On-Site Certified Advanced 208-Compliant Investigation
Dynamic Science, Inc. (DSI), Case Number DS09035
2007 Chevrolet Equinox
Arizona
August 2009

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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.

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16. Abstract

This on-site investigation focused on the deployed frontal air bag and resultant injuries from a head-on vehicle-to-vehicle crash. The subject vehicle was a 2007 Chevrolet Equinox that was being driven by a 39-year-old male. The Chevrolet was a Certified Advanced 208-Compliant (CAC) vehicle. A CAC vehicle is certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The crash occurred in the southbound lanes of an interstate highway interchange in August 2009 in the state of Arizona. The Chevrolet was traveling southbound. The other vehicle, a 2004 Pontiac Grand Prix, was being driven by a 28-year-old male and was traveling northbound in the southbound lanes. The vehicles came to rest near the point of impact and the Pontiac subsequently caught fire. Both drivers were declared deceased at the scene. The vehicles were towed due to damage and were later declared total losses by the respective insurance companies. A partial inspection of the Pontiac was based on police photographs.

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Background

This on-site investigation focused on the deployed frontal air bag and resultant injuries from a head-on vehicle-to-vehicle crash. The subject vehicle was a 2007 Chevrolet Equinox (**Figure 1**) being driven by a 39-year-old male. The Chevrolet was a Certified Advanced 208-Compliant (CAC) vehicle. A CAC vehicle is certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

Figure 1. Subject vehicle, 2007 Chevrolet Equinox

The crash occurred in the southbound lanes of an interstate highway interchange in August 2009 in the state of Arizona. The Chevrolet was traveling southbound. The other vehicle was a 2004 Pontiac Grand Prix that was being driven by a 28-year-old male and was traveling northbound in the southbound lanes. The front end of the Chevrolet impacted the front end of the Pontiac in a head-on configuration. The vehicles came to rest near the point of impact and the Pontiac subsequently caught fire. Both drivers were declared deceased at the scene. The vehicles were towed due to damage and were later declared total losses by the respective insurance companies.

This CAC vehicle investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) from a review of National Automotive Sampling System (NASS) General Estimates System (GES) police reports. On September 11, 2009, DSI was forwarded the police report with instructions to obtain cooperation. DSI contacted the insurance company and requested permission to inspect the subject vehicle. Due to unresolved issues, the insurance company advised DSI to follow-up on the request in 30-60 days. Permission to inspect the vehicle was obtained on November 12, 2009, the case was assigned on November 16, 2009, and the vehicle inspection was completed on November 23, 2009. The vehicle's Event Data Recorder (EDR) was supported by the Bosch Crash Data Retrieval (CDR) system and the crash data was imaged during the vehicle inspection. A truncated version of the Bosch report with the hexadecimal data removed is included in Attachment 2 of this report. A partial exterior inspection of the Pontiac was based on police photographs.

Summary

Crash Site

The crash occurred in the southbound lanes of an interstate highway interchange connecting one interstate highway to another (**Figure 2**). The roadway was configured with two southbound lanes and paved shoulders. The lanes each measured 3.7 m (12.0 ft) in width, the outboard shoulder measured 3.0 m (10.0 ft) in width, and the inboard shoulder measured 1.8 m (6.0 ft) in width. The

lanes were separated by a dashed white stripe; a solid yellow stripe bordered the inboard roadway edge and a solid white fog line bordered the outboard edge. The roadway surface was grooved concrete. Inboard and outboard of the paved shoulders were concrete traffic barriers. The roadway alignment was straight and the profile was a slight positive grade. The posted speed limit for this section of roadway was 89 km/h (55 mph). At the time of the crash the weather was clear, conditions were dark with streetlight illumination, and the roadway was dry.

Figure 2. Crash site, southbound approach

Pre-Crash

The Pontiac was traveling northbound in the southbound lanes and according to the police report it was traveling in the inboard lane. Several witnesses stated to police that they changed lanes to the outboard lane to avoid impacting the Pontiac.

At 2.5 seconds prior to Algorithm Enable (AE), the Chevrolet was traveling in the outboard southbound lane at an EDR-reported speed of 89 km/h (55 mph). At 1.0 second prior to AE the driver braked and the vehicle speed was 85 km/h (52 mph). At 0.5 second prior to AE, the vehicle speed was 77 km/h (48 mph).

Crash

The front end of the Chevrolet impacted the front end of the Pontiac in a head-on configuration. The Chevrolet was displaced rearward and came to rest in the outboard lane facing 10 degrees clockwise from its at-impact heading angle. The Pontiac was displaced rearward and left, and came to rest in both lanes facing 20 degrees counterclockwise from its at-impact heading angle. Based on the police report, the vehicles' at-rest locations measured 5.0 m (16.4 ft) apart (**Figure 3**). Minutes after the impact, the Pontiac caught fire and sustained major fire damage.

Figure 3. At-rest positions of vehicles, subject vehicle in background (police photograph)

For the Chevrolet, the Damage with CDC only algorithm of the WinSMASH program computed a Total Delta-V of 92.0 km/h (57.2 mph), based on the vehicle's front end crush profile. The longitudinal and lateral components were -92.0 km/h (-57.2 mph) and 0 km/h, respectively.

For the Pontiac, the WinSMASH program computed a Total Delta-V of 104.0 km/h (64.6 mph),

based on the estimated CDC. The longitudinal and lateral components were -102.4 km/h (63.6 mph) and -18.1 km/h (-11.2 mph), respectively. The WinSMASH results were out of scope due to the severity of the crash.

Post-Crash

The driver of the Chevrolet was found unbelted with his legs and feet on the driver's side seat area and his torso and upper extremities lying across the center console and passenger seat. An on-scene witness stated to police that the driver continued breathing for a few minutes, after which she was unable to detect a pulse. On-scene responders removed the vehicle's front row doors and attempted to revive the unresponsive driver. He was treated at the scene and then was declared deceased at 0205 hours, 22 minutes post-impact. The driver's autopsy report stated the cause of death was ascribed to multiple blunt force injuries including trauma to the head, neck, thorax, abdomen, and extremities. The driver's body was transported by ground to the county medical examiner's office.

The driver of the Pontiac died at the scene due to injuries he sustained in the crash and the fire. The police report and on-scene photos indicated he was restrained in his seat by the vehicle's safety belt. Due to the intensity of the fire, on-scene responders were unable to approach the vehicle or assist the driver for several minutes after the crash during the fire. The fire was eventually extinguished and the driver was pronounced deceased at 0159 hours, 16 minutes post-impact. His specific injuries and cause of death were not known. The driver's body was transported by ground to the county medical examiner's office.

The police report indicated that both drivers were tested for alcohol and each was determined to be driving while intoxicated. The autopsy reported that the driver of the Chevrolet tested positive for alcohol and narcotics. Based on a blood test his blood alcohol content (BAC) was 0.133 percent.

Vehicle Data - 2007 Chevrolet Equinox

The 2007 Chevrolet Equinox sport utility vehicle was identified by the Vehicle Identification Number (VIN): 2CNDL13F576xxxxxx; the vehicle's date of manufacture was not known. The exact mileage was not known due to the inoperable electronic odometer; the owner of the vehicle estimated its mileage to be approximately 46,670 km (29,000 mi). Standard equipment for the Chevrolet included a 3.4-liter, 6-cylinder engine, automatic transmission, front wheel drive, 4-wheel anti-lock brake system (ABS), electronic stability control, power steering with tilt column functionality, tire pressure monitoring system, and daytime running lights.

The vehicle manufacturer's recommended tire size was P235/65R16 and the recommended cold tire pressure was 210 kPa (30 psi) for the front and rear. The vehicle was equipped with Bridgestone Dueler H/T P235/65R16 tires. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire flat	4 mm (5/32 in)	Yes	De-beaded
LR	179 kPa (26 psi)	5 mm (6/32 in)	No	None
RR	172 kPa (25 psi)	2 mm (3/32 in)	No	None
RF	179 kPa (26 psi)	3 mm (4/32 in)	No	None

The Chevrolet's interior was configured with seating for five occupants. The front row seating consisted of outboard bucket seats with adjustable head restraints. The second row seating consisted of a 60/40 split bench seat with folding backs and adjustable head restraints for the outboard seats.

Vehicle Damage

Exterior Damage

The Chevrolet sustained direct damage to the front end and induced damage to the front, left, right, bottom, and top planes. The front axle was displaced rearward 51.0 cm (20.1 in) on the left side and 14.0 cm (5.5 in) on the right side. Direct damage to the front end was distributed from bumper corner to bumper corner and measured 156.0 cm (61.4 in). The bumper fascia was displaced from the vehicle during the crash and the bumper backing bar was used to obtain longitudinal crush measurements. The Field L included the entire length of the bumper backing bar and measured 105.0 cm (41.3 in) (**Figure 4**). Six crush measurements were taken at bumper level as follows: C_1 = 105.0 cm (41.3 in), C_2 = 101.0 cm (39.8 in), C_3 = 91.0 cm (35.8 in), C_4 = 85.0 cm (33.5 in), C_5 = 78.0 cm (30.7 in), C_6 = 64.0 (25.2 in). Maximum crush was located at C_1. The Collision Deformation Classification (CDC) for Event 1 was 12FDEW5.

Figure 4. Front end crush profile measurement

Interior Damage

The Chevrolet sustained interior damage as a result of intrusion, occupant loading, occupant contacts, and post-crash salvage activity. Longitudinal intrusion located in the front row included the instrument panel (IP), steering wheel and column, windshield, and toe pan. The floor pan intruded vertically and the center console and steering column assembly intruded laterally. Several trim pieces on the IP were fractured, deformed, or displaced.

Evidence of occupant loading and occupant contacts was located on the driver's deployed frontal air

bag, IP, seat cushion back, center console, and steering wheel. The air bag exhibited scuffs and transfers; the IP, seat cushion and seat back were scuffed; and the center console was deformed. The steering wheel rim was fractured completely through and sustained deformation to all four quadrants (**Figure 5**). The steering wheel rim collapsed due to loading and was deformed 7.0 cm (2.8 in) laterally, 14.0 cm (5.5 in) vertically, and 3.0 cm (1.2 in) longitudinally relative to the hub. The steering column was displaced upward 13.0 cm (5.1 in) vertically, 6.0 cm (2.4 in) laterally left, and 3.0 cm (1.2 in) longitudinally rearward.

Figure 5. Steering wheel rim deformation

The windshield was cracked and out of place; the left front, left rear, and backlight glazing were disintegrated.

Manual Restraints

The front row seating positions were equipped with 3-point manual lap and shoulder safety belts with sliding latch plates, adjustable D-rings, and retractor pretensioners. The driver's safety belt had an Emergency Locking Retractor (ELR) and the front right passenger's safety belt had a switchable ELR/Automatic Locking Retractor (ALR).

The driver's safety belt D-ring was in the full-down position and the latch plate was scratched indicating historical usage. The safety belt retractor pretensioner had actuated during the crash and the safety belt webbing was locked in the stowed position. The EDR report stated that the Driver's Belt Switch Circuit Status At Deployment was unbuckled. Based on the vehicle inspection, the occupant's injuries, and the EDR report, it was determined the driver was not restrained during the crash.

The right side safety belt retractor pretensioner also actuated during the crash. The D-ring was in the full-down position and the latch plate was scratched indicating historical usage.

The second row safety belts were configured with sliding latch plates and ELR/ALR retractors. The outboard seats were configured with Lower Anchors and Tethers for Children (LATCH) hardware and the center seat was equipped with tether hardware.

Supplemental Restraint System

The vehicle's Supplemental Restraint System (SRS) included an air bag control module (ACM), driver and passenger frontal air bags, side impact inflatable curtain (IC) air bags, and safety belt retractor pretensioners for the front row. The air bags were original equipment and had not been serviced or replaced.

The Chevrolet was a CAC vehicle. FMVSS No. 208 is a crashworthiness requirement pertaining

to occupant crash protection. The purpose of the standard is to reduce the number of fatalities and the number and severity of injuries to occupants involved in frontal crashes.[1] The requirement includes lap and shoulder safety belts for outboard seat positions, frontal air bags for front row outboard seat positions, and air bag warning labels.

Figure 6. Driver's deployed frontal air bag

At impact with the Pontiac, the driver's frontal air bag deployed and the front row safety belt retractor pretensioners actuated. The frontal air bag deployed in two stages. Based on the EDR, Driver 1st Stage Time From AE to Deployment Command Criteria Met was 6 milliseconds (msec), and 2nd Stage Time From AE to Deployment Command Criteria Met was 10 msec.

The frontal air bag deployed from the steering wheel hub through an I-configured cover flap. The air bag was oval in shape measuring 56.0 cm (22.0 in) in height and 46.0 cm (18.1 in) in width (**Figure 6**). The air bag was configured with two vent ports on the upper back panel and two internal tethers.

Figure 7. Driver's deployed frontal air bag showing holes at the seam

The frontal air bag exhibited evidence of occupant loading in the forms of skin oil transfers, fabric transfers, scuffs, and holes. A combination fabric and skin oil transfer was located on the lower aspect of the air bag's front panel that measured 14.0 x 14.0 cm (5.5 x 5.5 in). To the left of that transfer and located in the lower left quadrant of the front panel was a skin oil transfer measuring 6.0 x 6.0 cm (2.4 x 2.4 in). Those transfers began at the seam and extended upward. On the seam at the lower aspect of the air bag, a 14.0 cm (5.5 cm) section was holed (**Figure 7**). Two holes each measuring 2.0 cm (0.8 in) in length were located on the seam, and the remaining stitching in that area was stretched. On the upper aspect of the front panel a dark-colored scuff measuring 1.0 x 2.0 cm (0.4 x 0.8 in) was located 1.0 cm (0.4 in) from the seam. On the lower aspect of the back panel, an area measuring 10.0 x 12.0 cm (3.9 x 4.7 in) contained multiple scuffs, abrasions and small holes. The damage on the back panel resulted from contact with the cover flaps when the driver loaded the air bag.

The front right passenger air bag was located in the mid instrument panel. The passenger seat was

[1] Federal Motor Vehicle Safety Standards And Regulations, U. S. Department Of Transportation

empty, the air bag switch was set to On/Automatic, and the air bag was suppressed and did not deploy. The air bag suppression was configured for occupants whose size ranged from infant to six years of age. The suppression system used capacitive sensors.

The left and right side impact IC air bags were located in the roof side rails and did not deploy.

Event Data Recorder

The EDR recorded data for a single deployment event. For deployment events, the EDR can record 70 msec of data before deployment criteria is met and 220 msec of data after deployment criteria is met. Pre-crash data for parameters including Cruise Control, Accelerator Pedal Position, Vehicle Speed, and Brake Switch Circuit Status are recorded in 0.5 second intervals. Additional System Status data is recorded at Algorithm Enable (AE) and at Deployment. The recorded crash data was summarized as follows:

Pre-Crash Data indicated the following:

- Cruise Control was inactive.
- From -2.5 seconds to -0.5 seconds to AE the Accelerator Pedal Position was 0 percent.
- From -2.5 seconds to -0.5 seconds to AE vehicle speed changed from 88 km/h (55 mph) to 77 km/h (48 mph).
- At -1.5 seconds to AE the Brake Switch Circuit Status was "OFF" and at -1.0 it was "ON."

System Status At AE indicated the Low Tire Pressure Warning Lamp was "OFF."

System Status At Deployment indicated the following:

- Driver's Belt Switch Circuit Status was "OFF."
- Passenger Seat was Empty.
- Passenger Air Bag Position Indicator Status was "OFF."
- Driver 1st Stage Time From AE to Deployment Command Criteria Met was 6 msec.
- Driver 2nd Stage Time From AE to Deployment Command Criteria Met was 10 msec.
- Driver 1st and 2nd Stage Deployments Loop were Commanded.
- Driver and Passenger Pretensioner Deployment Loop were Commanded.
- Maximum Longitudinal Delta-V was 89 km/h (-55.6 mph) at 100 msec.
- Maximum Lateral Delta-V was 10 km/h (6.4 mph) at 80 msec.

Vehicle Data - 2004 Pontiac Grand Prix

The 2004 Pontiac Grand Prix GT2 four-door sedan was identified by the VIN: 2G2WS522141xxxxxx and the date of manufacture was 2/17/2004. Standard equipment for this model included a 3.8-liter, 6-cylinder engine, automatic transmission, front wheel drive, 4-wheel anti-lock disc brakes, traction control, Magnetic Steering Variable Assist (MSVA), low tire pressure

indicator, and daytime lights. The vehicle manufacturer's recommended tire size was P225/60R16 for the front and rear. As a result of the crash and fire the front tires were flat, restricted, and burned; and the rear tires appeared to be inflated.

Figure 8. 2004 Pontiac Grand Prix (police photograph)

Vehicle Damage

Exterior Damage

The Pontiac sustained direct front end damage and induced left, right, and top plane damage in the impact. The vehicle sustained additional interior and exterior damage from the post-crash fire (**Figure 8**). The front axle was displaced rearward, shortening the wheelbase on the left and right sides. Direct damage to the front end was distributed from bumper corner to bumper corner and maximum crush was located at and the front left bumper corner. For the Pontiac, the estimated CDC for Event 1 was 12FDEW4. The origin of the fire was not determined. The fire damage included the interior and exterior.

Occupant Demographics - 2007 Chevrolet Equinox

Driver

Age/Sex:	39 years/Male
Height:	196 cm (77 in)
Weight:	116 kg (256 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Rearmost track
Manual restraint usage:	Lap and shoulder belt, not used
Usage source:	Vehicle inspection
Air bags:	Frontal air bag, deployed; IC air bag, not deployed
Alcohol, drug involvement:	Alcohol, drugs present
Type of medical treatment:	Treated on-scene, declared deceased on-scene

Occupant Kinematics

Driver

The 39-year-old male driver was seated in an unknown posture and was not restrained. His seat back was slightly reclined and his seat cushion was set to the rearmost track position. The driver's hand position was not known; presumably he was steering the vehicle. Based on the interview, the steering wheel tilt was probably adjusted to mid-position. He was not wearing eyeglasses or contact lenses and there was no cargo of significance in the vehicle. Based on the EDR report, 1.0 second prior to impact, he applied the brakes.

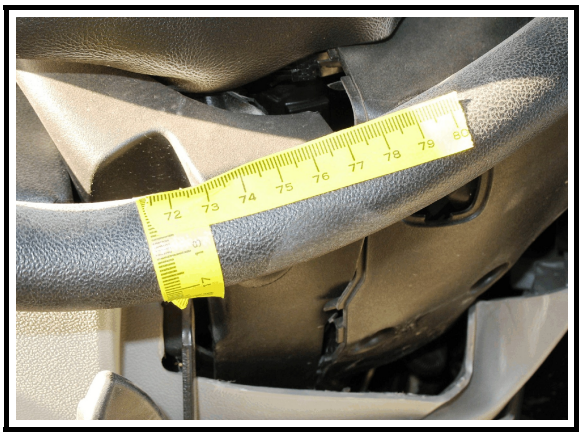


Figure 9. Steering wheel rim showing scuff to upper quadrant

At impact with the Pontiac, the driver's frontal air bag deployed and his safety belt retractor pretensioner actuated. The driver was displaced forward in response to the 12 o'clock direction of force. He loaded the air bag with his chest and abdomen sustaining an abrasion and contusion to his right chest, an abrasion to his left abdomen, and a contusion to his right abdomen. The frontal air bag deposited a scuff measuring 4.0 x 2.0 cm (1.6 x 0.8 in) on the steering wheel rim in the upper quadrant (**Figure 9**). The air bag sustained thermal burn damage at the lower aspect, resulting in holes at the seam. Additionally, the lower back panel contacted the cover flaps sustaining abrasions and small holes.

Figure 10. Steering wheel rim showing fracture in left quadrant

As the driver continued to be displaced forward, he loaded the steering assembly with his chest and abdomen. This combined with the intrusion of the steering assembly resulted in injuries to the thoracic aorta, a contusion of the myocardium, contusions to both lungs, and a laceration to the liver. He also sustained fractures to fifteen ribs including R1-R10 and L1-L5.

The combination of the rapid deceleration forces and the occupant loading of the air bag and steering assembly resulted in hyperextension/flexion of the driver's head, neck and back. Hyperextension mechanism injuries occur when deceleration forces overcome muscular and ligamentous attachments of the craniocervical junction.[2] His injuries resulting from this dynamic included atlanto-occipital

[2] American Journal of Roentgenology, Posterior Fossa Subarachnoid Hemorrhage Due to an Atlantooccipital Dislocation; W. Brinkman, W. Cohen, and T. Manning, July 25, 2002.

dislocation of the cervical spine and avulsion of the pons from the medulla at the brain stem. Additionally, the driver sustained multiple hemorrhages to the cerebellum, a laceration to the thoracic spinal column and a vertebral fracture.

The driver's left arm contacted the left door panel and IP, sustaining an abrasion and contusion to the left forearm from the door panel contact and fractures to the distal left radius and ulna from the IP contact.

The driver's pelvis and lower extremities loaded the seat cushion and deposited scuffs on the left and right sides at the cushion's forward aspect. His right knee and lower leg contacted the lower center IP resulting in multiple lacerations and contusions. The toe pan and intruded longitudinally 24.0 cm (9.5 in), the floor pan intruded 7.0 cm (2.8 in), and his right foot contacted the foot controls resulting in a foot fracture. His left knee contacted the lower left IP resulting in a contusion to the knee.

The vehicle initiated a post-impact rearward trajectory and rotated clockwise approximately 10 degrees. The vehicle traveled rearward an estimated 2.5 m's (8.2 ft) from the POI. The driver was displaced rearward and loaded the seat back, depositing a dark-colored 3.0 cm (1.2 in) scuff and a skin oil transfer to the upper right aspect of the seat back. He was then displaced to the right and his torso and upper extremities came to rest on the center console and right seat cushion, while his lower extremities remained within the driver's seat area. An on-scene witness stated to police that the driver continued breathing a few minutes after the crash. The driver remained in a reclined position while on-scene responders attempted to resuscitate him. He stopped breathing after a few minutes and was pronounced deceased 22 minutes post-crash.

Occupant Injuries

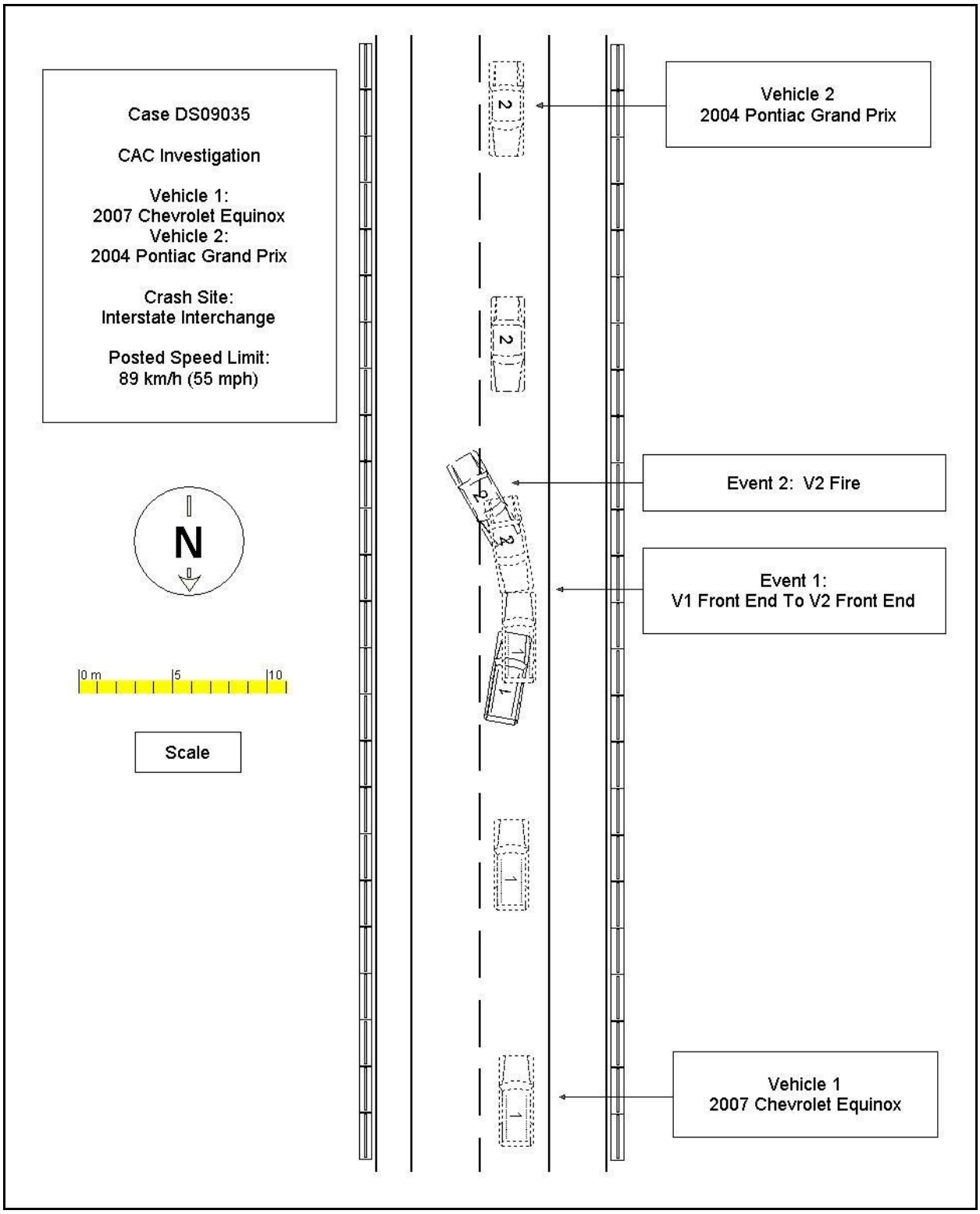
Driver

The injury data was obtained from the autopsy report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Brain stem, pons partially avulsed from medulla (laceration)	140212.6,8	Steering wheel (combination rim, hub, and spoke)	Probable
Cerebellum, subarachnoid hemorrhage	140466.3,6	Steering wheel (combination rim, hub, and spoke)	Probable
Cerebellum, subscapular and subgaleal hemorrhage	140410.4,6	Steering wheel (combination rim, hub, and spoke)	Probable
Cervical spine, atlanto-occipital dislocation	650208.2,6	Steering wheel (combination rim, hub, and spoke)	Probable

Right chest, Abrasion and contusion	490202.1,1 490402.1,1	Frontal air bag	Certain
Right abdomen contusion, Left abdomen abrasion	590402.1,1 590202.1,2	Frontal air bag	Certain
Thoracic aorta laceration, minor, transverse and full thickness, with 1300 ml blood loss	420208.4,4	Steering wheel hub, spoke	Certain
Heart (myocardium) contusion NFS	441002.3,4	Steering wheel hub, spoke	Certain
Spinal cord laceration with fracture and dislocation, T3	640450.5,7	Steering wheel (combination rim, hub, and spoke)	Probable
Lung contusions, bilateral	441410.4,3	Steering wheel hub, spoke	Probable
Rib fractures NFS, bilateral, R1- R10, L1- L5	450240.4,3	Steering wheel (combination rim, hub, and spoke)	Probable
Liver laceration NFS, partial thickness, 6.0 cm (2.5 in) in length	541820.2,1	Steering wheel rim	Probable
Left radius fracture NFS, Left ulna fracture NFS	752800.2,2 753200.2,2	Left IP	Probable
Left forearm abrasion, Left forearm contusion	790202.1,2 790402.1,2	Left door panel, forward upper quadrant	Possible
Right knee and lower leg contusions, Right knee and lower leg lacerations (minor)	890402.1,1 890602.1,1	Center IP	Probable
Left knee contusions	890402.1,2	Left IP	Probable
Right foot fracture NFS	852000.2,1	Foot controls	Probable

Attachment 1. Scene Diagram



Attachment 1. Bosch CDR Report

CDR File Information

User Entered VIN	2CNDL13F576******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	
Saved on	Monday, November 23 2009 at 10:46:40 AM
Collected with CDR version	Crash Data Retrieval Tool 3.3
Reported with CDR version	Crash Data Retrieval Tool 3.3
EDR Device Type	airbag control module
Event(s) recovered	Deployment

IMPORTANT NOTICE: Robert Bosch LLC recommends that the latest production release of Crash Data Retrieval software be utilized when viewing, printing or exporting any retrieved data from within the CDR program. This ensures that the retrieved data has been translated using the most recent information including but not limited to that which was provided by the manufacturers of the vehicles supported in this product.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. A locked Non Deployment Event cannot be overwritten by the SDM.

The second type of SDM recorded crash event is the Deployment Event. It also may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle 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. For Deployment Events, the SDM can record 220 milliseconds of data after deployment criteria is met and up to 70 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 300 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-The CDR tool displays time from Algorithm Enable (AE) to time of deployment command in a deployment event and AE to time of maximum SDM recorded vehicle velocity change in a non-deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Air bag systems such as frontal, side, or rollover, may be a source of an enable. The time represented in a CDR report can be that of the enable of one air bag system to the deployment time of another air bag system.

-Maximum Recorded Vehicle Velocity Change is the maximum square root value of the sum of the squares for the vehicle's combined "X" and "Y" axis change in velocity.

-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 by various factors, including but not limited to the following:

- -significant changes in the tire's rolling radius
- -final drive axle ratio changes
- -wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the status of the brake switch circuit.

-Pre-Crash data is recorded asynchronously.

-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:

- -the SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- -no data is received from the module sending the pre-crash data
- -no module present to send the pre-crash data

-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit.

-The Time Between Non-Deployment to 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 the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition cycle counter.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle’s communication network.
-The Belt Switch Circuit is wired directly to the SDM.

Multiple Event Data

Associated Events Not Recorded	0
An Event(s) Preceded the Recorded Event(s)	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	No
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	No

System Status At AE

Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active

Pre-crash data

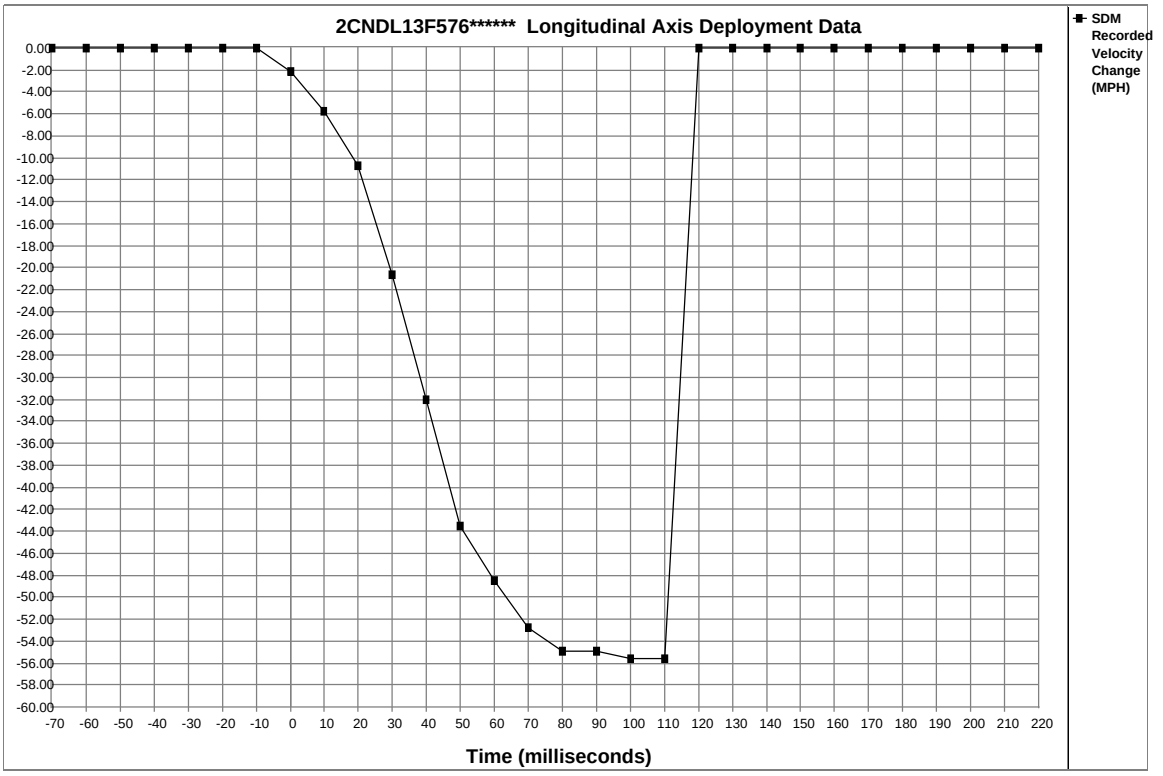
Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	-30.61	-33.19

Pre-Crash Data

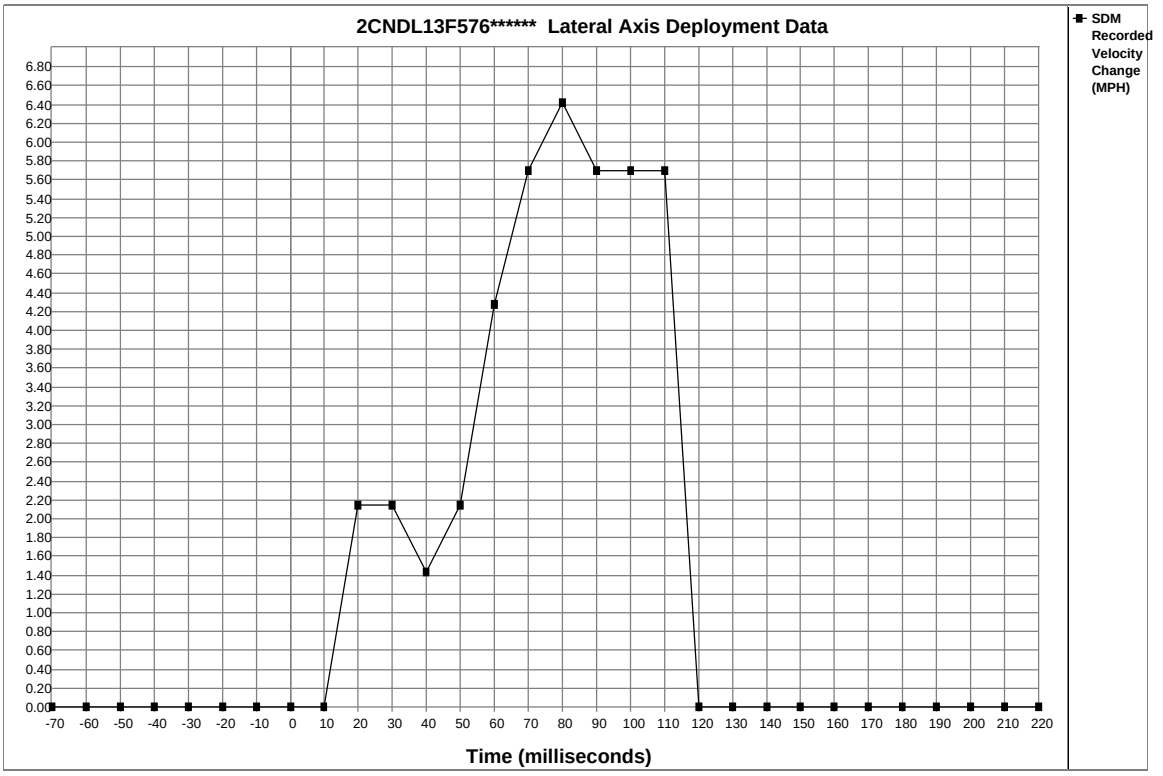
Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	0	0	0	0	0
Vehicle Speed (MPH)	55	54	54	53	48
Engine Speed (RPM)	1600	1408	1344	1280	1088
Percent Throttle	17	16	14	14	13
Brake Switch Circuit Status	OFF	OFF	OFF	ON	ON

System Status At Deployment

Ignition Cycles At Investigation	4292
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON Time Continuously (seconds)	0
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	4255
Ignition Cycles At Event	4292
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Passenger Classification Status at Event Enable	Passenger Seat Empty
Current Passenger Position Status at Event Enable	Position Not Applicable
Previous Passenger Position Status at Event Enable	Unknown
Passenger Air Bag Indicator Status at Event Enable	OFF
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	6
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	10
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Suppressed
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Suppressed
Driver Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Time Between Events (sec)	0
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
SDM Synchronization Counter	4291
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	Yes
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	Yes
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Driver Pretensioner Deployment Loop Commanded	Yes
Passenger Pretensioner Deployment Loop Commanded	Yes
Driver Side Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.14	-5.70	-10.69	-20.67	-32.08	-43.48	-48.47	-52.75
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-54.89	-54.89	-55.60	-55.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14	2.14	1.43	2.14	4.28	5.70
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	6.42	5.70	5.70	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00