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June 2020

Special Crash Investigations: On-Site Guardrail End Terminal Crash Investigation; Vehicle: 2004 Jeep Grand Cherokee; Location: Missouri; Crash Date: November 2017

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Each crash represents a unique sequence of events and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

16. Abstract

This report documents the on-site investigation of an SUV impact to an ET-Plus 10 cm (4 in.) model guardrail end terminal that is of interest to the Federal Highway Administration. This crash occurred in the median on the north side of the eastbound lanes of a five-lane, divided interstate highway. The Jeep was a 4-door SUV equipped with dual-stage frontal air bags. The vehicle was not equipped with an event data recorder (EDR) supported by the Bosch Crash Data Retrieval tool. An unbelted 23-year-old male drove the vehicle. The Jeep was traveling in a right curve in an undetermined eastbound lane. Witnesses reported to police that the vehicle passed them at a high rate of speed several miles prior to the crash site and the vehicle was "swerving all over the road." The Jeep departed the left side of the roadway into the median and the front plane struck the end terminal. The impact displaced the guardrail system and the Jeep rolled over, right-side-leading. The unbelted driver was ejected during the rollover and came to rest on the westbound roadway and was subsequently run over and possibly dragged by another vehicle. The Jeep came to final rest on its wheels in the median facing north. The driver sustained fatal injuries and was pronounced deceased at the crash scene. The Jeep was towed from the crash scene due to damage.

17. Key Words	18. Distribution Statement
ET-Plus guardrail end, motor vehicle traffic crash, terminal, fatal injury	Document is available to the public from the National Technical Information Service, www.ntis.gov.

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Vehicle: 2004 Jeep Grand Cherokee
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BACKGROUND

This report documents the on-site investigation of an SUV impact to an ET-Plus 10 cm (4 in.) model guardrail end terminal (**Figure 1**) that is of interest to the Federal Highway Administration (FHWA). This crash was identified by an engineer with the Missouri Department of Transportation, who submitted digital images of the damaged guardrail end terminal and vehicle to the FHWA. The FHWA determined that the guardrail end terminal and crash type were of interest. This crash investigation was then initiated by the National Highway Traffic Safety Administration in November 2017 and assigned to the Special Crash Investigations team at the Indiana University Transportation Research Center. This single-vehicle crash involved a 2004 Jeep Grand Cherokee (**Figure 2**). The crash occurred in Missouri in November 2017 in the early morning hours and was investigated by a local police agency. The guardrail, crash site, and vehicle were inspected in November 2017.

Figure 1: Jeep's road departure and initial contact with the ET-Plus.

Figure 2: The Jeep's front/left damage.

This crash occurred in the median on the north side of the eastbound lanes of a five-lane, divided, interstate highway. The Jeep was a 4-door SUV equipped with dual-stage frontal air bags. The vehicle was not equipped with an event data recorder (EDR) that was supported by the Bosch Crash Data Retrieval tool. An unbelted 23-year-old male drove the vehicle. The Jeep was traveling in a right curve in an undetermined eastbound lane. Witnesses reported to police that the vehicle passed them at a high rate of speed several miles prior to the crash site and that the vehicle was "swerving all over the road." The Jeep departed the left side of the roadway into the median and the front plane struck the end terminal. The impact displaced the guardrail system and the Jeep rolled over, right-side-leading. The unbelted driver was ejected during the rollover and came to rest on the westbound roadway and was subsequently run over by another vehicle. The Jeep came to final rest on its wheels in the median

facing north. The driver sustained fatal injuries and was pronounced deceased at the crash scene. The Jeep was towed from the crash scene due to damage.

CRASH SUMMARY

Crash Site

This crash occurred during dark early morning in the median of the eastbound and westbound lanes of a five-lane, divided, interstate highway. The weather conditions were clear visibility, northwest winds at 16 km/h (10 mph), a temperature of 0.6 °C (33 °F), and a dew point of -3.3 °C (26 °F), according to local weather reports. The eastbound lanes of the interstate consisted of two concrete through lanes and a right exit lane. The eastbound travel lanes curved to the right and had a calculated radius of curvature of 567.3 m (1,861.2 ft). These lanes were bordered by a 3.0 m (9.8 ft) wide concrete/bituminous median shoulder and a 1.8 m (5.9 ft) wide concrete right shoulder. The exit ramp and left through lanes were each 3.7 m (12.1 ft) wide. The right through lane was 3.4 m (11.2 ft) wide. A grass median with a cable guardrail system separated the east and westbound travel lanes. An additional W-beam guardrail system with the ET-Plus 10 cm (4 in.) model end terminal was located on the travel lane side of the cable median barrier beginning at the apex of the right curve. The first 7 posts of the guardrail system were wood. The roadway pavement markings consisted of a solid yellow median edge line, broken white lane lines, and a solid white right edge line. The speed limit was 113 km/h (70 mph). A crash diagram is included at the end of this report.

Pre-Crash

The Jeep was traveling eastbound at a witness-reported high rate of speed. The witnesses further stated that as the Jeep passed them several kilometers prior to the impending crash site, the driver was swerving between the travel lanes. As the Jeep driver entered the right curve, the Jeep drifted to the left and departed the travel lane onto the left (north) shoulder (**Figure 3**). There was no physical evidence on the roadway to support avoidance maneuvers by the driver of the Jeep. Due to the lack of pre-crash yaw marks, the Jeep was presumed to be tracking immediately prior to impact.

Figure 3: East view of the Jeep's travel path.

Crash

The front plane, left corner area (see **Figure 2**) struck the end terminal (Event 1). The engagement with the end terminal extended along the left plane involving the front wheel, cowl, and left front door, resulting in lower A-pillar separation from sill and a latch/striker failure. The Jeep began to rotate counterclockwise, resulting in approximately 8 m (26 ft) of tire marks on the concrete shoulder and dirt shoulder that were attributed to the right wheels. The right front wheel furrowed into the ground and the vehicle tripped into a right-side-leading rollover on top of the guardrail (Event 2). The vehicle's right, top, left and undercarriage planes contacted the guardrail. During the rollover, the driver was ejected through the left front door opening. The

vehicle separated from the guardrail and rolled to final rest upright in the median facing north after rolling over an estimated 12 quarter turns over an approximate distance of 36 m (118.1 ft).

Post-Crash

The driver of the Jeep came to rest in the right eastbound lane. The first blood stain on the concrete surface was located approximately 46 m (150.0 ft) east of the initial point of impact with the end terminal. A witness reported his body was run over by another vehicle. Blood evidence was present on the road surface for a distance of 30 m (98.0 ft). A witness stopped at the crash site and dragged the driver's body to the south shoulder to avoid additional vehicle contact. The driver sustained fatal injuries and was pronounced deceased at the crash site. His body was transported to the medical examiner's facility where a non-invasive autopsy was performed. The Jeep was towed from the crash site to a local tow facility where it was inspected for this investigation.

END TERMINAL AND GUARDRAIL DAMAGE

The front plane impact of the Jeep to the end terminal extruded 1.7 m (5.6 ft) of guardrail to the field side (**Figures 4 and 5**) and damaged 34.1 m (111.9 ft) of guardrail and 16 posts. The direct damage involved the full height and width 71 cm [28.0 in] and 30 cm [11.8 in]) of the face of the ET-Plus. Posts 1 to 7 were constructed of wood. The remaining posts were constructed of steel. Posts 1 and 2 were not equipped with offset blocks. Posts 3 to 9 had wood offset blocks. The remaining posts had composite offset blocks. Wood posts 1 to 7 were fractured and displaced during the crash. Post 8 was bent downstream approximately 55 degrees and the wood offset block was slightly damaged and the bolt was pulled through the guardrail. Post 9 was bent downstream approximately 20 degrees and the wood offset block was damaged and the bolt pulled through the guardrail. Post 10 was not bent. The composite offset block was slightly damaged and the bolt pulled through the guardrail. Post 11 was bent downstream approximately 20 degrees and the offset block was damaged and the bolt was pulled through the guardrail. Post 12 was bent downstream approximately 10 degrees and the composite offset block was damaged and the bolt pulled through the guardrail. Post 13 was bent downstream approximately 20 degrees and the composite offset block was separated from the post. Post 14 was bent downstream approximately 60 degrees and the offset block was damaged

Figure 4: Guardrail kinking (west facing lookback view).

Figure 5: ET-Plus and extruded guardrail (west facing lookback view).

and the bolt pulled through the guardrail. Posts 15 and 16 were displaced downstream approximately 50 degrees and the composite offset blocks were damaged and the bolt pulled through the guardrail. The guardrail was kinked in 13 locations. The width of the feeder channel was 12.7 cm (5.0 in.) and the guide chute exit height was 40.1 cm (15.8 in.).

The connection of the feeder channel to the head was damaged and the welds (**Figure 6**) were broken. The anchor cable was present at the time of the impact but separated due to the crash force. The anchor was displaced to the area between Posts 3 and 4. The height of the undamaged guardrail was 38.1 cm (15.0 in.). The FHWA guardrail form is appended to the end of this report.

Figure 6: Broken welds at feeder channel.

2004 JEEP GRAND CHEROKEE

Description

The Jeep Cherokee Limited was manufactured in April 2003 and identified by Vehicle Identification Number 1J4GW58N84Cxxxxxx. It was a 4-door SUV with a rear lift gate and a roof window. Built on a 269 cm (105.9 in.) wheelbase, the Jeep was powered by a 4.7-liter, V-8 engine linked to a 5-speed automatic transmission with a console-mounted shift lever with 4-wheel drive. The service brakes were power-assisted 4-wheel disc with ABS and electronic brake force distribution. The gross vehicle weight rating was 2,495 kg (5,500 lb) with gross axle weight ratings of 1,248 kg (2,750 lb) front and 1,339 kg (2,950 lb) rear. The vehicle manufacturer's recommended tire size was P235/65R17 with recommended cold tire pressures of 228 kPa (33 psi) for the front and rear axles. At the time of the crash, the Jeep was equipped with Yokohama Avid Touring S tires of the recommended size.

The interior of the Jeep was configured for seating of five occupants (2/3) with front row bucket seats and a three-passenger second row bench seat. All seating surfaces were leather. The front row and second row left and right seat positions were equipped with adjustable head restraints. The driver's head restraint was adjusted 6 cm (2.5 in.) above the seat back. The driver's seat track was power adjustable and was adjusted between the middle and rear-most positions. The recline position of the seat back at the time of the crash is not known since the seat back was displaced and deformed during the crash. Safety systems included manual 3-point lap and shoulder seat belts for the driver and second row left and right positions and a center rear lap belt. Supplemental protection was provided by dual-stage frontal air bags for the driver and front right positions and retractor pretensioners. Both frontal air bags deployed during the crash.

NHTSA Recalls
A VIN search of the NHTSA Safety Issues and Recalls website (NHTSA.gov/recalls) identified two open recalls for the 2004 Jeep Cherokee at the time of the crash. The recalls are as follows.

Date: April 07, 2009
Manufacturer Recall Number: 114
NHTSA Recall Number: 09V-117
Recall Status: Recall Incomplete
Summary: This recall pertains to the electric front seat heating elements that may overheat causing an interior fire or injury under certain operating conditions.

Date: January 27, 2015
Manufacturer Recall Number: R06
NHTSA Recall Number: 15V-046
Recall Status: Recall Incomplete
Summary: The air bag system occupant restraint control (ORC) module may experience a front air bag and/or seat belt pretensioner inadvertent deployment. An inadvertent deployment while driving could distract the driver and cause a crash without warning.

Exterior Damage
Exterior Damage Event 1: The Jeep sustained damage to the front and left planes during the impact with the guardrail end terminal (**Figure 7**). The direct contact damage to the front plane occurred at the left corner. Due to overlapping damage, the length of the direct contact damage on the front plane could not be determined and was estimated at 20 cm (7.9 cm). Engagement with the end terminal involved the bumper and bumper fascia, the left headlamp/turn signal assembly, left fender, left front tire and wheel, and left front door. A crush profile to the front plane could not be documented due to overlapping damage.

Figure 7: Front plane impact area on the Jeep.

Damage Classification Event 1: The Collision Deformation Classification was 12FLEE6 (0 degrees). The damage was rated severe.

Exterior Damage Event 2: The right, top, left planes and undercarriage sustained direct and induced damage during the rollover (**Figure 8**). The most severe damage occurred to the rear portion and forward right aspect of the top plane.

Figure 8: Right side rollover damage depicting the maximum vertical deformation located at Row 1.

The maximum vertical deformation occurred at the right roof side row in Row 1 and measured 62 cm (24.4 in.). The maximum lateral deformation was located at the top of the right B-pillar and measured 32 cm (12.6 in.). Damage occurred to the undercarriage with overlapping damage to the right, top, and left planes when the vehicle interacted with the guardrail during the rollover.

Damage Classification Event 2: The CDC for the rollover was 00TDDO6. The damage pattern was rated severe.

Figure 9: Intrusion of right A-pillar/roof side rail/windshield header (Pole represents guard rail).

Event Data Recorder

The Jeep was not equipped with an EDR that was supported by the Bosch CDR tool.

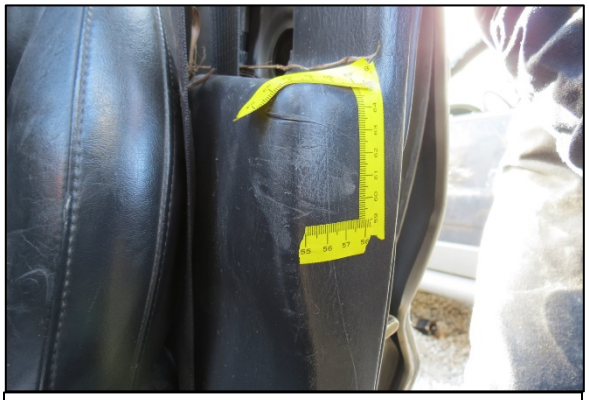


Figure 10: Occupant scuffs on left B-pillar.

Interior Damage

The interior of the Jeep sustained severe intrusion of the passenger compartment. The most severe intrusion involved the right A-pillar/roof side rail **(Figure 9**) and right moon roof track, both of which intruded vertically over 61 cm (24 in.). The right windshield header at the center and right seating positions also intruded vertically 30 - 46 cm (11.8 – 18.1 in.) and 46-61 cm (18.1 – 24 in.), respectively. Evidence of occupant contact consisted of a scuff on the upper rear of the left front door, likely from the driver's left flank and scuffs on the left B-pillar (**Figure 10**), probably from the driver's left hip. Scuffs were also found on the left roof side rail, possibly from the driver's head (**Figure 11**). The driver's chest loaded the air bag, which also loaded and deformed the steering wheel rim and steering column (**Figure 12**). The windshield was cracked and out of place from impact forces. The second left and right rear glazing was undamaged. The remaining glazing was disintegrated from impact forces.

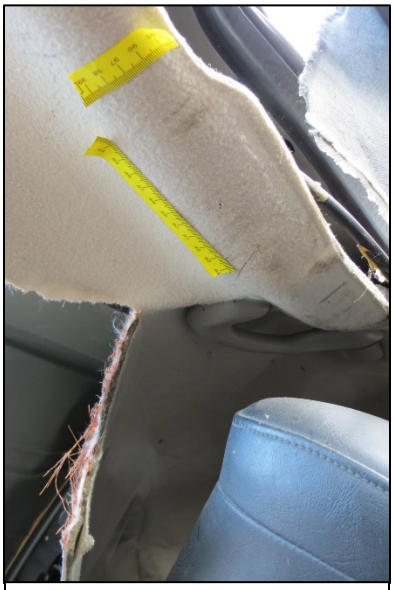


Figure 11: Occupant contact on left roof side rail.

The left and right front doors came open due to latch/striker failure and lower A-pillar separation from the sill. The left front seat was deformed from guardrail intrusion. The left and right rear doors and the tailgate were jammed shut.

Manual Restraint Systems

The front and second row left and right seat positions were equipped with 3-point lap and shoulder seat belts. The front row seat belts had sliding latch plates and adjustable upper anchors. The driver's adjustable anchor was in the full-down position. Second row seat belts were configured with light weight locking latch plates. The driver's retractor was an emergency locking retractor (ELR) with a pretensioner. Neither pretensioner actuated during the crash. Inspection of the driver's seat belt assembly revealed no evidence of usage in the crash as it was stowed against the B-pillar.

Figure 12: Deployed air bag (packed) and loading on lower steering wheel rim/column.

Supplemental Restraint Systems

The Jeep was equipped with dual-stage frontal air bags for the driver and right passenger positions. Both air bags deployed during the crash. The driver's air bag was mounted in the four-spoke steering wheel rim and concealed by H-configuration module cover flaps. The air bag in its deflated state was 56 cm (22.0 in.) in diameter and was tethered. There was a blood transfer on the left upper quadrant of the air bag, but no damage to the fabric or the inflator.

The front right air bag deployed through a single cover flap in the right mid instrument panel. A tear was present in the right side panel of the air bag from probable contact with the intruding roof structure and trim during the rollover.

2004 JEEP GRAND CHEROKEE OCCUPANT

Driver Demographics

Age/sex:	23 years/male
Height:	193 cm (76 in.)
Weight:	110 cm (242 lb)
Eyewear:	Unknown
Seat type:	Bucket
Seat track position:	Between middle and rear-most
Manual restraint usage:	None
Usage source:	Vehicle inspection, occupant ejection
Air bags:	Frontal, deployed
Alcohol/drug involvement:	BAC=.227 g/dL; positive for THC
Egress from vehicle:	Totally ejected during the rollover
Transport from scene:	Medical examiner
Medical treatment:	None, non-invasive autopsy

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Pneumocephalus	140682.3	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
2	Occipital skull fracture	150400.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
3	Parietal skull fracture, left	150400.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
4	Left femur fracture, NFS	853000.3	Isolated IPC Primary: Exterior of other motor vehicle – Tires and wheels Alternate: Other vehicle or object – Ground	Probable Possible
5	Bilateral rib fractures, NFS	450210.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
6	Comminuted left humerus shaft fracture	751271.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
7	Full thickness laceration to posterior scalp	110804.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels or more vehicles	Probable Possible
8	Laceration to anterior scalp	110600.1	Isolated IPC	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
			Other vehicle or object - Ground	
9	Skin avulsion right side at ear down to bone	210804.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
10	Full thickness laceration to left jaw down to bone	210804.2	Isolated IPC Primary: Other vehicle or object – Ground Alternate: Exterior of other motor vehicle – Tires and wheels	Probable Possible
11	Left zygoma fracture	251800.1	Isolated IPC Other vehicle or object - Ground	Probable
12	Laceration to inner right ear	240208.1	Isolated IPC Other vehicle or object - Ground	Probable
13	Laceration to area above right eye	210600.1	Isolated IPC Other vehicle or object - Ground	Probable
14	Multiple superficial punctate lacerations behind right ear	210602.1	Isolated IPC Other vehicle or object - Ground	Probable
15	Abrasion to right eye area	210202.1	Isolated IPC Other vehicle or object - Ground	Probable
16	Abrasion to right cheek	210202.1	Isolated IPC Other vehicle or object - Ground	Probable
17	Abrasion to nose	210202.1	Isolated IPC Other vehicle or object - Ground	Probable
18	Avulsion to skin of right back	410800.1	Isolated IPC Other vehicle or object - Ground	Probable
19	Avulsion to skin of left chest	410800.1	Isolated IPC Other vehicle or object - Ground	Probable
20	Abrasion to right back	410202.1	Isolated IPC Other vehicle or object - Ground	Probable
21	Abrasion to left back	410202.1	Isolated IPC Other vehicle or object - Ground	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
22	Multiple abrasions to right chest	410202.1	Isolated IPC Other vehicle or object - Ground	Probable
23	Multiple abrasions to left chest	410202.1	Isolated IPC Other vehicle or object - Ground	Probable
24	Abrasions to left abdomen	510202.1	Isolated IPC Other vehicle or object - Ground	Probable
25	Avulsion to skin of left forearm down to bone	710804.2	Isolated IPC Primary: Exterior of other motor vehicle – Tires and wheels Alternate: Other vehicle or object – Ground	Probable Possible
26	Laceration to left hand	710600.1	Isolated IPC Other vehicle or object - Ground	Probable
27	Abrasion to right hand	710202.1	Isolated IPC Other vehicle or object - Ground	Probable
28	Abrasion to right shoulder	710202.1	Isolated IPC Other vehicle or object - Ground	Probable
29	Contusion to inner right wrist	710402.1	Isolated IPC Other vehicle or object - Ground	Probable
30	Abrasion to left elbow	710202.1	Isolated IPC Other vehicle or object - Ground	Probable
31	Abrasion to right elbow	710202.1	Isolated IPC Other vehicle or object - Ground	Probable
32	Abrasion to left upper arm	710202.1	Isolated IPC Other vehicle or object - Ground	Probable
33	Abrasions to left forearm	710202.1	Isolated IPC Other vehicle or object - Ground	Probable
34	Laceration to left heel down to bone	810804.2	Isolated IPC Primary: Exterior of other motor vehicle – Tires and wheels Alternate: Other vehicle or object – Ground	Probable Possible

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
35	Avulsion of toenails and tissue of right foot	810800.1	Isolated IPC Other vehicle or object - Ground	Probable
36	Avulsion to skin of left hip	810800.1	Isolated IPC Other vehicle or object - Ground	Probable
37	Avulsion to skin of rear and side of left thigh	810800.1	Isolated IPC Other vehicle or object - Ground	Probable
38	Laceration to rear of right thigh	810600.1	Isolated IPC Other vehicle or object - Ground	Probable
39	Laceration between right toes 1-2	810600.1	Isolated IPC Other vehicle or object - Ground	Probable
40	Laceration to right shin	810600.1	Isolated IPC Other vehicle or object - Ground	Probable
41	Contusion to right foot	810402.1	Isolated IPC Other vehicle or object - Ground	Probable
42	Contusion to left foot	810402.1	Isolated IPC Other vehicle or object - Ground	Probable
43	Abrasion to left hip	810202.1	Isolated IPC Other vehicle or object - Ground	Probable
44	Abrasion to right knee	810202.1	Isolated IPC Other vehicle or object - Ground	Probable
45	Abrasion to left knee	810202.1	Isolated IPC Other vehicle or object - Ground	Probable
46	Abrasion to left shin	810202.1	Isolated IPC Other vehicle or object - Ground	Probable
47	Abrasion to right shin	810202.1	Isolated IPC Other vehicle or object - Ground	Probable
48	Abrasion to right foot	810202.1	Isolated IPC Other vehicle or object - Ground	Probable
49	Abrasion to rear of left thigh	810202.1	Isolated IPC Other vehicle or object - Ground	Probable

Source: Autopsy report (external)

Driver Kinematics

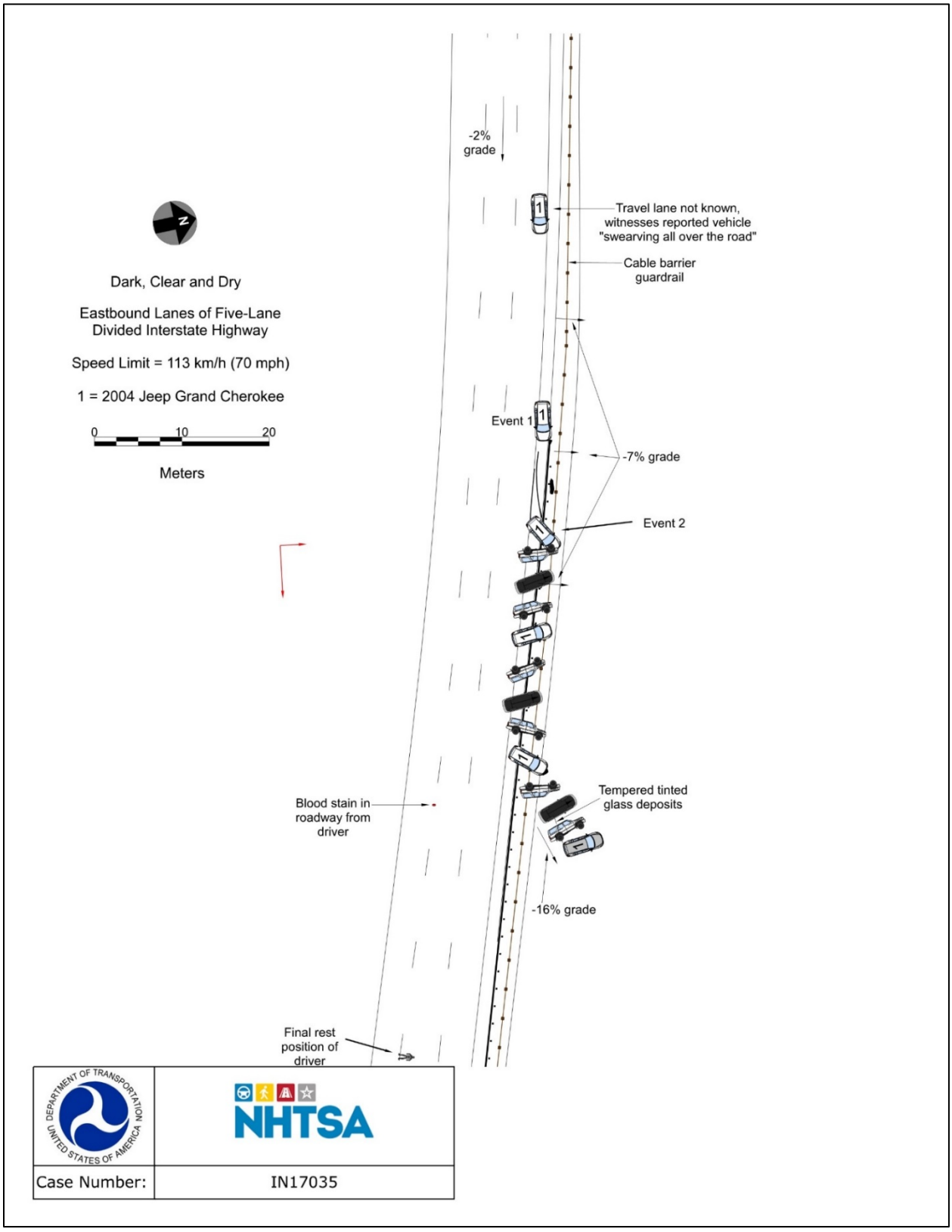
The driver was seated in the Jeep with the seat track adjusted between the middle and rear-most positions. His head restraint was adjusted 6 cm (2.5 in.) above the seat back. The driver was not restrained by the manual seat belt system. At the time of the SCI inspection, the driver's seat belt was retracted and stowed against the B-pillar with no evidence of usage, loading, or damage. Additionally, the driver was completely ejected from the vehicle supporting the lack of seat belt use.

At initial impact with the end terminal, the frontal air bag system deployed. The unbelted driver initiated a forward trajectory and loaded the deployed air bag and the steering assembly. His loading force was transmitted through the air bag, deforming the lower left quadrant of the steering wheel rim and bending the mounting flange at the wheel/column juncture. The left front door opened as the latch released due to stress overload and the lower A-pillar separated from the sill due to guardrail engagement. As the Jeep began to rotate counterclockwise due to the offset left engagement, the driver was displaced to his right. The vehicle overturned on top of the damaged guardrail and completed multiple quarter turns. The driver's head scuffed the intruding right roof side rail. He was thrust to his left by the centripetal force of the rollover and was ejected through the left front door opening. During the ejection, his left hip contacted and scuffed the left lower B-pillar and his left flank contacted and scuffed the door armrest.

The driver was thrown from the vehicle onto the road surface of the eastbound travel lanes. Due to the long throw distance, he tumbled and rolled to rest. Witnesses then reported that the driver was struck by a passing tractor, semi-trailer. Based on images of the driver at the scene and a review of his multiple injuries, his left thigh was probably run over by tires of the tractor, semi-trailer. It is presumed that he was struck and dragged by a second vehicle for an unknown distance along the right eastbound lane. The driver sustained multiple fractures of the skull, ribs and extremities along with multiple deep lacerations, avulsions, and abrasions to his entire body from his initial impact with the concrete road surface and subsequent vehicle impacts and dragging along the road surface. Additionally, his clothing was torn and displaced. There was no evidence of crush type injures to his head or torso. The left femur appeared to have been run over and was severely distorted. Due to the severity and extensive injury to his body from the ejection, specific injuries were not sourced to the vehicle's interior.

A passer-by stopped at the crash site and dragged the driver's body from the right travel lane to the right shoulder to avoid further vehicle contact. The medical examiner removed the body from the crash site and a non-invasive autopsy was performed.

CRASH DIAGRAM



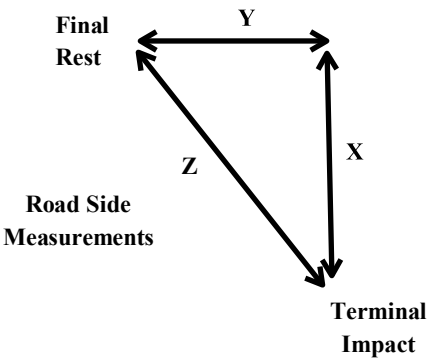
APPENDIX A: FHWA GUARDRAIL FORM

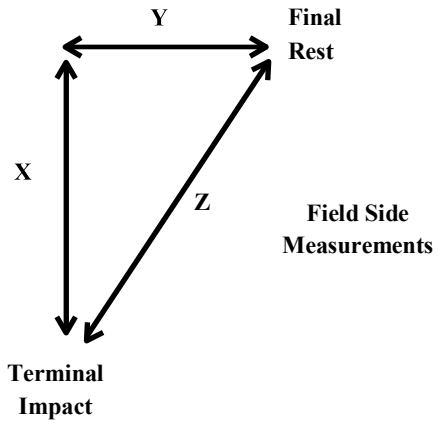
PREPOPULATED DATA (BY OTHERS)			
Date of Crash	November 2017	**TIME OF CRASH (MILITARY)**	Nighttime
Case Number	IN17035	**State**	Missouri
Traffic Route	Interstate	**Direction (Southbound = SB)**	WB
Ambient Conditions (at time of crash)			
Temperature (°F)	33	**Lighting**	Dark
Atmospheric	Clear		

SCENE INFORMATION	
Type of area where crash occurred	❒Urban ❒Rural ☒Suburban
Terminal on a horizontal curve?	❒No ❒Curve/LT ☒Curve/RT
Estimated or Reconstructed Speed at Impact (MPH)	Unknown
Est. distance (straight line) from terminal impact to COM final rest position (ft.)	Z = 151 ft
Est. distance (longitudinal) along guardrail from terminal impact to COM final resting location (ft.)	X = 150 ft
Est. distance (normal) from either 1. the white paint line; or 2. roadway/shoulder/pavement edge to COM rest position (ft.)	Y = 33 ft
Super elevation	☒+2% (+4%) ❒-2% ❒ NONE or FLAT
Curve Radius (ft.)	1,860.7

KEY:

- COM - Center of Mass of Vehicle
- Distance Measurements





ON-SCENE INFORMATION		
End Treatment Type	☒Extruder	❒ET2000 ☒ET-PLUS 4in ❒ET-PLUS 5in ❒SKT ❒FLEAT ❒SOFT STOP
	❒Telescope	❒X-LITE ❒X-TENSION
Curb?	☒No ❒Yes	❒AASHTO Type A ❒AASHTO Type B ❒AASHTO Type C ❒AASHTO Type D ❒AASHTO Type E ❒AASHTO Type F ❒AASHTO Type G ❒AASHTO Type H
Curb Height:		

GUARDRAIL INSTALLATION									
Post No.	Post		Offset Block		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	Wood	7.5 x 7.8	None	N/A	Unk		5.5	N/A	6’ 3”
2	Wood	7.8 x 7.8	None	N/A	Unk		5.1	N/A	5’ 9”

Case No.: IN17035

Post No.	Post		Offset Block		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
3	Wood	Unk	Wood	Unk	Unk		5.6	N/A	5’ 10”
4	Wood	Unk	Wood	Unk	Unk		5.2	N/A	5’ 8”
5	Wood	Unk	Wood	Unk	Unk		5.0	N/A	6’ 2”
6	Wood	Unk	Wood	Unk	Unk		5.2	N/A	6’ 4”
7	Wood	Unk	Wood	Unk	Unk		5.2	N/A	6’ 4”
8	Steel	6.0 x 4.0	Wood	7.5 x 6.0	Unk		5.0	N/A	6’ 3”

Case No.: IN17035

Post No.	Post		Offset Block		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
9	Steel	6.0 x 4.0	Wood	7.5 x 6.0	Unk		5.2	N/A	5’ 11”
10	Steel	5.8 x 4.0	Composite	7.5 x 4.0	Unk		5.2	N/A	6’ 2”
11	Steel	5.8 x 4.0	Composite	7.8 x 4.0	No		5.1	N/A	6’ 2”
12	Steel	6.0 x 4.0	Composite	8.0 x 4.0	No		5.1	N/A	6’ 2”

Additional Comments

EXTRUDER			
Feeder Channel Width at impact head	☒4inches ☐5 inches ☐Other _____		
Guide Chute Exit Height (in.)	15.8		
Connection of feeder channels to head damaged?	☐No ☒Yes	Are Welds Broken?	☐No ☒Yes
Anchor Cable Present?	☐No ☒Yes	Connected?	☒No ☐Yes
Rail Extrusion?	☐No ☒Yes	Length (ft. in.)	5' 8"
Rail Extrusion Direction	☐Traffic Side ☒Field Side		
Total Length of Rail Damaged (ft.) [total length would include extruded rail plus damaged rail downstream from head.]	112		

TELESCOPE				
Rail Displacement	☐No	☐Yes; Length:	No of Panels Displaced	☐1 ☐2 ☐3 ☐4 ☐5 ☐6

ALL-SYSTEM PERFORMANCE			
Railkinks Downstream of Head?	☐No	☒Yes ;	No. of Kinks in Rail: 13
Was there intrusion into the Occupant Compartment by foreign object (guardrail)?	☒No ☐Yes		
Did vehicle impact other objects after impact with terminal?	☐No ☒Yes		
Object Contacted	Cable Barrier Guardrail and Ground		

ALL-SYSTEM PERFORMANCE ENVIRONMENT			
SIDESLOPE	**50 ft in advance of Post 1**	**At Post 1**	**50 ft Past Post 1**
Percent - %	-7%	-7%	-7%
Adjacent Lane Width (ft)	12.1		
Lane Type (NAS EDS Variable: Sur. Type)	Concrete		
Shoulder Type	Concrete/Bituminous		

Shoulder Width (ft)	5.9
Guardrail Height (in)	15

VEHICLE INFORMATION		
Vehicle Type (NHTSA Input)	Sport Utility Vehicle	
Vehicle Identification Number (VIN)	1J4GW58N84Cxxxxxx	
Vehicle Mass (NASS var.: veh.wgt)	4,094	
Vehicle orientation upon impact	☒Case Type 1 ❒ Case Type 2 ❒Case Type 3 ❒ Case Type 4 ❒ Case Type 5 ❒ Case Type 6 ❒ Case Type 7 ❒ Case Type 8 ❒ Other	
If 'Other', describe		
Collision Deformation Classification	12FLEE6	
Delta-V	Unknown, Severe damage	
Occupant Compartment Penetration of rail	☐No	☒Yes ; Describe: Rail intruded through roof during rollover when top plane landed on the rail
Quarter Turns (NASS EDS variable: Rollover)	❒1 ❒2 ❒3 ❒4 ❒5 ❒6 ❒7 ❒8 ❒9 ❒10 ❒11 ☒12 ❒13 ❒14 ❒15 ❒16 ❒17+	
Object Precipitating Rollover, (NASS EDS variable: Rollobj)	Non-collision	
Rollover Type, Terhune Scale, (NASS EDS variable: rolintyp)	Turnover	

DOT HS 812 954
June 2020

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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