TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS REMOTE CERTIFIED ADVANCED COMPLIANT VEHICLE CRASH INVESTIGATION

SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 03-48-095C

VEHICLE – 2003 CHEVROLET AVALANCHE

LOCATION - STATE OF ALABAMA

CRASH DATE – MAY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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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.

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16. Abstract This remote investigation focused on the performance of the Certified Advanced Compliant safety system in the 2003 Chevrolet Avalanche. The manufacturer of this vehicle has certified that this 2003 Chevrolet Avalanche meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208.The safety system included dual stage frontal air bags, seat track position sensors for the front left and front right seats and an occupant presence sensor for the front right seat. In addition, the Avalanche was equipped with an Event Data Recorder (EDR) that was downloaded (non-deployment) by the NASS researcher. However, the printout could not be located, therefore its not included in this report. The 2003 Chevrolet Avalanche was occupied by an unrestrained 52-year-old male driver and an unrestrained 49-year-old female front right occupant. The GMC was involved in a moderate severity intersection crash with a 2001 Chevrolet Silverado. This impact subsequently resulted in the Avalanche rolling over onto its roof. The Silverado was occupied by a 49-year-old male driver. Both vehicles were traveling southbound on a four-lane, one-way roadway approaching an intersection. The Silverado was in the left lane and the Avalanche was in the adjacent lane to the right. The Avalanche initiated a left turn at the intersection and the front of the Silverado impacted the left side of the Avalanche. The Avalanche subsequently rolled onto its roof as a result of the impact with the Silverado. The driver and front right passenger of the Avalanche sustained AIS-1 soft tissue injuries and were transported to a hospital where they were treated and released. Both vehicles sustained disabling damage and were towed from the crash site.			
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NASS/SCI COMBO CASE NO. 03-48-095C
SUBJECT VEHICLE – 2003 CHEVROLET AVALANCHE
LOCATION - STATE OF ALABAMA
CRASH DATE - MAY 2003

BACKGROUND

This remote investigation focused on the performance of the Certified Advanced Compliant safety system in the 2003 Chevrolet Avalanche **(Figure 1)**. The manufacturer of this vehicle has certified that this 2003 Chevrolet Avalanche meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual stage frontal air bags, seat track position sensors for the front left and front right seats and an occupant presence sensor for the front right seat. In addition, the Avalanche was equipped with an Event Data Recorder (EDR) that was downloaded (non-deployment) by the NASS researcher. However, the printout could not be located, therefore its not included in this report. The 2003 Chevrolet Avalanche was occupied by an unrestrained 52-year-old male driver and an unrestrained 49-year-old female front right occupant. The GMC was involved in a moderate severity intersection crash with a 2001 Chevrolet Silverado. This impact subsequently resulted in the Avalanche rolling over onto its roof. The Silverado was occupied by a 49-year-old male driver. Both vehicles were traveling southbound on a four-lane, one-way roadway approaching an intersection. The Silverado was in the left lane and the Avalanche was in the adjacent lane to the right. The Avalanche initiated a left turn at the intersection and the front of the Silverado impacted the left side of the Avalanche. The Avalanche subsequently rolled onto its roof as a result of the impact with the Silverado. The driver and front right passenger of the Avalanche sustained AIS-1 soft tissue injuries and were transported to a hospital where they were treated and released. Both vehicles sustained disabling damage and were towed from the crash site.

Figure 1. Subject vehicle 2003 Chevrolet Avalanche.

This crash was identified by the National Automotive Sampling System (NASS) PSU 48 during the weekly sampling of Police Accident Reports (PARs). This crash was selected and researched as CDS Case No. 03-48-095C. The NASS PSU performed the vehicle and scene inspections. Due to the presence of the Certified Advanced Compliant safety system in the Chevrolet Avalanche, NHTSA assigned the tasks of case review and report preparation to the General Dynamics SCI team.

SUMMARY

Crash Site

This two-vehicle crash occurred during the morning hours of May 2003 in the state of Alabama. At the time of the crash, there were no adverse weather conditions and the asphalt road surface was dry. The crash occurred at an intersection of two local roads. The southbound roadway was a four-lane, one-way roadway that was bordered by concrete barrier curbs. The east/westbound roadway was a three-lane, two-way roadway that was divided by a solid double yellow centerline. The intersection was controlled by overhead three-phase traffic signals. The posted speed limit for the southbound roadway was 72 km/h (45 mph).

VEHICLE DATA

2003 Chevrolet Avalanche

The 2003 Chevrolet Avalanche was identified by the Vehicle Identification Number (VIN): 3GNEC13TX3 (production sequence omitted). The odometer reading was 3,428 kilometers (2,130 miles) at the time of the inspection. The vehicle was a four-door pickup truck that was equipped with a 5.3-liter, eight-cylinder engine, four-wheel disc brakes with ABS, rear-wheel drive and a four-speed automatic transmission. The tires on the Avalanche were Goodyear Wrangler HP, size P265/70R17. The maximum pressure for these tires was 303 kpa (44 psi). The manufacturer recommended front and rear tire pressure was 207 kpa (30 psi). The specific tire data is as follow:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	241 kpa (35 psi)	10 mm (13/32”)	No	None
LR	262 kpa (38 psi)	10 mm (13/32”)	No	None
RF	0 kpa	9 mm (11/32”)	No	Flat
RR	248 kpa (36 psi)	10 mm (13/32”)	No	None

The Avalanche was configured with a front three-passenger split bench seat with height adjustable head restraints for the outboard positions. The front left head restraint was adjusted between the mid to full-up position at the time of the inspection. The front right head restraint was adjusted to the full-down position at the time of the inspection. The second row was configured with a three-passenger bench seat and height adjustable head restraints for the outboard positions and an integrated head restraint for the center position. The rear head restraints were adjusted to the full-down position at the time of the inspection.

2001 Chevrolet Silverado

The 2001 Chevrolet Silverado was identified by the VIN: 2GCEC19W41 (production sequence omitted). The odometer reading was 54,196 kilometers (33,676 miles) at the time of the inspection. The vehicle was a four-door pickup truck that was equipped with a 4.3-liter, six-cylinder engine, rear-wheel drive and a four-speed automatic transmission, and four-wheel ABS. The Silverado was coded in the NASS Electronic Data System

(EDS) as a two-door pick up truck. The tires on the Silverado were Goodyear Wrangler ST, size P235/75R16. The maximum pressure for these tires was 303 kpa (44 psi). The manufacturer recommended front and rear tire pressure was 241 kpa (35 psi). The specific tire data is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	262 kpa (38 psi)	8 mm (10/32”)	Unknown	None
LR	269 kpa (39 psi)	7 mm (9/32”)	No	None
RF	255 kpa (37 psi)	8 mm (10/32”)	Unknown	None
RR	276 kpa (40 psi)	8 mm (10/32”)	No	None

The Silverado was configured with a front three-passenger split bench seat with adjustable head restraints for the outboard positions. The front head restraints were adjusted to the full-down position at the time of the inspection. The second row was configured with a three-passenger bench seat and height adjustable head restraints for the outboard positions. The rear head restraints were adjusted to the full-down position at the time of the inspection.

CRASH SEQUENCE

Pre-Crash

The unrestrained 52-year-old male driver of the Avalanche was operating the vehicle southbound in the second through lane **(Figure 2)** approaching an intersection where the driver was intending to turn left. An unrestrained 49-year-old female front right occupant also occupied the Avalanche. The driver of the Silverado was operating the vehicle southbound in the left lane adjacent to the Avalanche. The driver of the Avalanche failed to detect the Silverado and turned left across the path of the Silverado from the second lane at the intersection. There was no physical evidence documented at the crash site. The EDR data indicated that the Avalanche was traveling at 41.8 km/h (26.0 mph) five seconds prior to the crash and had slowed to 16.1 km/h (10.0 mph) one second prior to the crash. The EDR also indicated that the brake switch status was in the on-position from five to two seconds prior to the crash. The NASS scene schematic is included as **Figure 10** of this report.

Figure 2. Southbound approach for the Chevrolet Avalanche.

Crash

The front aspect of the Silverado impacted the left center aspect of the Avalanche **(Figure 3)** in the intersection. The impact resulted in minor severity damage to the left side of the Avalanche and unknown severity damage to the front aspect of the Silverado. The Silverado was under repair at the time of the NASS inspection therefore, the damage extent was unknown. This impact did not result in the deployment of the frontal air bag system in either vehicle. The resultant directions of force were within the 9 o'clock sector for the Avalanche and 1 o'clock sector for the Silverado. The WINSMASH program was not used by the NASS researcher to calculate a delta-V for this impact due to the Silverado being under repair and the Avalanche being out of the scope of the WINSMASH program. The Avalanche was configured with steel tubular step rails that were engaged during the impact. The step rails altered the stiffness of the side plane of the Avalanche therefore; this vehicle is out of the scope of the WINSMASH program for NASS. SCI used the results of the WINSMASH missing vehicle algorithm as a baseline velocity change for this impact. The total calculated delta-V by the WINSHASH program for the Avalanche was 5.0 km/h (3.1 mph). The longitudinal and lateral components were 0 km/h and 5.0 km/h (3.1 mph), respectively. The total calculated delta V for the Silverado was 6.0 km/h (3.7 mph). The longitudinal and lateral components were -5.6 km/h (-3.5 mph) and -2.1 km/h (-1.3 mph), respectively. The Avalanche's EDR recorded a maximum longitudinal velocity change of -0.5 km/h (-0.3 mph).

Figure 3. Area of impact between the Avalanche and the Silverado.

As a result of the front of the Silverado impacting the left the side of the Avalanche, the Avalanche subsequently initiated a lateral rollover with its right side leading. The rollover was initiated in the intersection **(Figure 4)** as a result of the vehicle engagement. The Avalanche rolled two quarter turns coming to rest on its roof. At rest, the vehicle was position south of the intersection facing a westerly direction partly on the sidewalk and in the left travel lane.

Figure 4. Avalanche's trajectory to rollover and final rest.

Post-Crash

Both vehicles came to rest south of the point of impact. The driver and front right passenger of the Avalanche sustained AIS-1 soft tissue injuries and were transported to a hospital where they were treated and released. Both vehicles sustained disabling damage and were towed from the crash site.

VEHICLE DAMAGE

Exterior – 2003 Chevrolet Avalanche

The 2003 Chevrolet Avalanche sustained minor severity left side damage as a result of the collision with the Silverado **(Figure 5)**. The NASS researcher documented the direct damage width as 133.0 cm (52.4”), which began rear of the left rear door and extended forward to the leading edge of the left rear door. The damage consisted of a laterally deformed door panel, sill, and tubular step rail. The Collision Deformation Classification (CDC) for this impact was 09-LZEW-3.

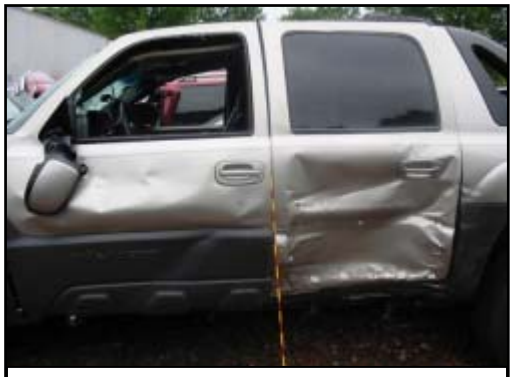

Figure 5. Area of damage from impact with the Silverado. Note: the damage to the upper left door and side view mirror is from vehicle being rolled back onto its wheels.

The Avalanche sustained moderate severity damage to its right side and roof as a result of the rollover **(Figure 6)**. The direct damage extended the full length of the vehicle on the right side and across the entire width of the roof at the windshield header and forward aspect of the roof. The damage on the right side consisted of abrasions and lateral deformation of the body panels. The roof and windshield header damage consisted of vertical deformation. As a result of the windshield header deformation, the windshield was fractured and vertically deformed. The left front window frame, A-pillar, and side view mirror also appeared to have sustained rollover damage. However, based on the final rest position of the vehicle, the tow removal was probably executed by rolling the vehicle over onto its left side, then onto its wheels in southerly direction away from the intersection in order to upright the vehicle. The left front and right doors remained closed and operational post-crash. The left rear door was jammed closed as result of the initial impact. The left front and right front glazing were disintegrated as result of the rollover. The remainder of the glazing was not damaged.

Figure 6. Roof and right side damage from rollover.

Interior – 2003 Chevrolet Avalanche

The 2003 Chevrolet Avalanche sustained moderate interior damage **(Figure 7)** as a result of interior intrusions and occupant contacts. The occupant contacts consisted of the driver's head contacting and deforming the front left area of the roof. The front right passenger's contacts consisted of the passenger's head contacting and deforming the front right area of the roof. The interior intrusions are listed in the table below:

Figure 7. Interior of 2003 Chevrolet Avalanche.

Intruded Component	Intrusion Extent	Direction
Front left windshield header	5.0 cm (1.9")	Vertical
Front left roof (estimated)	8.0-15.0 cm (3.1-5.9")	Vertical
Front center windshield header	4.0 cm (1.6")	Vertical
* Front center windshield (estimated)	3.0-8.0 cm (1.2-3.1")	Vertical
Front center roof (estimated)	3.0-8.0 cm (1.2-3.1")	Vertical
Front right A-pillar	8.0 cm (3.1")	Vertical
* Front right windshield (estimated)	3.0-8.0 cm (1.2-3.1")	Vertical
Front right roof side rail	7.0 cm (2.8")	Vertical
Front right roof	8.0 cm (3.1")	Vertical
Front right windshield header	5.0 cm (1.9")	Vertical

* The front center and right windshield intrusion direction was coded as longitudinal in the NASS EDS. SCI revised the intrusion direction to vertical for this report.

** The front center roof intrusion was not coded in the NASS EDS. Based on interior images, this intrusion was added to the SCI report.

Exterior – 2001 Chevrolet Silverado

The 2001 Chevrolet Silverado sustained unknown severity frontal damage **(Figure 8)**. The specific damage could not be identified due to the frontal components being replaced prior to the NASS inspection. The CDC for this impact was coded in the NASS EDS as 99-9999-9. Based on the crash configuration and impact location on the Silverado the CDC used for this SCI remote investigation was 01-F999-9.

Figure 8. 2001 Chevrolet Silverado. Note: vehicle was under repair.

Manual Restraint Systems – 2003 Chevrolet Avalanche

The 2003 Chevrolet Avalanche was equipped with integrated manual 3-point lap and shoulder safety belts for the front outboard seating positions **(Figure 9)**. The front center and rear center seating positions were configured with manual 2-point lap belts. The rear outboard seating positions were configured with manual 3-point lap and shoulder safety belts. The driver's safety belt was configured with a sliding latch plate and a belt-sensitive Emergency Locking Retractor (ELR). Although the NASS researcher documented belt usage for the driver and front right passenger there were no witness marks to support belt usage at the time of the crash. The EDR data indicated that the driver's belt system was unbuckled at the time of the crash. Therefore, the SCI revised the belt status for the driver and front right passenger to unrestrained. The front right and rear safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractor's (ALR). The front center safety belt was configured with a locking latch plate and no retractor. The NASS EDS was coded with six seating positions, however the front center safety belt was not coded in the NASS file. Additionally, the NASS EDS coding of the safety belt retractors of ELR only for the front right and rear safety belts was incorrect.

Figure 9. Integrated restraints in the Avalanche.

Certified Advanced Compliant Safety System – 2003 Chevrolet Avalanche

The 2003 Chevrolet Avalanche was equipped with a Certified Advanced Compliant safety system. The system included dual stage frontal air bags, seat track position sensors for the front left and front right seats and an occupant presence sensor for the front right seat. The system was monitored and controlled by a Sensing and Diagnostic control Module (SDM) that was located on the floor under the driver's seat. The SDM deploys the appropriate safety component(s) dependant on occupant presence, belt usage, seat track position and crash severity. In this crash, the SDM did not command a deployment of the frontal air bag system.

Event Data Recorder (EDR) 2003 Chevrolet Avalanche

The 2003 Chevrolet Avalanche was equipped with an Event Data Recorder (EDR). The NASS researcher successfully downloaded the EDR, which recorded a non-deployment event. The EDR data indicated that the driver's safety belt was not buckled at the time of the crash. The EDR data also indicated that the Avalanche was traveling at 41.8 km/h (26.0 mph) five seconds prior to the crash and had slowed to 16.1 km/h (10.0 mph) one second prior to the crash. The EDR recorded a maximum velocity change of -0.5 km/h (-0.3 mph). The EDR output could not be located; therefore it's not included with this report. The output data was coded into the NASS EDS case file.

OCCUPANT DEMOGRAPHICS – 2003 Chevrolet Avalanche

Driver

Age/Sex:	52-year-old male
Height:	185.0 cm (72.8")
Weight:	91.0 kg (201.0 lbs)
Seat Track Position:	Between mid and full-rear
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a local hospital where he was treated and released.

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Pain to anterior left thigh with minor 5.0 cm (1.9") laceration into subcutaneous tissue	Minor (890602.1,2)	Steering wheel
Abrasions, unknown multiple regions	Minor (990200.1,9)	Unknown multiple sources
Contusions, unknown multiple regions	Minor (990400.1,9)	Unknown multiple sources
Complaint of pain to left shoulder	Not applicable	Door panel
Complaint of pain to left knee	Not applicable	Door panel
Complaint of pain to neck	Not applicable	Roof, indirect
Complaint of pain to back	Not applicable	Roof, indirect

Injury source: ER records

Driver Kinematics

The 52-year-old male driver of the 2003 Chevrolet Avalanche was seated in a presumed upright driving posture and was not restrained by the integrated manual 3-point lap and shoulder belt. The NASS researcher documented the driver as using his safety belt in this crash. However, there was no loading evidence on the belt system to support belt usage; therefore SCI revised the driver's belt status to unrestrained. The EDR printout also indicated that the driver's belt system was unbuckled at the time of the crash. The seat track was adjusted to a mid to full-rear position. At impact with the Chevrolet, the unrestrained driver initiated a left trajectory and probably loaded the left door panel. The door panel loading resulted in the pain to the left shoulder and left knee. As a result of the impact with the Chevrolet, the vehicle began to rollover with its right side leading. The driver initiated a vertical and right trajectory with his left thigh contacting the steering wheel, which resulted in the minor 5.0 cm (1.9") anterior left thigh laceration. The driver's movement in the vehicle resulted in the driver's head contacting and deforming the front left area of the roof. The roof contact resulted in indirect neck and back pain. The specific locations of the whole area abrasions and contusions were unknown; consequently a specific injury mechanism could not be assigned. The driver was transported to a local hospital where he was treated and released.

Front Right Passenger

Age/Sex:	49-year-old female
Height:	Unknown
Weight	Unknown
Seat Track Position:	Mid-track
Manual Restraint Use:	None Used
Usage Source:	Vehicle Inspection
Eyewear:	Unknown
Type of Medical Treatment:	Treated and released from a local hospital

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
*Superficial laceration to buttocks	Minor (890602.1,8)	Flying Glass
Abrasion to buttocks	Minor (690202.1,8)	Flying Glass
Contusions unknown/multiple regions	Minor (990400.1,9)	Unknown multiple sources
Left hip pain	Not applicable	Center seat/armrest

Injury source: ER records.

* SCI revised per Medical Records

Front Right Passenger Kinematics

The 49-year-old female front right passenger was seated in a presumed upright posture and was not restrained by the integrated manual 3-point lap and shoulder belt. There was no loading evidence to support belt usage; therefore SCI revised the passenger's belt status to unrestrained. The seat track was in the mid-track position. At impact with the Chevrolet, she initiated a left trajectory in response to the 9 o'clock direction of force. The passengers left hip contacted the center seat/armrest, which resulted in the left hip pain. As the Avalanche rolled over, the passenger began a lateral right trajectory. The front right glazing disintegrated contacting the passenger, which resulted in the superficial lacerations and abrasions to the buttocks. The specific locations of the whole area contusions are unknown; consequently a specific injury mechanism could not be assigned. The front right passenger was transported to a local hospital where she was treated for her injuries and released.

Figure 10. NASS Scene Schematic