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### SCI/NASS COMBINATION REAR OCCUPANT PROTECTION PROGRAM INVESTIGATION

CASE NUMBER - NASS-2004-72-118J  
LOCATION - Illinois  
VEHICLE - 2003 JEEP GRAND CHEROKEE  
CRASH DATE - July 2004

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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. <i>Abstract</i> This report covers a SCI/NASS combination investigation of a crash involving a 2003 Jeep Grand Cherokee (case vehicle) that ran off the road and impacted a concrete traffic barrier. This crash is of special interest in connection with the NHTSA's Rear Occupant Protection Program (ROPP). The case vehicle was traveling southward in the inside southbound through lane of a four lane, one-way roadway that was part of a divided urban Interstate trafficway (three through lanes with an entrance ramp and merge lane in the vicinity of this crash), intending to continue straight ahead. The case vehicle driver braked hard when a non-contact vehicle cut in front of the case vehicle. The driver lost control of the case vehicle and it skidded to the right, running off the roadway and onto the shoulder. The case vehicle's front right corner, and then the entire right side, swiped along a concrete ("Jersey") traffic barrier. The case vehicle's right front and right rear wheel/tire assemblies engaged the barrier's flared base and both right wheels/tires sustained extensive damage. The barrier impact redirected the case vehicle back onto the roadway, in a slight counterclockwise yaw, and it slid to rest straddling the center through lane heading southeastward. The case vehicle was towed due to disabling damage and all four occupants were transported via ground ambulance to a hospital. The case vehicle's back seat left passenger (21-year-old female), who was restrained by her lap-and-shoulder safety belt, sustained three lower right rib fractures and was hospitalized for two days. The restrained back seat right passenger (16-year-old male), the restrained case vehicle driver (20-year-old male) and the restrained front right passenger (15-year-old male) all sustained minor injuries and were treated and released in the emergency department. There were no other occupants in the case vehicle.					
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This SCI/NASS combination investigation was brought to the NHTSA's attention in July 2004 by NASS-CDS sampling activities and was designated for SCI on March 17, 2005. This crash involved a 2003 Jeep Grand Cherokee SUV (case vehicle) that ran off the road and impacted a concrete traffic barrier. The crash occurred in July 2004, at 10:07 p.m., in Illinois, and was investigated by the applicable municipal police department. This crash is of special interest in connection with the NHTSA's Rear Occupant Protection Program (ROPP) because the case vehicle's back seat left passenger (21-year-old female, white, Hispanic), who was restrained by her lap-and-shoulder safety belt, sustained a serious (AIS-3) injury. The restrained back seat right passenger (16-year-old male, white, Hispanic), the restrained case vehicle driver (20-year-old male, white, Hispanic) and the restrained front right passenger (15-year-old male, white, Hispanic) all sustained minor (AIS-1) injuries. All four occupants were transported to a hospital via ambulance. There were no other occupants in the case vehicle. This report is based on the coded NASS case, occupant kinematic principles and this contractor's evaluation of the evidence.

### CRASH CIRCUMSTANCES

The case vehicle was traveling southward in the inside southbound through lane of a four lane, one-way roadway that was part of a divided urban Interstate trafficway (three through lanes with an entrance ramp and merge lane in the vicinity of this crash), intending to continue straight ahead (**Figure 1**). The weather was clear, it was dark but lighted, the bituminous road surface was dry and free of defects and the speed limit was 72 km.p.h. [45 m.p.h.]. The interviewee (back right passenger) indicated that the case vehicle was traveling approximately 97-113 km.p.h. [60-70 m.p.h.]. According to the interviewee, a non-contact vehicle cut in front of the case vehicle, the case vehicle driver braked hard, the right front tire blew out and the driver lost control. The case vehicle swerved to the right and departed the roadway.



**Figure 1:** Case vehicle's southbound pre-crash path of travel in the general area where control was lost; the concrete traffic barrier can be seen at the far right edge of the roadway (note, the crash occurred during the evening when traffic was not as heavy as seen in this photograph)

The crash occurred on the right (west) shoulder. The case vehicle's front right corner impacted a concrete traffic barrier ( a “ Jersey” barrier) and then its entire right side swiped along the barrier, with both right wheel/tire assemblies engaging the barrier's flared base and with both right wheels/tires sustaining extensive damage. The barrier impact redirected the case vehicle back onto the roadway, in a slight counterclockwise yaw, and it slid to rest straddling the center through lane heading southeastward.

The case vehicle was a 2003 Jeep Grand Cherokee “Laredo” four wheel drive, four-door, five-passenger SUV (VIN: 1J4GW48S53C-----), equipped with an I-6, 4.0 liter gasoline engine and an automatic transmission with a console-mounted selector lever. Four wheel anti-lock brakes were standard for this model. The case vehicle was equipped with driver and front right passenger air bags, and manual, three-point, lap-and-shoulder safety belt systems at all five seat positions. The odometer reading is not known due to the non-functional electronic instrument cluster, but the interviewee estimated approximately 20,922 kilometers [13,000 miles]. Its wheelbase was 269 centimeters [105.9 inches]. The case vehicle was towed due to disabling damage.



**Figure 2:** Case vehicle's front and right side



**Figure 3:** Case vehicle's back and left side

The case vehicle sustained extensive abrading but only minor deformation along the entire right side, and both right wheels were heavily damaged (**Figures 2, 4 and 5**). The front right corner of the bumper cover was abraded and slightly crushed, but the headlamp/turn signal assembly was intact. The right fender was slightly crushed and heavily abraded, and the hood was slightly displaced. The abrading continued along the front door, back door and quarter panel, with direct contact above the belt line on the A-, B- and C-pillars. The right outside rear view mirror was broken off. The windshield was cracked along its junction with the right A-pillar, the glazing in the right front and back doors was shattered and there was no other glazing damage.



**Figure 4:** Case vehicle's right side, rear portion



**Figure 5:** Case vehicle's right side, front portion



The wheels were made of a brittle alloy and, for both the right front and rear wheels, portions of the rim were shattered and broken away. The right front tire was completely off the damaged wheel and was not available for inspection (**Figure 5**). The right rear tire was dismantled but otherwise not damaged (**Figure 4**). The left rear tire was dismantled and its sidewall was torn, but the wheel was intact (**Figure 3**). The manufacturer's specified tire size for the case vehicle was P225/75R16 and all of the tires that were available for inspection were of this size. The wheelbase on both sides was unchanged.

The CDC for case vehicle's single impact with the barrier was determined to be **12-FRAE-9 (0)**. This impact is out of scope for the WinSMASH reconstruction program due to the swiping-type nature of the impact. This crash was of moderate severity (24-40 km.p.h. [15-25 m.p.h.]) for the case vehicle, at the low end of this range.

Inspection of the case vehicle's interior revealed minor intrusion by the right A-pillar (2 centimeters [0.8 inches] laterally) and no other intrusions. The case vehicle was equipped with driver and front right passenger frontal air bags that did not deploy. The four safety belt systems in the outboard seat positions all showed evidence of use during the crash, consisting of scuffing and/or stretching of the webbing. There was evidence of occupant contact on various interior components, including: scuffing on the steering wheel and the center console, attributed to the driver; scuffing on the front right door, attributed to the front right passenger; and scuffing on the back right door, attributed to the back right passenger.

#### **CASE VEHICLE BACK LEFT PASSENGER'S KINEMATICS**

The case vehicle's back left passenger (21-year-old female, white, Hispanic, 140 centimeters, 64 kilograms [55 inches, 141 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. The seat was a split bench with separate, folding backs, with the seat track and seat back not adjustable. The head restraint was adjusted at the full down position. She was seated in a normal posture, facing forward with her back against the seat back and her feet on the floor (**Figure 6**).

The case vehicle driver braked hard when a non-contact vehicle cut in front of the case vehicle. The back left passenger moved forward in response to the braking deceleration, loading against the belt restraint system as the retractor locked. The driver lost control of the case vehicle and it skidded to the right, running off the roadway and onto the shoulder. The case vehicle's front right corner, and then the entire right side, swiped along the concrete traffic barrier. Although the case vehicle's interaction with the barrier was a swiping-type engagement, there was substantial deceleration as the tires were dismantled and the wheel rims broke apart. The



**Figure 6:** Back left passenger's seat area

back left passenger moved further forward and slightly rightward in response to the impact deceleration. She loaded against the torso portion of the safety belt system (which passed over her left shoulder and downward across the lower right side of her thorax) and she sustained fractures of right ribs 9 through 12. The case vehicle was redirected by the barrier into a slight counterclockwise yaw and it slid across the shoulder and back into the roadway, where it came to rest. The back left passenger was held in place by the safety belt system and she stayed in her seat.

**BACK LEFT PASSENGER'S INJURIES**

The back left passenger was transported via ambulance to a hospital, where she was admitted for two days.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Fracture, right ribs 9 - 12	serious 450230.3,1	Belt restraint system	certain	hospitalization records

**CASE VEHICLE BACK RIGHT PASSENGER'S KINEMATICS**

The case vehicle's back right passenger (16-year-old male, white, Hispanic, 168 centimeters, 86 kilograms [66 inches, 190 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. The seat was a split bench with separate, folding backs, with the seat track and seat back not adjustable. The head restraint was adjusted several centimeters [approximately 1.5 inches] up from the full down position. He was seated in a normal posture, facing forward with his back against the seat back and his feet on the floor (**Figure 7**).

The case vehicle driver braked hard when a non-contact vehicle cut in front of the case vehicle. The back right passenger moved forward in response to the braking deceleration, loading against the belt restraint system as the retractor locked. The driver lost control of the case vehicle and it skidded to the right, running off the roadway and onto the shoulder. The case vehicle's front right corner, and then the entire right side, swiped along the concrete traffic barrier. Although the case vehicle's interaction with the barrier was a swiping-type engagement, there was substantial deceleration as the tires were dismounted and the wheel rims broke apart. The back right passenger moved further forward and slightly rightward in response to the impact deceleration. He loaded against the torso portion of the safety belt system and he sustained a



**Figure 7:** Back right passenger's seat area



cervical spine strain as his head moved forward while his torso and hips were held in place by the belt restraint system. The back right window glazing shattered and the back right passenger sustained abrasions on his right forearm from flying glass shards. The case vehicle was redirected by the barrier into a slight counterclockwise yaw and it slid across the shoulder and back into the roadway, where it came to rest. The back right passenger was held in place by the safety belt system and he stayed in his seat.

**BACK RIGHT PASSENGER'S INJURIES**

The back right passenger was transported via ambulance to a hospital, where he was treated and released in the emergency department.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Cervical spine strain	minor 640278.1,6	Belt restraint system	Certain	Emergency Room records
2.	Skin abrasion, right forearm	minor 790202.1,1	Flying glass	Certain	Emergency Room records

**CASE VEHICLE DRIVER'S KINEMATICS**

The case vehicle's driver (20-year-old male, white, Hispanic, 168 centimeters, 71 kilograms [66 inches, 157 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. The driver's steering wheel air bag did not deploy. The bucket seat track was adjusted between the middle and rear most positions and the seat back was slightly reclined. The head restraint was adjusted slightly above full down. The driver was in a normal driving posture, with his back against the seat back, both hands on the steering wheel, his left foot on the floor and his right foot operating the foot controls (**Figure 8**).

The case vehicle driver braked hard when a non-contact vehicle cut in front of the case vehicle. The driver moved forward in response to the braking deceleration, loading against the belt restraint system as the retractor locked. The driver lost control of the case vehicle and it skidded to the right, running off the roadway and onto the shoulder. The case vehicle's front right corner, and then the entire right side, swiped along the concrete traffic barrier. Although the case vehicle's interaction with the barrier was a swiping-type engagement, there was substantial deceleration as the tires were dismounted and the



**Figure 8:** Driver's seat area

wheel rims broke apart. The driver moved further forward and slightly rightward in response to the impact deceleration. His right hand/arm loaded against the steering wheel and this force was transmitted along his arm causing a sprain in his right shoulder. He also sustained a contusion and abrasion on his chin. The NASS injury causation data attribute the abrasion to flying glass from the shattered front right window glazing, with the contusion attributed to contact with the steering wheel, but it seems likely that both the abrasion and contusion were caused by the steering wheel contact. The case vehicle was redirected by the barrier into a slight counterclockwise yaw and it slid across the shoulder and back into the roadway, where it came to rest. The driver was held in place by the safety belt system and he stayed in his seat.

**DRIVER'S INJURIES**

The driver was transported via ambulance to a hospital, where he was treated and released in the emergency department.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Right shoulder sprain	minor 751020.1,1	Steering wheel {indirect}	Certain	Emergency Room records
2.	Abrasion, chin	minor 290202.1,6	Flying glass	Certain	Emergency Room records
2.	Contusion, chin	minor 290402.1,6	Steering wheel	Probable	Emergency Room records

**CASE VEHICLE FRONT RIGHT PASSENGER'S KINEMATICS**

The case vehicle's front right passenger (15-year-old male, white, Hispanic, 168 centimeters, 66 kilograms [66 inches, 146 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. The front right passenger's instrumental panel air bag did not deploy. The bucket seat track was adjusted at the full forward position and the seat back was slightly reclined. The head restraint was in the full down position. There was a supplemental cushion in the front right seat at the time of the vehicle inspection, but it is not known if this was in use at the time of the crash. The front right passenger was otherwise in a normal posture with his back against the seat back and his feet on the floor (**Figure 9**).

The case vehicle driver braked hard when a non-contact vehicle cut in front of the case vehicle. The front right passenger moved forward in response to the braking deceleration, loading against the belt restraint system as the retractor locked. The driver lost control of the case vehicle and it skidded to the right, running off the roadway and onto the shoulder. The case vehicle's front right corner, and then the entire right side, swiped along the concrete traffic barrier. Although the case vehicle's interaction with the barrier was a swiping-type engagement, there was substantial deceleration as the tires were dismounted and the wheel rims broke apart. The front

right passenger moved further forward and slightly rightward in response to the impact deceleration. The front right window glazing shattered and the front right passenger sustained lacerations on this right hand from flying glass. The case vehicle was redirected by the barrier into a slight counterclockwise yaw and it slid across the shoulder and back into the roadway, where it came to rest. The front right passenger was held in place by the safety belt system and he stayed in his seat.



**Figure 9:** Front right passenger's seat area

**FRONT RIGHT PASSENGER'S INJURIES**

The front right passenger was transported via ambulance to a hospital, where he was treated and released in the emergency department.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Laceration, right fifth finger	minor 790602.1,1	Flying glass	certain	Emergency Room records

