



U.S. Department
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**National Highway
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February 2019

Special Crash Investigations

Remote Vehicle Fire

Child Restraint System

Investigation

Vehicle: 2004 Jeep Grand

Cherokee

Location: Indiana

Crash Date: October 2014

DISCLAIMERS

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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.

This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

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16. Abstract This report documents the remote investigation of a crash-related fire in a 2004 Jeep Grand Cherokee in which a 6- year-old and a 4-year-old male were seated in Child Restraint Systems (CRS) located in the second row left and right seating positions, respectively. The Jeep was a four-door sport utility vehicle equipped with frontal air bags and Lower Anchors and Tethers for Children (LATCH) in the second row left and right seating positions. An unbelted 28-year- old female driver also occupied the vehicle. Each child was seated in an unknown make/model CRS. The Jeep was traveling south on a two lane roadway in the southbound lane and the vehicle departed the right side of the road into the grass. The driver initiated a left steering maneuver and the vehicle reentered the roadway and the driver lost control of the vehicle and it rolled over, right side leading. Meanwhile, a 2013 Hyundai Santa Fe was traveling north in the northbound lane and the driver initiated a right steering maneuver in an attempt to avoid a crash with the Jeep. The Hyundai departed the east side of the road where its front plane impacted the back slope of a ditch (event 2). Its front plane then impacted the top plane of the Jeep (event 3) as the Jeep continued to roll over. The Hyundai then rolled over (event 4), left side leading, one quarter turn. The left plane of the Jeep sideswiped a utility pole (event 5) as the vehicle came to final rest upright heading northwest after rolling over 7 quarter turns across a total distance of approximately 36 m (118 ft). The Hyundai came to final rest in the ditch partially on its left plane and top plane heading northeast. The driver of the Jeep was ejected during the rollover and came to final rest adjacent to the right rear wheel of her vehicle. The Jeep caught fire (event 6) immediately after it came to final rest. At least one passerby, two fire fighters, and two people from a nearby residence used hand-held fire extinguishers to extinguish the fire. The severity of the fire was minor. Two volunteer fire fighters and a passerby removed the two second row passengers from the Jeep. The driver of the Jeep sustained fatal injuries. The two second row passengers sustained police- reported "B" (non-incapacitating) injuries and were transported by helicopter to a children's hospital. The driver and front row passenger of the Hyundai each sustained police-reported "B" (non-incapacitating) injuries and were transported by ambulance to a hospital. The vehicles were towed from the crash scene due to damage.					
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Indiana University Transportation Research Center
Special Crash Investigations
Remote Vehicle Fire Child Restraint System Investigation
Case Number - IN17008
Location - Indiana
Vehicle - 2004 Jeep Grand Cherokee
Crash Date - October 2014

BACKGROUND

This report documents the remote investigation of a crash-related fire in a 2004 Jeep Grand Cherokee (**Figure 1**) in which a 6-year-old and a 4-year-old male were seated in Child Restraint Systems (CRS) located in the second row left and right seating positions, respectively. This investigation was initiated and assigned by the National Highway Traffic Safety Administration (NHTSA) in January 2017. This crash involved the Jeep and a 2013 Hyundai Sante Fe. The crash occurred in Indiana in October 2014 during afternoon hours and was investigated by a local police agency. Photographs of the crash scene and vehicles were obtained in January 2017. An interview with the volunteer fire fighter that was first on-scene and extinguished the fire was conducted in August 2017.



Figure 1: Police photo of the damaged 2004 Jeep Grand Cherokee

This crash occurred on a straight, two-lane U.S. highway. The Jeep was a four-door sport utility vehicle equipped with frontal air bags and Lower Anchors and Tethers for Children (LATCH) in the second row left and right seating positions. An unbelted 28-year-old female driver occupied the vehicle. Each child was seated in an unknown make/model CRS. The Jeep was traveling south in the southbound lane and the vehicle departed the right side of the road into the grass.

The driver initiated a left steering maneuver and the vehicle reentered the roadway and the driver lost control of the vehicle and it rolled over, right side leading. Meanwhile, the Hyundai was traveling north in the northbound lane and the driver initiated a right steering maneuver in an attempt to avoid a crash with the Jeep. The Hyundai departed the east side of the road where its front plane impacted the back slope of a ditch (event 2). Its front plane then impacted the top plane of the Jeep (event 3) as the Jeep continued to roll over. The Hyundai then rolled over (event 4), left side leading, one quarter turn. The left plane of the Jeep sideswiped a utility pole (event 5) as the vehicle came to final rest upright heading northwest after rolling over 7 quarter turns across a total distance of approximately 36 m (118 ft). The Hyundai came to final rest in the ditch partially on its left plane and top plane heading northeast. The driver of the Jeep was ejected during the rollover and came to final rest adjacent to the right rear wheel of her vehicle. The Jeep caught fire (event 6) immediately after it came to final rest. At least one passerby, two

fire fighters, and two people from a residence near the crash used hand-held fire extinguishers to extinguish the fire. The severity of the fire was minor. Two fire fighters and a passerby removed the two second row passengers from the Jeep. The driver of the Jeep sustained fatal injuries. The two second row passengers sustained police-reported “B” (non-incapacitating) injuries and were transported by helicopter to a children’s hospital. The driver and front row passenger of the Hyundai each sustained police-reported “B” (non-incapacitating) injuries and were transported by ambulance to a hospital. The vehicles were towed from the crash scene due to damage.

CRASH SUMMARY

Crash Site

This crash occurred during daylight hours on a straight, two-lane U.S. highway. The weather conditions were dry and clear with 16 kilometers (10 miles) visibility, east-northeast winds at 11 km/h (7 mph), a temperature of 15.0 °C (59 °F), and a dew point of 4.4 °C (40 °F), according to police crash report and local weather reports. The highway traversed in a north/south direction and had one bituminous lane in each direction. Each lane was bordered by bituminous shoulder. A county roadway and two residential driveways intersected the west side of the roadway. The road was bordered in several locations by a ditch, and utility poles were located on each side of the road. The roadway pavement markings consisted of solid white edge lines and a solid yellow centerline for southbound traffic and broken yellow centerline for northbound traffic at the north end of the crash scene. The centerline then became broken yellow south of the county roadway. Each lane was approximately 3.6 m (11.8 ft) wide and each shoulder was approximately 1.0 m (3.2 ft) wide. The speed limit was 89 km/h (55 mph). The Crash Diagrams are included at the end of this report.

Pre-Crash

The Jeep was traveling south in the southbound lane and the Hyundai was traveling north in the northbound lane at a considerable distance from the Jeep. The driver of the Jeep was intoxicated¹ and her vehicle departed the right side of the



Figure 2: Police photo showing the Jeep’s road departure, view south



Figure 3: Police photo showing the area the Jeep reentered the roadway, view southeast

¹ The police crash report stated that the driver’s Blood Alcohol Content (BAC) was 0.351%

road into the grass (**Figure 2**). The vehicle traveled a police-reported distance of 51.0 m (168.0 ft) with the right side tires on the grass and the left side tires on the shoulder. The driver initiated a left steering maneuver as the vehicle approached a county roadway that intersected the west side of the highway. The vehicle reentered the roadway (**Figure 3**) and traveled approximately 34 m (112 ft) as it crossed the southbound lane at the mouth of the county roadway and entered the northbound lane. The driver initiated a right steering maneuver as the vehicle traveled approximately 54 m (177 ft) across the northbound lane and onto the east shoulder. The vehicle then traveled an additional approximately 27 m (89 ft) as it traveled across the northbound lane (**Figure 4**). The driver again initiated a left steering maneuver as the vehicle approached the southbound lane. The vehicle then rotated counterclockwise producing yaw marks on the roadway from the right side tires as it traveled approximately 24 m (79 ft) approaching the east side of the roadway to the area of rollover initiation (**Figure 5**).

Crash

The Jeep rolled over (event 1), right side leading, in the northbound lane and rolled over toward the east side of the road. The driver of the northbound Hyundai initiated a right steering maneuver in an attempt to avoid a crash and departed the right side of the road into the ditch. The vehicle's front plane impacted the back slope of a ditch (event 2) and its front plane also impacted the top plane of the Jeep (event 3) as the Jeep continued to roll over. The Hyundai then rolled over (event 4), left side leading, one quarter turn as the two vehicles separated. The Jeep continued to roll over following this impact, but in an end-over-end motion according to witnesses. The vehicle landed on its wheels and traveled backward in a southeast direction and the left plane sideswiped a utility pole (event 5). The vehicle then came to final rest heading northwest (**Figure 6**) after rolling over an estimated total of 7 quarter turns across a total distance of approximately 36 m (118 ft). The Hyundai came to final rest in the ditch partially on its left and top planes heading northeast (**Figure 6**). The driver of the Jeep was ejected during the rollover and came to final rest adjacent to the right wheel of her vehicle. The driver was probably ejected through either the left front or right front windows.



Figure 4: Police photo showing the Jeep's travel from east shoulder across northbound lane, view southwest



Figure 5: Police photo showing right side tire yaw marks from the Jeep as it approaches area of rollover, view south

Post-Crash and Fire-Related Discussion

The Jeep caught fire immediately following the crash based on the SCI interview with the first fire fighter to respond to the crash scene. The fire fighter was a member of a local volunteer fire department and lived near the crash scene and arrived within several minutes. The vehicle was on fire when he arrived with the flames emanating from the left cowl/instrument panel area. Two people from a residence near the crash and at least one passerby were attempting to extinguish the fire with small hand-held fire extinguishers. It was reported that these people succeeded in “knocking down” the fire but exhausted their fire extinguishers in the process. The fire fighter used a larger hand-held fire extinguisher that he brought with him from his residence and also exhausted it as he extinguished the flames. A passerby then removed the child seated in the second row right CRS from the vehicle through the disintegrated third right rear window. The roof was severely intruded into the second row right seating position and the child was removed from the vehicle through the space between the head restraint and the right C- pillar. The fire fighter stated that the feet, and particularly the right foot, of the child in the second row left CRS were entrapped between the CRS and the driver’s seat back. The fire fighter used a baseball bat to pry the seat back forward while a second fire fighter freed the child’s left foot, then manipulated the child’s right foot to free it from the entrapment. The second fire fighter then removed the child from the vehicle through the space between the crushed door frame and the displaced window frame (**Figure 7**). The first fire fighter stated that as the second row left child was being removed from the vehicle, the fire suddenly re-ignited and singed his back. By this time a fire truck had arrived at the crash scene and the first fire fighter retrieved a hand- held fire extinguisher from that fire truck

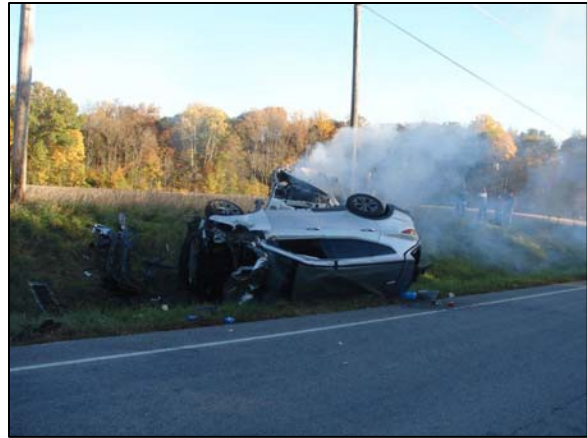


Figure 6: Police photo showing final rest positions of the Jeep and Hyundai, view southeast



Figure 7: Area where second row left occupant was removed from Jeep



Figure 8: Police photo showing first fire fighter preparing to extinguish fire after it re-ignited

to extinguish the fire (**Figure 8**). The second fire fighter also obtained a hand-held fire extinguisher and assisted the first fire fighter. The first fire fighter estimated that the fire truck arrived on-scene 12 minutes after his arrival at the crash scene.

The origin of the fire was in the left cowl/instrument panel area suggesting that the likely cause of the fire was electrical. The majority of the fire damage appeared to have occurred in the left cowl and left rear area of the engine compartment (**Figure 9**). The severity of the fire was considered to be minor.



Figure 9: Area of fire damage to the Jeep

The police were notified of the crash at 1711 hours and arrived on scene at 1719 hours. The driver of the Jeep sustained fatal injuries. The two second row passengers sustained police-reported “B” (non-incapacitating) injuries and were transported by helicopter to a children’s hospital. The driver and front row passenger of the Hyundai each sustained police-reported “B” (non-incapacitating) injuries and were transported by ambulance to a hospital. The vehicles were towed from the crash scene due to damage

2004 JEEP GRAND CHEROKEE

Description

The Jeep was a four wheel drive, five-occupant, four-door sport utility vehicle (VIN: 1J4GW58N04Cxxxxxx) equipped with a 4.7-liter V-8 engine, five-speed automatic transmission, and four-wheel anti-lock disc brakes with electronic brake force distribution. The vehicle was also equipped with frontal air bags and a LATCH system in the second row left and right seating positions. The specified wheelbase was 269 cm (105.9 in).

The vehicle manufacturer’s recommended tire size was P235/65R17. The vehicle manufacturer’s recommended cold tire pressure for the front and rear tires was 228 kPa (33 psi). The make, model, and size of the tires on the vehicle at the time of the crash is not known.

The front row was equipped with driver and passenger leather-covered bucket seats with adjustable head restraints. The second row was equipped with a leather-covered split bench seat with folding backs and adjustable head restraints in the outboard setting positions.

Exterior Damage

Exterior Damage Crash Events 1, 3, and 5: The Jeep sustained direct damage to the top and both side planes during the crash. The most severe damage occurred to the top plane as the vehicle was rolling over (event 1) when it was impacted by the front plane of the Hyundai. The Jeep’s roof was crushed beyond the beltline and intruded into all the seating positions. The damage to

the top plane from the rollover was masked by this damage. Scratches from contact with the pavement during the rollover extended down the right plane from the fender to the right rear door. The right rear wheel had a large amount of dirt embedded in approximately half of the rim and the tire bead was separated from the rim. The damage from the impact with the utility pole (event 5) involved the left quarter panel and left side of the back bumper fascia. The fire damage was discussed in the “Post-Crash and Fire-Related Discussion” section on page 4 of this report.

Damage Classifications Crash Event 1: The Collision Deformation Classification (CDC) for the rollover event was estimated to be 00TDDO2. The severity of the damage was minor.

Damage Classifications Crash Event 3: The CDC for the damage to the top plane from the front plane impact by the Hyundai that occurred during the rollover was 00TYDW6. The severity of the damage was severe.

Damage Classifications Crash Event 5: The CDC for the left quarter panel sideswipe impact with the utility pole was 06LBES2 (180 degrees). The severity of the damage was minor.

Interior Damage

The interior of the Jeep sustained severe damage from intrusion to the roof. There also was lateral displacement of the left A-, B-, C-pillars, and the left roof side rail into the occupant compartment. The fire damage to the interior was minor. The top of the left instrument panel was burned and the steering wheel rim appeared to have been burned slightly. The driver’s seat back was displaced rearward. The left front and rear doors were jammed shut. The right side doors also appeared to be jammed shut. The glazing in all the left side windows, right front, and third right rear windows were disintegrated from impact forces. The windshield was cracked, holed, and out-of-place.

Manual Restraint Systems

The front and second rows of the Jeep were equipped with three-point lap and shoulder safety belts. The driver was unbelted at the time of the crash and ejected from the vehicle. It is not known if the lap and shoulder safety belts in the second row left and right seating positions were used to secure the CRSs to the vehicle.

Supplemental Restraint Systems

The Jeep was equipped with frontal air bags. Neither air bag deployed during the crash.

Child Restraint System

The second row left and right passengers were seated in forward-facing convertible CRSs based on the interview with a fire fighter who assisted in removing the children from the vehicle. The make and model of the CRSs is not known.

2004 JEEP GRAND CHEROKEE OCCUPANTS

Driver Demographics

Age/Sex:	28 years/Female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Type:	Bucket
Seat Track Position:	Unknown
Manual Restraint Usage:	None
Usage Source:	Police crash report
Air Bags	Frontal, not deployed
Alcohol/Drug Involvement:	Yes (BAC 0.351)
Egress from Vehicle:	Ejected from vehicle
Transport from Scene:	Ambulance
Medical Treatment:	None, deceased at crash scene

Driver Injuries

No injury data was available for the driver.

Driver Kinematics

The driver was not belted at the time of the crash. The position of her seat track is not known. The driver was displaced in multiple directions during the rollover and was ejected from the vehicle. The path of the ejection is not known. The driver sustained fatal injuries and was pronounced deceased at the crash scene.

Second Row Left Occupant Demographics

Age/Sex:	6 years/Male
Height:	Unknown
Weight:	Unknown
Eyewear:	None
Seat Type:	Split bench with folding backs
Seat Track Position:	Fixed
Manual Restraint Usage:	Child Restraint System
Usage Source:	Police crash report
Air Bags	None
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Removed by fire fighters
Transport from Scene:	Helicopter
Medical Treatment:	Unknown

Second Row Left Occupant Injuries

No injury data was available for the second row left occupant.

Second Row Left Occupant Kinematics

The second row left occupant was seated in an unknown make/model CRS. The occupant was displaced in multiple directions during the rollover prior to the top plane impact with the Hyundai. The impact with the Hyundai probably redirected the occupant toward the roof, forward, and to the right within the CRS harness. The second row left occupant remained in the CRS following the crash and was removed from the vehicle by the first and second fire fighters, who had to free his entrapped feet from between the CRS and the displaced driver's seat back. The occupant was transported by helicopter to a children's hospital.

Second Row Right Occupant Demographics

Age/Sex:	4 Years/Male
Height:	Unknown
Weight:	Unknown
Eyewear:	None
Seat Type:	Split bench with folding backs
Seat Track Position:	Fixed
Manual Restraint Usage:	Child Restraint System
Usage Source:	Police crash report
Air Bags	None
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Removed by passerby
Transport from Scene:	Helicopter
Medical Treatment:	Unknown

Second Row Right Occupant Injuries

No injury data was available for the second row right occupant.

Second Row Right Occupant Kinematics

The second row right occupant was seated in an unknown make/model CRS. The occupant's kinematics were probably similar to those of the second row left occupant. The second row right occupant was transported by helicopter to a children's hospital.

2013 HYUNDAI SANTE FE

Description

The Hyundai was a front wheel drive, five-passenger, four-door sport utility vehicle (VIN: 5XYZT3LB7DGxxxxxx) equipped with a 2.4-liter V-6 engine, four-wheel anti-lock brakes with electronic brake force distribution, electronic stability control, traction control, and a tire pressure monitoring system. The vehicle was also equipped with multi-stage frontal air bag, front seat-mounted side impact air bags, and side impact IC air bags.

Exterior Damage

Exterior Damage Crash Events 2 and 3: The Hyundai sustained overlapping direct damage to the front plane from the impacts with the back slope of a ditch and the top plane of the Jeep. The top plane impact with the Jeep also resulted in direct damage to hood, right fender, and right roof side rail as the Jeep continued to roll over and separated from the impact with the Hyundai.

Damage Classifications Crash Events 2 and 3: The CDC for the impact to the back slope of the ditch was estimated to be 12FDEW1 (0 degrees). The severity of the damage was minor. The CDC for the impact to the top plane of the Jeep was estimated to be 00FDMW2. The severity of the damage was moderate.

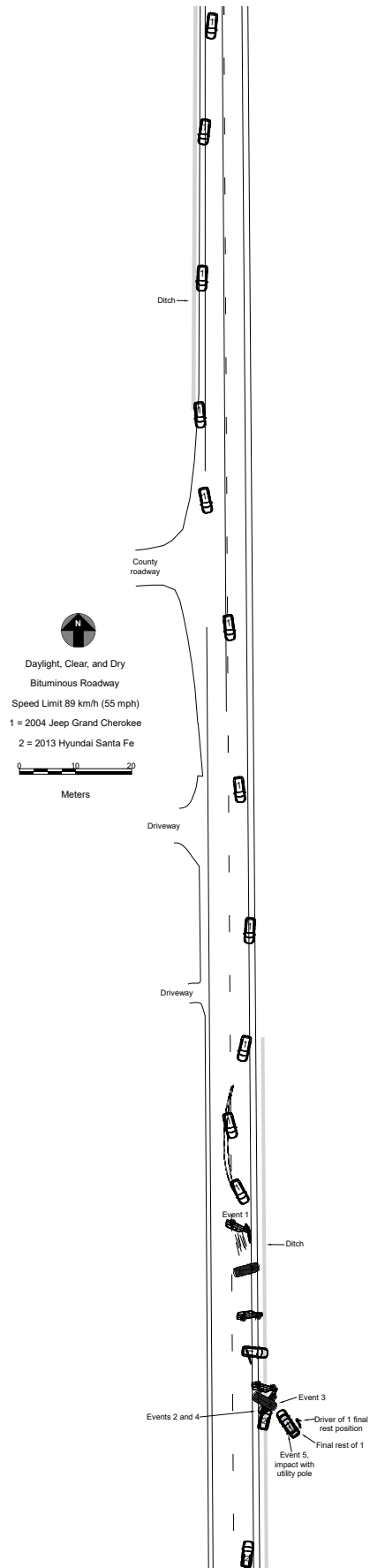
Exterior Damage Crash Events 4: The Hyundai sustained direct and induced damage to the left plane during the rollover. The top plane also sustained induced damage from this event.

Damage Classification Crash Event 4: The CDC for the rollover onto the left plane was estimated to be 00LDAO2. The severity of the damage was minor.

Occupant Data

The driver (59-year-old male) and front row passenger (61-year-old female) were each restrained by a lap and shoulder safety belt according to the police crash report. They each sustained police-reported “B” (non-incapacitating) injuries and were transported to a medical facility. Their injuries and level of treatment are not known.

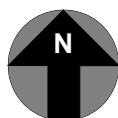
CRASH DIAGRAM



Case Number:

IN17008

CRASH DIAGRAM, DETAIL VIEW



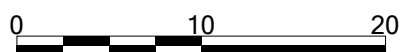
Daylight, Clear, and Dry

Bituminous Roadway

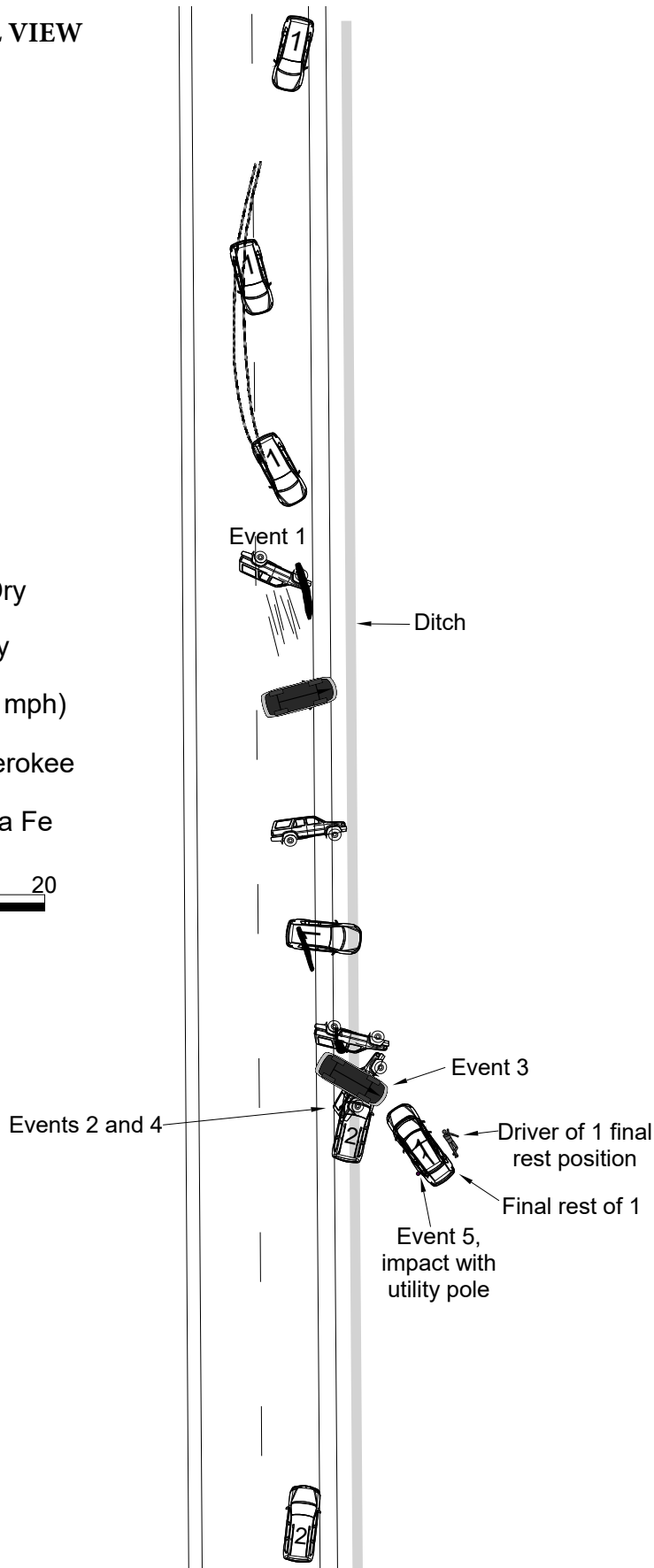
Speed Limit 89 km/h (55 mph)

1 = 2004 Jeep Grand Cherokee

2 = 2013 Hyundai Santa Fe



Meters



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