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REMOTE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 02-45-040B

VEHICLE – 1998 JEEP GRAND CHEROKEE

LOCATION - STATE OF TENNESSEE

CRASH DATE – MARCH 2002

Contract No. DTNH22-01-C-17002

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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 a forward-facing child safety seat (CSS) that was installed in the rear center position of a 1998 Jeep Cherokee. The Jeep Cherokee sustained severe damage as a result of a high-speed rollover crash while traveling on a divided highway. The 25-year-old female driver was unrestrained and was ejected from the vehicle during the rollover event. The vehicle rolled over the driver which resulted in a right frontal open vault skull fracture, multiple bilateral rib fractures, left hand fractures, left thumb amputation, left lower leg fractures, a liver avulsion and laceration, and an avulsion of the intestine. The driver expired at the scene. The 19-month-old male child passenger was restrained in a Century Breverra CSS by the 5-point harness. During the rollover event, the child loaded the harness system of the CSS which resulted in a small contusion on the left shoulder. The child did not sustain any additional injuries. He was transported by ambulance to a regional trauma center where he was admitted for one day and released.			
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TABLE OF CONTENTS

REMOTE CHILD SAFETY SEAT CRASH INVESTIGATION
SCI SUMMARY TECHNICAL REPORT
NASS/SCI COMBO CASE NO. 02-45-040B
SUBJECT VEHICLE – 1998 JEEP GRAND CHEROKEE
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BACKGROUND

This remote investigation focused on the performance of a forward-facing child safety seat (CSS) that was installed in the rear center position of a 1998 Jeep Cherokee. The Jeep Cherokee sustained severe damage as a result of a high-speed rollover crash while traveling on a divided highway **(Figure 1)**. The 25-year-old female driver was unrestrained and was ejected from the vehicle during the rollover event. The vehicle rolled over the driver which resulted in a right frontal open vault skull fracture, multiple bilateral rib fractures, left hand fractures, left thumb amputation, left lower leg fractures, a liver avulsion and laceration, and an avulsion of the intestine. The driver expired at the scene. The 19-month-old male child passenger was restrained in a Century Breverra CSS by the 5-point harness. During the rollover event, the child loaded the harness system of the CSS which resulted in a small contusion on the left shoulder. The child did not sustain any additional injuries. He was transported by ambulance to a regional trauma center where he was admitted for one day and released.

Figure 1. Damaged 1998 Jeep Grand Cherokee

This crash was selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 02-45-040B. The crash occurred in March 2002. Initial notification of this crash was made following a NASS CDS case review. The NASS PSU performed the vehicle inspection and scene inspection. Due to the presence of the CSS, NHTSA assigned the tasks of case review and report preparation to the Veridian Special Crash Investigation (SCI) team.

SUMMARY

Crash Site

This single vehicle crash occurred on the southbound lanes of a five lane divided highway during the daylight hours of March 2002. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The roadway was configured with two northbound lanes and three southbound lanes that were separated by a grassy median and bordered by asphalt shoulders. The outboard aspects of the median were gravel, and the median had a negative lateral slope between the southbound lanes and northbound lanes. At the crash site, the roadway was straight and had a positive southbound grade. The roadside environment consisted of grassy areas and commercial properties. There were no traffic controls present at the scene and the posted speed limit for the roadway was 89 km/h (55 mph) The NASS scene schematic is included as **Figure 10** at the end of this report.

Pre-Crash

The 25-year-old female driver was operating the 1998 Jeep Grand Cherokee on the inboard southbound lane **(Figure 2)**. For unknown reasons, the driver drifted onto the inboard shoulder and onto the gravel portion of the outboard aspect of the median. The Cherokee traveled 57 m (187') along the inboard shoulder. The driver steered right in an attempt to regain control of the vehicle and the Cherokee traveled back across the three southbound lanes. The driver overcompensated with a left steer input, which resulted in a counterclockwise (CCW) yaw on the southbound center lane.

Figure 2. Southbound approach for the Jeep Grand Cherokee

Crash

The vehicle's yaw caused bead separation and air-outs of the right front and right rear tires. The wheel rim contact with the road surface resulted in gouges, which tripped the Cherokee into a lateral rollover with the right side leading. The rollover began on the center southbound lane and continued in a southeast direction onto the median. Additional gouges were present on the travel lane and on the median within the vehicle's trajectory **(Figure 3)**. The Cherokee rolled seven quarter turns over a total distance of 57 m (187'). The rollover resulted in severe damage to the Cherokee. During the rollover, the unrestrained driver was ejected through the left front window. The Jeep Cherokee came to rest on its left side on the east aspect of the median and was facing northeast **(Figure 4)**.

Figure 3. View of rollover trajectory onto the median

Post-Crash

The 25-year-old female driver was fatally injured as a result of the ejection and was found on the inboard shoulder 37 m (121') north of the final rest position of the Jeep Cherokee. She was pronounced dead at the scene. Bystanders removed the child from the CSS prior to the arrival of rescue personnel. Rescue personnel further reported that the CSS was not removed from the vehicle due to the instability of the vehicle at final rest. The 19-month-old child sustained minor injuries and was transported by ambulance to a regional trauma center and admitted for treatment. He was released the following day.

Figure 4. Final rest position of the Jeep Grand Cherokee

VEHICLE DATA – 1998 Jeep Grand Cherokee

The 1998 Jeep Grand Cherokee was identified by the Vehicle Identification Number (VIN): 1J4GZ78Y0WC (production sequence omitted). At the time of the vehicle inspection, the odometer read 118,247 km (73,477 miles). The vehicle was a four-door sport utility vehicle equipped with a 5.2 liter, 8 cylinder engine, four wheel drive, automatic four-speed transmission, four-wheel power disc brakes with anti-lock, power steering, tilt steering wheel, power sunroof, power windows, and tinted glazing. The Jeep Grand Cherokee was equipped with a Goodyear Wrangler HP P225/70R16 tire on the left front wheel. The remaining wheels were equipped with Bridgestone Dueler H/L P225/70R16 tires. The specific tire data is summarized as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0.0 kpa	8.0 mm (10/32”)	Yes	None
LR	0.0 kpa	6.0 mm (8/32”)	Yes	None
RF	0.0 kpa	4.0 mm (5/32”)	Yes	None
RR	34 kpa (5 psi)	7.0 mm (9/32”)	Yes	None

The front seating positions in the 1998 Jeep Grand Cherokee were configured with front bucket seats with adjustable head restraints. The rear seating positions were configured with a rear bench seat with a 60/40 folding back and adjustable head restraints on the outboard aspects.

VEHICLE DAMAGE

Exterior Damage – 1998 Jeep Grand Cherokee

The 1998 Jeep Grand Cherokee sustained severe damage as a result of the rollover. The entire roof was crushed vertically and the luggage rack was fractured. Lateral abrasions were present on the roof. The left side plane sustained vertical abrasions along the lower aspects of the doors and the left front fender was deformed inward and abraded **(Figure 5)**. The left side lower body cladding was separated. Heavy abrasions were present on the upper aspect of the left A-pillar and on the forward aspect of the left roof side rail. The left front door was deformed inward. The front left corner of the bumper was abraded and fractured, and the front left headlamp was separated. The hood was buckled rearward. The right side sustained heavy abrasions along the entire length of the roof side rail **(Figure 6)**. The right rear wheel was separated, and the lower rear aspect of the right rear quarter panel was separated. The right side alloy wheels were abraded. The right side body cladding was separated. The left wheelbase was reduced by 11.0 cm (4.3”) and the right wheelbase was reduced by 12.0 cm (4.7”). The Collision Deformation Classification (CDC) for the rollover was 00-TDDO-3.

Figure 5. View of left side damage

Figure 6. View of right side damage

Interior Damage – 1998 Jeep Grand Cherokee

Interior damage to the 1998 Jeep Grand Cherokee was severe and was attributed to passenger compartment intrusion. Integrity was lost through the windshield, sunroof, side windows, and the backlight. The left front door, left rear door, and rear hatch were jammed shut. The windshield laminate was fractured and out of place. The glazing in the left side doors disintegrated from impact forces. The left and right side rear glazing and the backlight glazing also disintegrated from impact forces. There was no steering wheel deformation. Multiple contacts were identified from the driver **(Figure 7)**. The left A-pillar was scuffed from contact with the driver's right shoulder, the steering wheel rim was scuffed from contact with the driver's chest, the left instrument panel was deformed from contact with the driver's left knee, the left B-pillar was scuffed as a result of contact with the driver's left leg, and the console-mounted transmission lever was scuffed from the driver's right ankle. Multiple intrusions were present as a result of the rollover. Intruded components included the following:

Figure 7. Interior view showing occupant contact damage

Position	Intruded Component	Magnitude of Intrusion	Direction
11	Roof	9.0 cm (3.5")	Vertical
11	Left A-pillar	12.0 cm (4.7")	Vertical
11	Left door panel	6.0 cm (2.4")	Lateral
11	Left side panel forward of the A-pillar	3.0 cm (1.2")	Lateral
11	Left instrument panel	5.0 cm (2.0")	Longitudinal
21	Roof	3.0 cm (1.2")	Vertical
Rear cargo area	Right side panel aft of the B-pillar	7.0 cm (2.8")	Lateral

MANUAL RESTRAINT SYSTEMS – 1998 Jeep Grand Cherokee

The front seating positions in the 1998 Jeep Grand Cherokee were configured with manual 3-point lap and shoulder belts, emergency locking retractors (ELR's) and adjustable D-rings. The driver's seat belt was configured with a sliding latch plate and the front right passenger's seat belt was configured with a cinching latch plate. The rear outboard seating positions were configured with manual 3-point lap and shoulder belts with ELR's and cinching latch plates. The rear center position was configured with a 2-point lap belt with a locking latch plate.

CHILD SAFETY SEAT – 1998 Jeep Grand Cherokee

A Century Breverra Metro forward-facing CSS was installed in the rear center position in the 1998 Jeep Cherokee **(Figure 8)**. The model number was 44850CKM and the date of manufacture was December 12, 2001. There were no NHTSA recalls associated with this CSS, and it had not been involved in any previous crashes. The CSS was purchased new for this child and was used on a regular basis. The CSS was designed for forward-facing use and was equipped with a five-point harness system for children that weighed between 13.6 – 18.1 kg (30.0 – 40.0 lb) and measured 88.9 – 109.2 cm (35.0 – 43.0") in height. There were two sets of shoulder harness slots. The CSS was also compatible for use as a belt-positioning booster seat for children that weighed 13.6 – 27.2 kg (30 – 60 lb) and who measured 88.9 – 127.0 cm (35.0 – 50.0"). The Century Breverra CSS was occupied by a 19-month-old male child who weighed 12.0 kg (26.4 lb) and measured 86.4 cm (34.0") in height. The 19-month-old child was not within the manufacturer's recommended height and weight limits outlined on the seat's label.

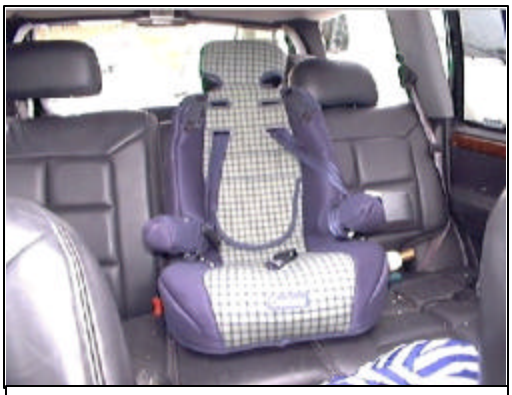

Figure 8. Century Breverra Metro CSS

The Century Breverra was installed on the center rear position with the 2-point lap belt with a locking latch plate. The seat belt was routed through the positioning channels on the rear aspect of the CSS. It was not known who installed the CSS prior to the crash, and it was not known if the individual consulted the CSS instructions or vehicle owner's manual. The CSS was equipped with a tether, which was secured to a cargo hook in the rear cargo area **(Figure 9)**. The installation of the CSS was snug with minimal movement.

Figure 9. View of tether anchored to the cargo hook

The 19-month-old child was restrained in the CSS with the five-point harness system. The shoulder harness straps were routed through the bottom slots. It was not known how tight the child was restrained within the harness system, or the pre-crash location of the harness retainer clip.

The CSS sustained minimal damage as a result of the crash. Stretch marks were present on the shoulder harnesses as a result of the child's loading forces.

FRONTAL AIR BAG SYSTEM – 1998 Jeep Grand Cherokee

The 1998 Jeep Grand Cherokee was equipped with frontal air bags for the driver and front right passenger positions. The redesigned driver's air bag was housed in the center of the steering wheel and the non-redesigned front right passenger's air bag was located on the mid aspect of the right instrument panel. The frontal air bag system did not deploy in this crash.

OCCUPANT DEMOGRAPHICS – 1998 Jeep Grand Cherokee

Driver

Age/Sex:	25-year-old female
Height:	168.0 cm (66.2")
Weight:	52.0 kg (114.6 lb)
Seat Track Position:	Between full-forward and mid-track
Manual Restraint Use:	Unrestrained
Usage Source:	Ejection, vehicle inspection
Eyewear:	None
Type of Medical Treatment:	Expired at the scene and not transported to any medical facility

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Liver laceration/avulsion	Maximum (541830.6,1)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant
Massive avulsion of the intestine	Critical (541028.5,7)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant
Comminuted vault skull fracture, NFS	Serious (150404.3,5)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant
Multiple bilateral rib fractures, NFS	Moderate (450220.2,3)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant
Left thumb amputation	Moderate (752402.2,2)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant
Left hand fracture, NFS	Moderate (752500.2,2)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant
Left lower leg fracture, NFS	Moderate (852002.2,2)	Ground/exterior vehicle, occupant ejected, vehicle rolled over occupant

Injury source: Medical Examiner's report, EMS records

Driver Kinematics

The 25-year-old driver of the 1998 Jeep Grand Cherokee was seated in an upright posture with the seat track adjusted between the full-forward and mid-track positions. She was not restrained by the available manual 3-point lap and shoulder belt. For unknown reasons, the driver lost control of the vehicle on the divided highway. She was displaced slightly as she attempted to regain control of the vehicle. As the Grand Cherokee initiated the rollover, she initiated a lateral trajectory to the right and was redirected to the left as the rollover continued. The left front door window glazing disintegrated as a result of the rollover. As the vehicle entered the second and

third quarter turn onto the median, the unrestrained driver was ejected through the open left front door window. The Cherokee continued to roll over the ejected driver and crushed her between the ground and the vehicle. The driver sustained a comminuted vault skull fracture, multiple bilateral rib fractures, a left hand fracture, a left thumb amputation, a liver laceration/avulsion, a left lower leg fracture, and a massive avulsion of the intestine as a result of the vehicle rolling over her. She was pronounced dead at the scene and was not transported to any medical facility.

Rear Center Child Passenger

Age/Sex:	19-month-old male
Height:	86.0 cm (33.9")
Weight:	12.0 kg (26.5 lb)
Seat Track Position:	N/A
Manual Restraint Use:	Forward-facing CSS with 5-point harness
Usage Source:	Vehicle inspection, CSS inspection
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a regional trauma center and admitted for one day

Rear Center Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left shoulder contusion	Minor (790402.1,2)	Left CSS harness strap

Injury source: Interview

Rear Center Child Passenger Kinematics

The 19-month-old child passenger was restrained in the forward-facing CSS that was installed on the rear center position of the Jeep Grand Cherokee with the 2-point lap belt. Although the CSS tether was anchored to a cargo hook in the rear aspect of the Cherokee, the use of the tether prevented significant lateral movement of the top aspect of the CSS. The child was restrained in the CSS by the five-point harness system. As the vehicle initiated the rollover, the child initiated a lateral trajectory to the right and was redirected laterally as the vehicle continued to roll. The child loaded the five-point harness system, which mitigated significant movement within the vehicle and kept the child in position during the event. The child came to rest suspended in the CSS. The loading to the harness system resulted in a left shoulder contusion. Bystanders removed the child from the CSS prior to the arrival of rescue personnel. The child was transported by ambulance to a regional trauma center, and admitted for one day and released.

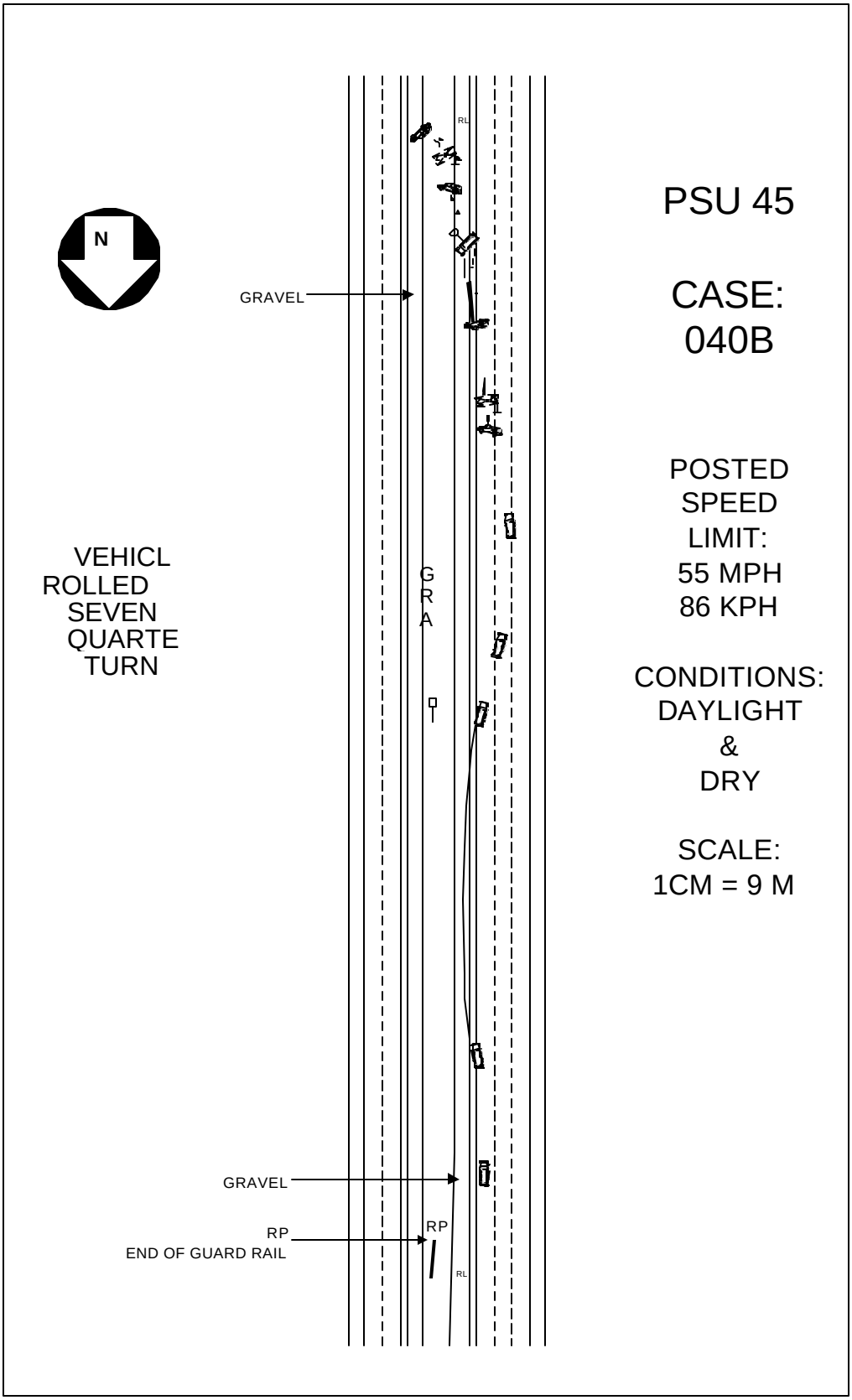

Figure 10. NASS scene schematic