belt height adjuster

The driver and front right passenger's positions were equipped with seat belt buckle pretensioners that fired in conjunction with the frontal air bag system as a result of the frontal impact with the Saturn. The post-crash distance from the forward aspect of the piston to the forward edge of the barrel for the driver's and front right passenger's buckle pretensioners were 2.4 cm (0.9") and 2.1 cm (0.8"), respectively. Plastic trim covers prohibited exemplar measurements of the pretensioners. The front right seat belt buckle housing was fractured as a result of the front right pretensioner firing without an occupant restrained in the seat **(Figure 11)**.

Figure 11. View of front right passenger's buckle pretensioner and fractured buckle housing

The driver's seat belt webbing exhibited minor stretching on the lap and shoulder portions from the driver's loading. The loading evidence on the shoulder belt began 15.2 cm (6.0") above the latch plate and extended 25.4 cm (10.0") upward along the webbing. The loading on the lap belt began 15.9 cm (6.3") above the latch plate and extended 15.9 cm (6.3") along the lap belt webbing.

The rear seating positions were configured with manual 3-point lap and shoulder belts with cinching latch plates and ELR's. The rear outboard shoulder belts were configured with the same upper anchorages as the front seat shoulder belts, however, their vertical positions were fixed. The rear seat positions were equipped with LATCH anchorages and tether anchors.

ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS) – 2002 CADILLAC DEVILLE

The 2002 Cadillac Deville was equipped with an AOPS that consisted of dual-stage frontal air bags, seat belt buckle pretensioners, and an Event Data Recorder (EDR). The dual-stage frontal air bags deployed as a result of the frontal impact with the Saturn **(Figure 12)**. The driver's air bag was housed in the center of the steering wheel with symmetrical I-configuration cover flaps. Each flap measured 8.3 cm (3.3") in width and 11.4 cm (4.5") in height. The driver's air bag was circular in shape and measured 66.0 cm (26.0") in diameter in its deflated state. The air bag was tethered by four internal straps that measured 8.3 cm (3.3") in width and were located at the 12, 3, 6, and 9 o'clock positions. The air bag was vented by two circular ports

Figure 12. View of deployed frontal air bags in the Cadillac Deville

that measured 3.2 cm (1.3") in diameter that were located at the 11 and 1 o'clock aspects on the rear aspect of the air bag 7.0 cm (2.8") aft of the peripheral seam. A small linear transfer that measured 1.3 cm (0.5") in length was located on the upper left quadrant of the face of the air bag 18.4 cm (7.3") from the center of the air bag.

The front right passenger's air bag deployed from the mid-instrument panel area. There were no cover flaps, as the air bag deployed from separation of the right upper and mid-instrument panels. The post-deployment separation of the instrument panel measured 5.7 cm (2.3") in height. An internal plastic contoured flap that was adjacent to the mid-instrument panel aspect measured 26.7 cm (10.5") in width and 6.4 cm (2.5") in height. This flap was positioned over the lower aspect of the separated instrument panel and centered in relation to the air bag, which prevented the air bag from snagging edge of the instrument panel as it deployed **(Figure 13)**. The front right passenger's air bag measured 35.6 cm (14.0") in width and 55.9 cm (22.0")

Figure 13. View of internal plastic flap for the front right passenger's air bag

in height in its deflated state. The air bag was vented by two circular ports that measured 6.4 cm (2.5") in diameter. The vent ports were located 35.6 cm (14.0) aft of the forward seams at the 3
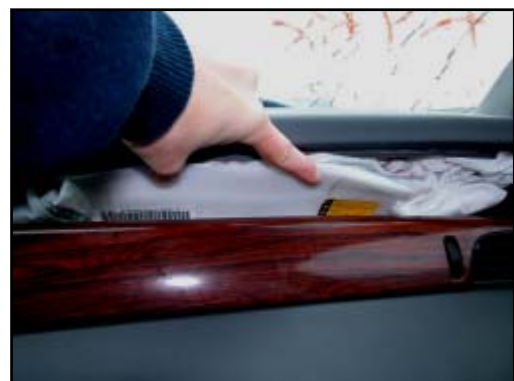
and 9 o'clock positions on side aspects of the air bag. There was no contact evidence on the air bag.

The EDR summary indicated that both the first and second stages of the frontal air bag system deployed in the crash. The first stage was commanded 5 milliseconds after the algorithm was enabled, and the second stage was commanded 7.5 milliseconds after the algorithm was enabled.

SIDE IMPACT AIR BAG SYSTEM – 2002 CADILLAC DEVILLE
The 2002 Cadillac Deville was equipped with side impact air bags that were located in the outboard aspects of the driver's and front right passenger's seat backs. The side impact air bags did not deploy in this crash. The vinyl module cover flaps measured 7.0 cm (2.8") in width at the top aspect, 8.9 cm (3.5") in width at the bottom aspect, and 19.7 cm (7.8") in height.

OCCUPANT DEMOGRAPHICS – 2002 CADILLAC DEVILLE
Driver

Age/Sex:	49-year-old female
Height:	177.8 cm (70.0")
Weight:	77.1 kg (170.0 lb)
Seat Track Position:	Full-rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	None
Type of Medical Treatment:	Not transported to any medical facility

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left hand injury (NFS)	Minor (790099.1,2)	Driver's air bag

Injury source: Driver interview

Driver Kinematics
The 49-year-old driver was seated in an upright posture with the seat adjusted to the full-rear position. She was restrained by the manual 3-point lap and shoulder belt. At impact, the frontal air bag system deployed and the seat belt buckle pretensioners fired. The driver initiated a forward trajectory in response to the frontal crash force and loaded the manual restraint. She contacted the deployed driver's air bag which offered additional protection against the frontal crash forces. She rebounded rearward into the seat back and the restraint system mitigated additional driver movement in the vehicle as the Cadillac rotated in a CW direction to final rest. The driver reported that she shifted the transmission to the "park" position, unlocked the driver's door, and turned off the vehicle's ignition. The driver exited the vehicle under her own power. She stated that she sustained a minor left hand injury from interaction with the driver's air bag which she described as redness that improved the following day. The driver also stated that she sustained a pinched nerve in her neck. She was not transported to any medical facility.

SCI-1
Case No. CA02-039
State of Michigan
August 2002

N

Vehicle 1: 2002 Cadillac Deville
Vehicle 2: 1998 Saturn SL2

Posted speed limit for North/South roadway: 89 km/h (55 mph)
Posted speed limit for East/West roadway: 72 km/h (45 mph)
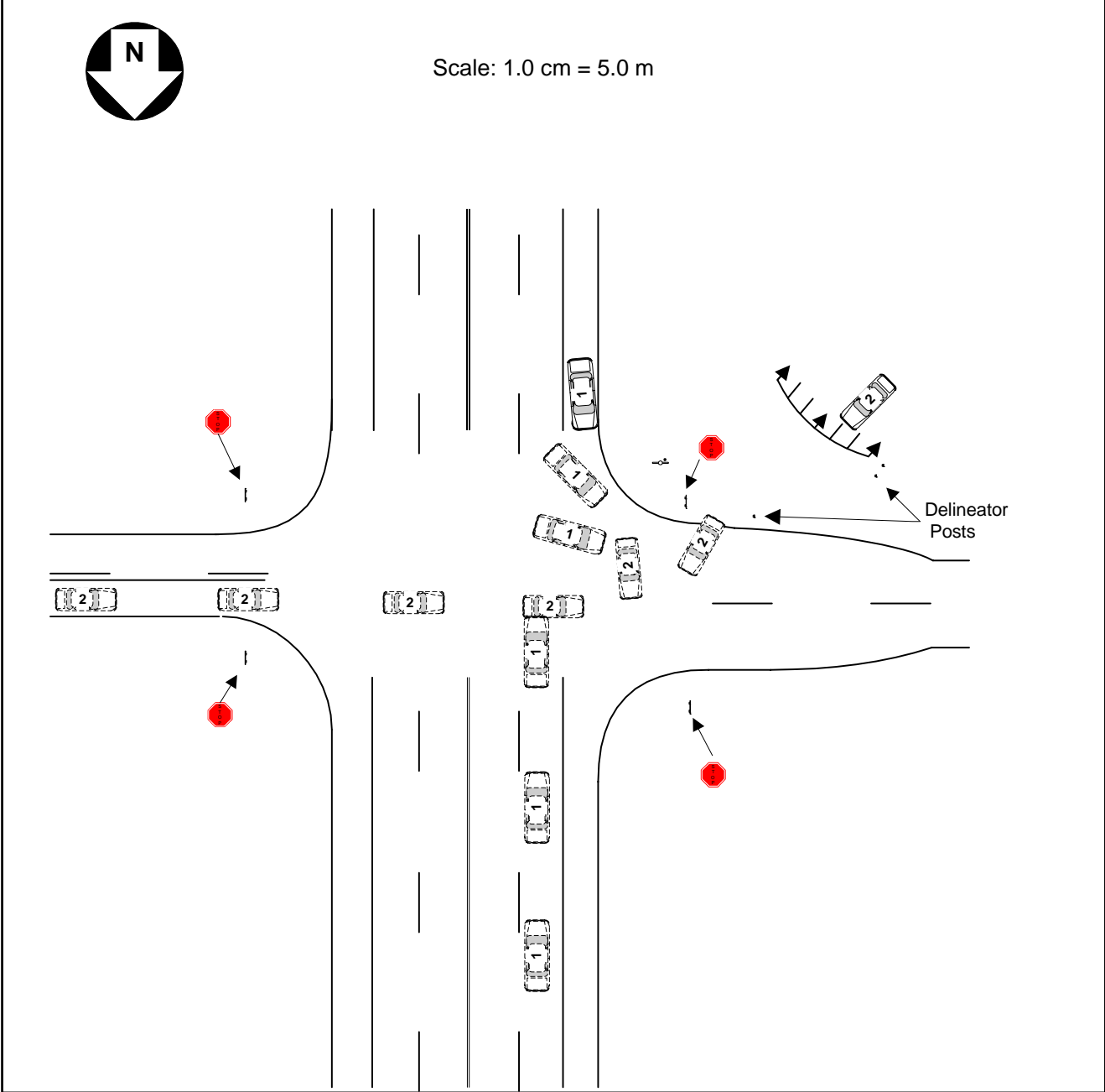
Scale: 1.0 cm = 5.0 m

Delineator
Posts

Figure 14. Scene schematic

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Attachment A: EDR Summary for the 2002 Cadillac Deville

CDR File Information

Vehicle Identification Number	1G6KD54Y42Uxxxxxx
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	NO SEQUENCE.CDR
Saved on	10/21/2002 1:38:07 PM
Data check information	F898788E
Collected with CDR version	Crash Data Retrieval Tool 1.602
Collecting program verification number	AD206938
Reported with CDR version	Crash Data Retrieval Tool 2.24
Reporting program verification number	70CD83DD
Event(s) recovered	Deployment

SDM Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment events can not be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the non-deployment file will be locked after a deployment, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the deployment.

SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For deployments and deployment level events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For non-deployments, the SDM will record the first 150 milliseconds of data after algorithm enable.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM does not receive a valid message.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit
-The Time Between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than 25.4 seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.

SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the SDM.
-In most vehicles, the Driver's Belt Switch Circuit is wired directly to the SDM. In some vehicles, the Driver's Belt Switch Circuit Status data is transmitted from the Body Control Module (BCM), via the Class 2 data link, to the SDM.

System Status At Deployment

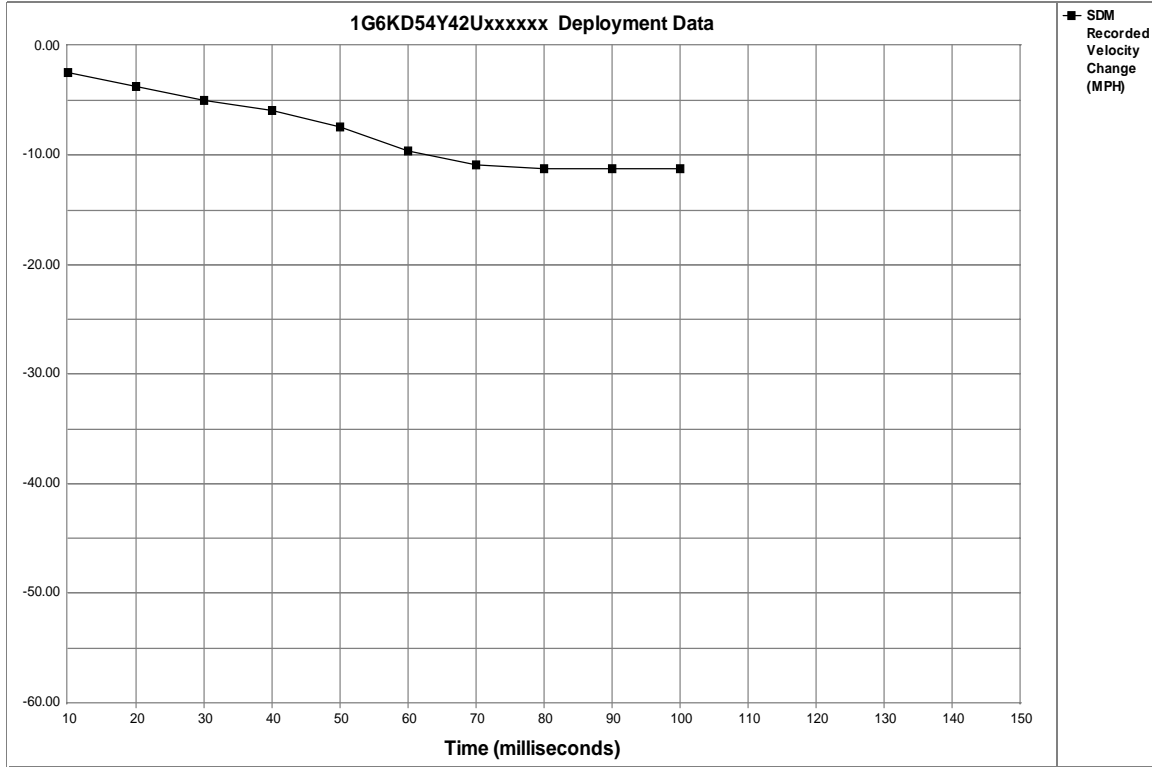|	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	1397
Ignition Cycles At Investigation	1407
Maximum SDM Recorded Velocity Change (MPH)	-11.41
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	92.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	7.5
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	7.5
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No

1G6KD54Y42Uxxxxxx Deployment Pre-Crash Graph

Legend:
- Vehicle Speed (MPH)
- Engine Speed (RPM / 100)
- Percent Throttle
- Brake Switch Circuit Status (100 = ON)

Approximate Time Before Algorithm Enable (seconds)
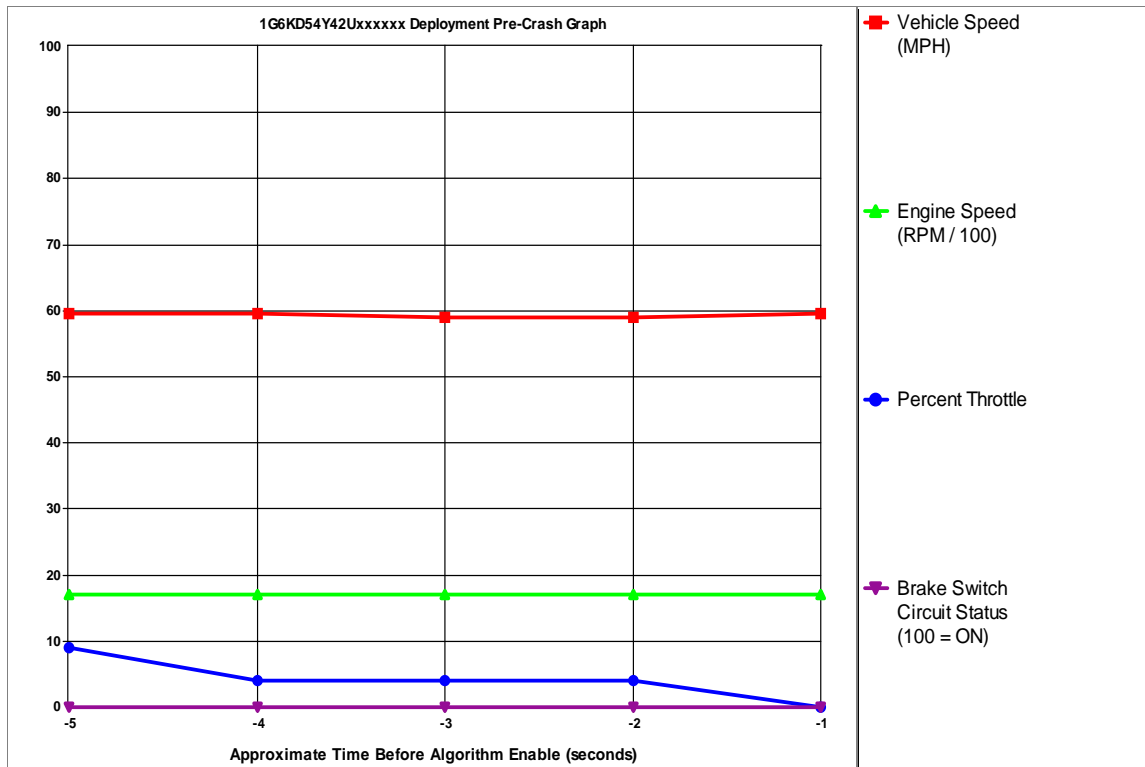
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	60	1664	9	OFF
-4	60	1664	4	OFF
-3	59	1664	4	OFF
-2	59	1664	4	OFF
-1	60	1664	0	OFF

1G6KD54Y42Uxxxxxx Deployment Data

Legend: SDM Recorded Velocity Change (MPH)

X-axis: Time (milliseconds)

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-2.48	-3.72	-4.96	-5.89	-7.44	-9.61	-10.85	-11.16	-11.16	-11.16	N/A	N/A	N/A	N/A	N/A

Hexadecimal Data

This page displays all the data retrieved from the air bag module.
It contains data that is not converted by this program.

```
$01   0A 05 FB 75 9E B6
$02   D5 00 33 33 00 00
$03   41 53 31 32 39 38
$04   4B 31 4A 53 41 31
$05   00 00 00 00 00 00
$06   25 73 67 20 00 00
$07   00 00 00 00 00 00
$08   41 44 62 52 58 12
$09   81 30 31 41 4E 56
$0A   00 00 00 00 00 00
$0B   00 00 00 00 00 00
$0C   00 00 00 00 00 00
$0D   00 00 00 00 00 00
$0E   00 00 00 00 00 00
$0F   00 00 00 00 00 00
$10   FF 50 80 00 00 00
$11   7B 7B 7B 85 85 85
$12   A1 02 8D 20 20 00
$13   FF 02 00 00 00 00
$14   1D 00 05 05 00 00
$15   36 FA 4B 44 45 46
$16   46 45 FA 45 48 48
$17   48 48 00 00 00 00
$18   00 FF 51 EC 01 00
$19   00 00 00 00 00 00
$1A   00 00 00 00 00 00
$1B   00 00 00 00 00 00
$1C   00 00 00 00 00 00
$1D   00 00 00 00 00 00
$1F   FE 00 00 00 00 00
$20   FF FF FF FF FF FF
$21   FF FF FF FF FF FF
$22   FF FF FF FF FF FF
$23   FF FF FF FF FF FF
$24   FF FF FF FF FF FF
$25   FF FF FF FF FF FF
$26   FF FF FF FF FF FF
$27   FF FF FF FF FF FF
$28   FF FF FF FF FF FF
$29   FF FF FF FF FF FF
$2A   FF FF FF FF FF FF
$2B   FF FF FF FF FF FF
$2C   FF FF FF FF FF FF
$2D   FF FF 00 00 00 00
$30   B2 FE 00 00 FF FF
$31   FF F7 FF FF FF FF
$32   FF F7 FF FF FF FF
$33   EF FF FF FF 7F FF
$34   00 11 00 05 02 03
$35   11 00 05 02 03 33
$36   30 06 03 03 33 30
$37   06 03 03 02 4C 1D
$38   25 03 33 1A 00 00
$39   CF 00 00 03 00 00
$3A   08 0C 10 13 18 1F
$3B   23 24 24 24 00 00
$3C   00 00 00 0A FF 51
$3D   E0 A5 00 00 00 00
$40   60 5F 5F 60 60 00
$41   00 00 00 0A 0A 0A
$42   18 00 1A 1A 1A 1A
$43   1A 00 44 F0 00 00
```

```
$44   FF FF FF FF FF FF
$45   FF FF FF FF FF FF
$46   FF FF FF FF FF FF
$47   FF FF FF FF 00 00
$48   FF FF FF FF FF FF
$49   FF FF FF FF FF FF
$4A   FF FF FF FF FF FF
$4B   FF FF FF FF 00 00
$4C   FF FF FF FF FF FF
$4D   FF FF FF FF FF FF
$4E   FF FF FF FF FF FF
$4F   FF FF FF FF 00 00
$50   FF FF FF FF FF FF
$51   FF FF FF FF FF FF
$52   FF FF FF FF FF FF
$53   FF FF FF FF FF FF
$54   FF FF FF FF FF FF
```

Attachment B: EDR Summary for the 1998 Saturn SL2

CDR File Information

Vehicle Identification Number	1G8ZK5272WZxxxxxx
Investigator	
Case Number	███████
Investigation Date	
Crash Date	
Filename	SATURN EDR - NO SEQUENCE.CDR
Saved on	10/04/2002 12:48:43 PM
Data check information	9981710F
Collected with CDR version	Crash Data Retrieval Tool 1.602
Collecting program verification number	AD206938
Reported with CDR version	Crash Data Retrieval Tool 2.24
Reporting program verification number	70CD83DD
Interface used to collected data	Block number: 00 Interface version: 31 Date: 06-13-02 Checksum: 5B00
Event(s) recovered	Non-Deployment

SDM Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment events can not be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the non-deployment file will be locked after a deployment, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the deployment.

SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. The SDM records the first 300 milliseconds of Vehicle Forward Velocity Change after Algorithm Enable. The maximum value that can be recorded for Vehicle Forward Velocity Change is 56 MPH.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit.
-The Time between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded. An indication of a loss of power would be if the ignition cycles at Deployment or Non-Deployment is recorded as zero. Data recorded after that may not be reliable, such as Time Between Non-Deployment and Deployment Events, Driver Belt Switch Circuit Status, and Passenger SIR Suppression Switch Circuit Status.

SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-The Driver's Belt Switch Circuit is wired directly to the SDM.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Non-Deployment	11904
Ignition Cycles At Investigation	11905
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	10
Maximum SDM Recorded Velocity Change (MPH)	-1.97
A Deployment was Commanded Prior to this Event	No

1G8ZK5272WZxxxxxx Non-Deployment Data

Legend: ■ SDM Recorded Velocity Change (MPH)

X-axis: Time (milliseconds)

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hexadecimal Data

This page displays all the data retrieved from the air bag module.
It contains data that is not converted by this program.

```
B600:   20 40 08 00 00 AA AA 00
B608:   00 00 00 00 00 AA AA 00
B610:   00 00 00 00 00 2F F9 F9
B618:   F9 F9 F9 F9 F9 9B FF 00
B620:   AA AA 00 00 00 00 00 00
B628:   00 00 00 00 00 00 00 00
B630:   00 00 00 00 00 00 00 00
B638:   00 00 00 00 00 00 00 00
B640:   00 00 00 00 00 00 00 00
B648:   00 00 00 00 00 00 00 00
B650:   00 00 00 00 00 00 00 00
B658:   00 00 7D 00 00 00 08 09
B660:   09 00 00 00 00 00 00 00
B668:   00 00 00 00 00 00 00 00
B670:   00 00 00 00 00 00 00 00
B678:   00 00 00 00 00 00 2E 80
B680:   00 00 00 55 55 AA AA AA
B688:   01 00 00 00 00 00 00 00
B690:   00 00 00 00 7D FA 00 00
B698:   7D FA 00 00 7D FA 00 00
B6A0:   7D FA 00 00 7D FA 00 00
B6A8:   7D FA 2F 9B 00 00 81 00
B6B0:   00 00 00 00 00 00 00 00
B6B8:   00 00 00 00 00 92 6E C6
B6C0:   34 4E 1A 01 00 64 02 00
B6C8:   00 00 00 00 00 00 FF FF
B6D0:   BE B1 BC CA B2 BA BE AC
B6D8:   F7 6F B4 77 F9 A0 00 00
B6E0:   00 00 FF FF 00 00 01 53
B6E8:   01 55 00 00 00 00 00 00
B6F0:   FF 03 F0 05 50 06 0C 22
B6F8:   58 6E 6E 6E 6E 6E 6E 6E
B700:   6E 6E 6E 6E 6E 6E 6E 6E
B708:   6E 73 79 81 88 91 98 A3
B710:   AA B6 C0 CA D3 DD E5 ED
B718:   F3 FC 40 43 45 47 49 4C
B720:   4F 51 54 57 59 5C 5E 60
B728:   62 64 66 67 69 6A 6B 6C
B730:   6E 6F 70 71 72 73 74 74
B738:   75 76 77 7C 82 87 8C 90
B740:   94 99 9D A1 A7 AB B1 B6
B748:   BB BF C3 C7 CC CF D3 D6
B750:   DA FF FF FF FF FF FF FF
B758:   FF FF FF FF FF 00 48 01
B760:   68 05 04 46 28 12 10 01
B768:   06 AA 00 46 47 37 37 37
B770:   39 3A 42 42 42 48 4A 4B
B778:   4B 4F 54 57 5D 5E 5E 5E
B780:   5E 5E 5E 5E 5E 5E 5E 5E
B788:   5E 5E 5E 5E 5E 5E 5E 5E
B790:   63 67 6C 71 76 7B 80 85
B798:   8A 8A 8C 8F 8F 8F 8F 8F
B7A0:   8F 8F 8F 8F 8F 8F 8F 8F
B7A8:   8F 8F 8F 8F 8F 8F 8F 8F
B7B0:   8F 8F 8F FF FF FF FF FF
B7B8:   FF FF FF FF FF 00 AA 00
B7C0:   00 00 C0 57 00 00 00 00
B7C8:   00 00 00 00 00 00 00 00
B7D0:   00 00 00 00 00 00 00 00
B7D8:   00 00 00 00 00 00 00 00
B7E0:   00 00 00 00 00 00 00 00
B7E8:   00 00 00 00 00 00 00 00
```

```
B7F0:   00 00 00 00 00 00 00 00
B7F8:   00 00 A5 A5 A5 A5 75 01
```

Comments

Vehicle 2