CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

NASS/SCI CASE NO: 2003-09-017J

VEHICLE: 2003 CHEVROLET TAHOE

LOCATION: MARYLAND

CRASH DATE: JANUARY 2003

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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 SCI crash investigation focused on the performance of a Certified Advanced-208 Compliant (CAC) frontal air bag system in a 2003 Chevrolet Tahoe sport utility vehicle. The manufacturer of this vehicle has certified that the 2003 Chevrolet Tahoe meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No: 208. The CAC system consisted of dual stage frontal air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switches, a front right occupant detection sensor, and an Event Data Recorder (EDR). The Tahoe was operated by a 37-year old restrained female driver and was traveling in an eastbound direction on the middle lane of a six-lane roadway. The roadway was separated by a center grassy median. A 35-year old male driver of a 2000 Mazda 626 was traveling in an eastbound direction on the inboard left-turn lane in the opposite direction of the Tahoe and was intending to turn left. The Mazda initiated the left turn at the intersection and across the path of the Tahoe. The Mazda's front plane was impacted by the front left corner of the Tahoe. The impact was sufficient to deploy the frontal air bags in the Mazda; however, the advanced frontal air bags in the Tahoe did not deploy. The driver of the Tahoe was not injured in the crash and received no medical treatment. The driver and 8-year old female passenger of the Mazda sustained minor injuries and were transported to a local hospital by ambulance. The driver was treated and released and the front right child passenger was hospitalized for one day and then released. Both vehicles were towed due to moderate damage.			
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NASS/SCI COMBO CASE NO: 03-09-017J
VEHICLE: 2003 CHEVROLET TAHOE
LOCATION: MARYLAND
CRASH DATE: JANUARY 2003

BACKGROUND

Figure 1 - Damaged 2003 Chevrolet Tahoe.

This remote SCI crash investigation focused on the performance of a Certified Advanced-208 Compliant (CAC) frontal air bag system in a 2003 Chevrolet Tahoe sport utility vehicle. The manufacturer of this vehicle has certified that the 2003 Chevrolet Tahoe **(Figure 1)** meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No: 208. The CAC system consisted of dual stage frontal air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switches, a front right occupant detection sensor, and an Event Data Recorder (EDR). The Tahoe was operated by a 37-year old restrained female driver and was traveling in an eastbound direction on the middle lane of a six-lane roadway. The roadway was separated by a center grassy median. A 35-year old male driver of a 2000 Mazda 626 was traveling in a westbound direction on the inboard left-turn lane and was intending to turn left. The Mazda initiated the left turn at the intersection across the path of the Tahoe. The Mazda's front plane was impacted by the front left corner of the Tahoe. The impact was sufficient to deploy the frontal air bags in the Mazda; however, the advanced frontal air bags in the Tahoe did not deploy. The driver of the Tahoe was not injured in the crash and received no medical treatment. The driver and 8-year old female front right passenger of the Mazda sustained minor injuries and were transported to a local hospital by ambulance. The driver was treated and released and the front right child passenger was hospitalized for one day and then released. Both vehicles were towed due to moderate damage.

The crash was identified by the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). It was initially selected as NASS CDS No: 03-09-017J. The NASS PSU performed the vehicle and scene inspections and completed an interview with the driver of the Tahoe. The EDR was not downloaded during the NASS inspection. Due to the presence of the CAC system in the 2003 Chevrolet Tahoe, NHTSA assigned the tasks of case review and report preparation to the Calspan SCI team on February 5, 2003.

SUMMARY

Crash Site

This two-vehicle crash occurred in the state in the state of Maryland in January 2002 at an at-grade 3-leg intersection of a state roadway. The east/west roadway was configured with two lanes in each direction, contiguous left-turn-only lanes, and was divided by a center grassy median. The lanes in each direction were delineated by painted-yellow broken lane lines. Each of the six lanes was approximately 3 m (10') in width. The roadway was bordered by asphalt shoulders and the roadside environment consisted of natural growth. The grassy median was approximately 10 m (33') in width. The intersecting roadway emanated from the south and was approximately 4 m (13') in width. The south roadway allowed access for eastbound traffic through designated left turns and westbound traffic through designated right turns. The crash occurred during nighttime hours and artificial lighting in the form of street lamps was active. At the time of the crash, the roadway was dry and there were no adverse weather conditions. The asphalt roadway was level and the posted speed limit was 56 km/h (35 MPH). An SCI revised scene schematic is included as **Figure 8** at the end of this narrative report.

Vehicle Data

2003 Chevrolet Tahoe

The 2003 Chevrolet Tahoe was identified with the Vehicle Identification Number (VIN): 1GNEK13Z3JN (production sequence omitted). The vehicle was a four-door Sport Utility Vehicle (SUV) that was equipped with a 5.3-liter, 8-cylinder engine linked to an automatic transmission. The four-wheel drive vehicle was configured with 4-wheel disc brakes with antilock (ABS), electronic brake distribution, and daytime running lamps. The odometer reading was not reported in the NASS case. The Tahoe was equipped with 41 cm (16") wheels and Firestone Wilderness LE P265/70T16 tires. The manufacturer's recommended tire pressure was 241 kPa (35 PSI). The specific tire information at the time of the NASS vehicle inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
LF	0 kPa	10 mm (13/32")	Tear in sidewall from contact with Mazda
LR	228 kPa (33 PSI)	11 mm (14/32")	None
RF	221 kPa (32 PSI)	10 mm (13/32")	None
RR	221 kPa (32 PSI)	10 mm (13/32")	None

The 2003 Chevrolet Tahoe was configured with front bucket seats with adjustable head restraints, inboard integrated armrests, and integrated 3-point lap and shoulder belts. Both adjustable head restraints were in the full-down position at the time of the NASS inspection. The NASS investigation further revealed that the front seats were located at the mid-track position. The second row consisted of a split-bench seat with folding backs and adjustable head restraints for both outboard positions. All three second row seating positions were equipped with manual 3-point lap and shoulder belts. Interior features within the Tahoe included a tilt steering wheel which was in the full-up position, power windows and door locks, and cruise control.

2000 Mazda 626

The 2000 Mazda 626 was identified by the VIN: 1YVGF22D2Y5 (production sequence omitted). The vehicle was a four-door sedan that was equipped with a 2.0-liter, 4 cylinder engine linked to a four-speed automatic transmission. The front-wheel drive vehicle was configured with front disc/rear drum brakes. The odometer reading was not reported within the NASS investigation. The vehicle was equipped with 38 cm (15") steel wheels and varied P205/60R15 tires. The specific tire information at the time of the NASS inspection was as follows:

Position	Manufacturer	Air Pressure	Tread Depth	Damage
LF	Yokohama A55 OH	276 kPa (40 PSI)	7 mm (9/32")	None
LR	Yokohama A55 OH	241 kPa (35 PSI)	8 mm (10/32")	None
RF	Yokohama A55 OH	303 kPa (44 PSI)	7 mm (9/32")	None
RR	Bridgestone Toranza EL 41	283 kPa (41 PSI)	6 mm (8/32")	None

Crash Sequence

Pre-Crash

The 37-year old driver of the Chevrolet Tahoe was operating the vehicle in an eastbound direction on the middle lane of a state roadway and was approaching a 3-leg intersection **(Figure 2)**. The 35-year old driver of the Mazda 626 was operating his vehicle in the westbound direction on the left-turn only lane **(Figure 3)**. The driver of the Mazda executed a left turn across the path of the Tahoe. It is likely that the driver of the Mazda steered right to avoid the impact. This is based on the direction of force to the Mazda in relation to the characteristics of the intersection. The driver of the Tahoe reacted to the Mazda by applying her brakes in an attempt to avoid the crash. The lack of scene evidence indicates that the ABS system activated and prevented lock-up of the wheels.

Figure 3 - Eastbound approach of Chevrolet Tahoe.

Figure 2 - Westbound approach of Mazda 626.

Crash

The front left aspect of the Tahoe impacted the front plane of the Mazda. As the two vehicles began to disengage, the eastbound momentum of the Chevrolet propelled the Mazda into a counterclockwise rotation as it pivoted around the front left corner of the Tahoe impacting the Tahoe's front left wheel in a continuous manner. This resulted in direct contact damage on the full frontal plane of the Mazda. The directions of force for the Tahoe and Mazda were in the 12 o'clock and 1 o'clock sectors, respectively. The impact resulted in moderate damage to both vehicles. The damage algorithm of the WinSMASH program calculated a total delta-V of 8 km/h (5 mph) for the Tahoe and 13 km/h (8.1 mph) for the Mazda, based on their respective crush profiles. The longitudinal and lateral velocity changes were -8 km/h (-5 mph) and 2 km/h (1.2 mph) for the Tahoe and -10 km/h (-6.2 mph) and -8 km/h (-5 mph) for the Mazda. Following the impact, the Tahoe continued eastbound an unknown distance and came to rest facing east. The Mazda continued rotating in a counterclockwise direction and came to rest facing southeast.

Post Crash

The 37-year old driver of the Tahoe was not injured in the crash and received no medical treatment. The 35-year old driver and 8-year old female passenger of the Mazda sustained minor injuries and were transported to a local hospital by ambulance. The driver was treated and released. The front right child passenger was hospitalized for one day and then released. Both vehicles were towed from the scene.

Vehicle Damage

Exterior Damage – 2003 Chevrolet Tahoe

The 2003 Chevrolet Tahoe **(Figure 4)** sustained moderate damage as a result of the impact with the 2000 Mazda 626. The NASS vehicle inspection revealed that the direct contact damage began at the front left bumper corner and extended 34 cm (13.4") to the right. The combined direct and induced damage encompassed the entire front bumper and measured 166 cm (65.4") in length. The maximum crush was located at the front left bumper corner and measured 20 cm (8") in depth. The SCI revised Collision Deformation Classification (CDC) for this frontal impact was 12-FLEE-1. Six equidistant crush measurements were documented across the full width of the chrome bumper and were as follows: C1 = 20 cm (8"), C2 = 0 cm, C3 = 0 cm, C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The SCI made a revision of the C1 measurement, extending the crush from 9 cm (3.5") to 20 cm (8"). The original C1 measurement was underestimated during the NASS investigation as it was measured to the outer bumper covering strip rather than to the chrome bumper at its deepest level of crush.

Figure 4 - Damaged 2003 Chevrolet Tahoe.

The front end of the Mazda contacted and damaged the front left wheel of the Tahoe as the Mazda pivoted around its front left corner. As a result of this continuous contact, the chrome bumper was deflected rearward into the front left wheel and restricted the tire.

Interior – 2003 Chevrolet Tahoe

There was no damage to the interior of the 2003 Chevrolet Tahoe. The NASS investigation identified two possible contact points to the steering assembly attributable to the driver's chest and right hand. However, no correlative evidence was present for substantiation. **Figures 5 and 6** are views of the front aspect and the driver's area of the interior.

Figure 6 - Overall view of front aspect of interior.

Figure 5 - Driver's area of Tahoe.

Exterior – 2000 Mazda 626

Figure 7 - Damaged 2000 Mazda 626.

The 2000 Mazda 626 sustained moderate damage as a result of the frontal impact with the 2003 Chevrolet Tahoe. The NASS inspection revealed that the direct contact damage began at the front right bumper corner and extended the full length of the bumper measuring 137 cm (54"). The maximum crush was located 14 cm (5.5") right of the vehicle's centerline and measured 20 cm (8") in depth. Crush profiles were taken to both the bumper reinforcement beam to the radiator support by the NASS team. The crush profile taken to the bumper beam resulted in the following profile: C1 = 5 cm (2"), C2 = 3 cm (1.2"), C3 = 4 cm (1.6"), C4 = 5 cm (2"), C5 = 4 cm (1.6"), C6 = 9 cm (3.5"). The crush profile taken to the upper radiator support resulted in the following profile: C1 = 0 cm, C2 = 7 cm (2.8"), C3 = 13 cm (5.1"), C4 = 20 cm (8"), C5 = 10 cm (4"), C6 = 0cm. The two crush profiles were averaged the result of which was used to generate the delta-V. The averaged crush profile resulted in following: C1 = 5 cm (2"), C2 = 3 cm (1.2"), C3 = 4 cm (1.6"), C5 = 13 cm (5.1"), C5 = 4 cm (1.6"), C6 = 9 cm (3.5"). The CDC for this impact was 01-FDEW-1.

The principal direction of force (PDOF) to the Mazda was determined to be 40 degrees. As a result of the impact, the front bumper cover was separated from the bumper and was not present at the vehicle inspection. The front right bumper mount was shifted to the right; however, the left bumper mount remained was not deformed. The front end was slightly swayed to the right, but short of an incremental level.

Manual Restraints – 2003 Chevrolet Tahoe

The 2003 Chevrolet Tahoe was configured with integrated manual 3-point lap and shoulder belts for the front seating positions. The belt webbing spooled into its housing located within the seatback. The driver's belt was designed with a sliding latch plate and an Emergency Locking Retractor (ELR). The NASS investigation determined that the driver utilized the manual belt; however, no evidence of loading was identified on the belt's webbing, latch plate, or on the seatback. The front right belt was designed with a sliding latch plate and an ELR/Automatic Locking Retractor (ALR). The front right seating position was unoccupied and the belt was not used.

The second row consisted of manual 3-point lap and shoulder belts for all three seating positions. The second row belts were designed with sliding latch plates and switchable ELR/ALR. A Lower Anchors and Tethers for Children (LATCH) system was present but not in use during the crash.

Certified Advanced 208-Compliant Safety System

Frontal Air Bag System – 2003 Chevrolet Tahoe

The 2003 Chevrolet Tahoe was equipped with a Certified Advanced 208-Compliant (CAC) safety system. The manufacturer of this vehicle has certified that the 2003 vehicle meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No.: 208. The CAC system consisted of dual stage frontal air bags for the driver and front right passenger, seat track position sensors, front safety belt buckle switches, a front right occupant detection sensor, and an Event Data Recorder (EDR).

The driver's air bag was housed within the steering wheel hub and the front right air bag was mid-mount design that was housed within the instrument panel. Neither air bag deployed during the crash due to the low severity of the impact.

Event Data Recorder

The Tahoe's EDR was not downloaded during the NASS inspection. The NASS case indicated that damage prevented the team from accessing the EDR.

Occupant Demographics

Driver – 2003 Chevrolet Tahoe

Age/Sex:	37-year old/Female
Height:	173 cm (68”)
Weight:	155 kg (342 lbs)
Seat Track Position:	Mid-track
Manual Restraint Use:	Integrated 3-point lap and shoulder belt
Usage Source:	Vehicle inspection; interview
Eyewear:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	Injury Severity (AIS90/Update98)	Injury Source
Not injured	Not applicable	Not applicable

Driver Kinematics

The 37-year old female driver was seated in an upright posture and was restrained by the integrated lap and shoulder belt. At impact, the driver initiated a forward trajectory responding to the 12 o’clock direction of force. The driver loaded the integrated restraint and sustained what the driver classified as minor pain in her chest. The driver denies any soft tissue injuries associated with this chest pain. Following the crash, the driver exited the vehicle under her own power. She declined any medical treatment.

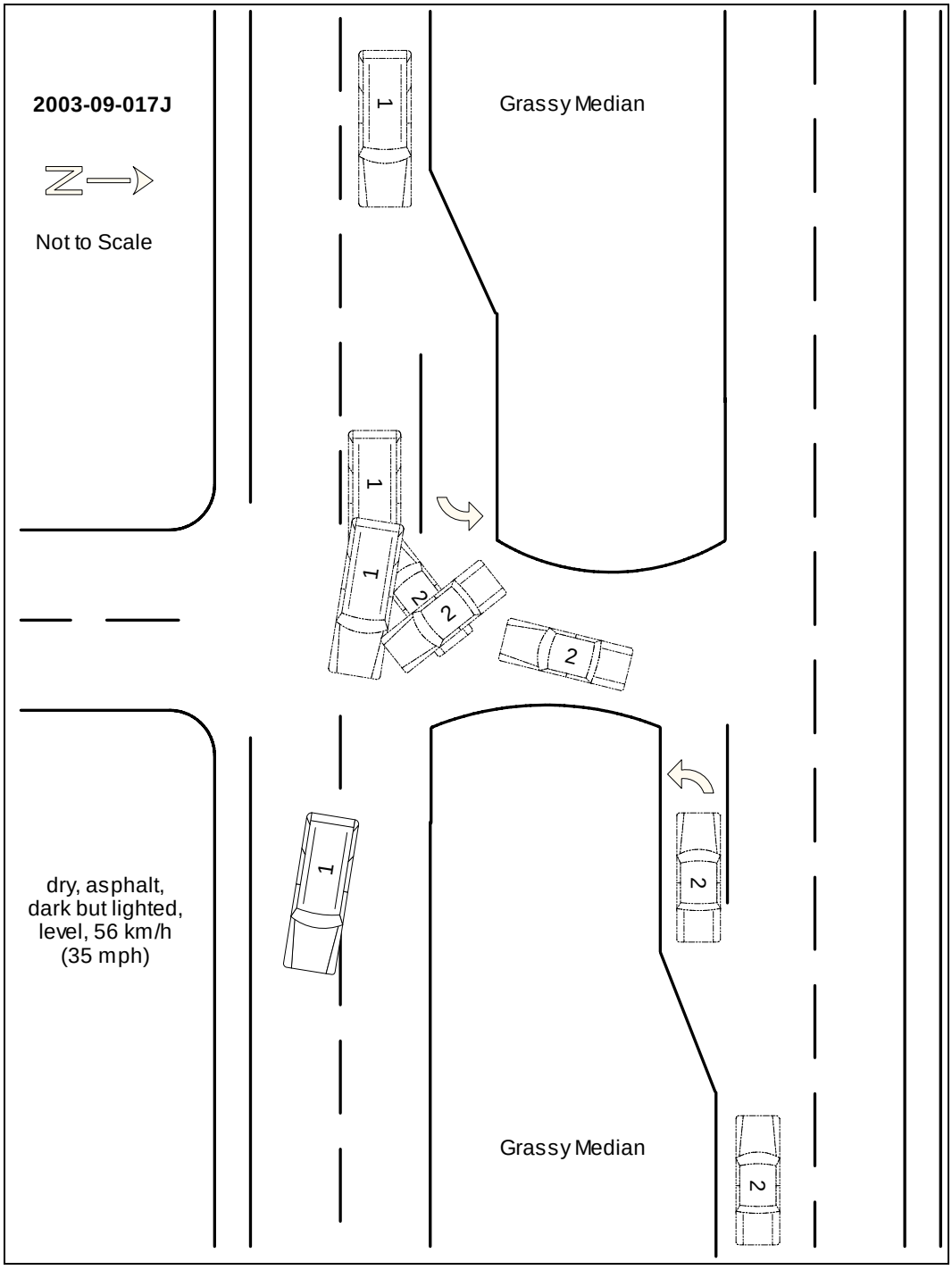

Figure 8 – SCI Revised Scene Schematic