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Special Crash Investigations On-Site Guardrail End Terminal Crash Investigation Vehicle: 2002 Hyundai Sonata Location: Pennsylvania Crash Date: November 2016

DISCLAIMER

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15. Supplementary Note

An investigation of the impact to an SKT guardrail end terminal by a 2002 Hyundai Sonata.

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.

16. Abstract

This report documents the on-site investigation of the crash that involved a sequential kinking terminal (SKT) and guardrail struck by a 2002 Hyundai Sonata. The Hyundai was traveling east on a single-lane exit ramp from a multi-lane divided interstate highway at a driver-reported speed of 48 to 56 km/h (30 to 35 mph). The belted 61-year-old male driver reported to the police that a deer entered his path, causing him to steer and brake in an avoidance maneuver. The Hyundai departed the left side of the road and struck the guardrail end terminal. The end terminal was displaced along a portion of the guardrail and extruded the W-beam. Following engagement with the guardrail system, the Hyundai rotated counterclockwise, coming to final rest. The driver of the Hyundai sustained police-reported suspected minor (C- level) injuries as a result of the crash and was transported to a local hospital for evaluation. The crash was identified by the Pennsylvania Turnpike Commission (PTC), who in turn submitted notification to the Federal Highway Administration (FHWA). The FHWA determined that the crash type and guardrail end treatment met the criteria for further research and subsequently forwarded the notification to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration in November 2016. The CID assigned an on-site investigation of the crash to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc. in November 2016. The SCI team initiated contact and cooperation with the PTC and the on-site investigation took place in December 2016.

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BACKGROUND

This report documents the on-site investigation of the crash that involved a sequential kinking terminal (SKT) and guardrail (**Figure 1**) struck by a 2002 Hyundai Sonata. The Hyundai was traveling east on a single-lane exit ramp from a multi-lane divided interstate highway at a driver-reported speed of 48 to 56 km/h (30 to 35 mph). The belted 61-year-old male driver reported to the police that a deer entered his path, causing him to steer and brake in an avoidance maneuver. The Hyundai departed the left side of the road and struck the guardrail end terminal. The SKT end terminal was displaced along a portion of the guardrail and extruded the W-beam. Following engagement with the guardrail system, the Hyundai rotated counterclockwise, coming to final rest. The driver of the Hyundai sustained police-reported suspected minor (C-level) injuries as a result of the crash and was transported to a local hospital for evaluation. The crash was identified by the Pennsylvania Turnpike Commission (PTC), who in-turn submitted notification to the Federal Highway Administration (FHWA). The FHWA determined that the crash type and guardrail end treatment met the criteria for further research and subsequently forwarded the notification to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration in November 2016. The CID assigned an on-site investigation of the crash to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., in November 2016. The SCI team initiated contact and cooperation with the PTC and the on-site investigation took place in December 2016.

Figure 1: East-looking trajectory view of the Hyundai showing the struck guardrail end-treatment.

The on-site investigation documented the roadway, the guardrail system and the damage it sustained during the crash. Photographs and a Nikon Nivo 5+M total station mapping system documented the physical environment of the crash site. The Hyundai was inspected to document its exterior and interior damage, identify the interior occupant points of contact, assess the manual restraint systems, and evaluate and inspect the supplemental restraint deployment/ actuation. Due to its age, the Hyundai was not equipped with an event data recorder (EDR). An interview of the driver was conducted by the SCI Investigator via telephone.

CRASH SUMMARY

Crash Site

The crash occurred on an exit ramp from a divided interstate highway at night. The posted advisory speed limit was 40 km/h (25 mph). At the time of the crash, the National Weather Service reported a temperature at 6 ºC (43 ºF) and a relative humidity of 71 percent, with mostly cloudy skies and north-northwest winds at 7.4 km/h (4.6 mph). The police-reported environmental conditions were clear and dry.

The exit ramp near the crash consisted of a single lane that measured 3.6 m (11.8 ft) wide. The ramp was delineated by a solid white line on the right and a solid yellow line on the left. Asphalt shoulders bordered the roadway. The width of the right shoulder measured 3.3 m (10.8 ft). The left shoulder was 3.2 m (10.5 ft) wide. The ramp was oriented to the east and was straight for approximately 305 m (1,000 ft) with a negative 3.5 percent grade in the direction of travel. The ramp then curved right approximately 90 degrees. The radius of the curve measured 82 m (269 ft) with a positive 5.1 percent super-elevation at the point of impact. The SKT end terminal and guardrail was installed on the left roadside. The installation began approximately 76 m (250 ft) east of the beginning of the curve. **Figure 2** is a west-facing lookback view along the Hyundai's trajectory. **Figure 3** is an east-facing trajectory view approximately 46 m (150 ft) from the point of impact. Crash diagrams are included at the end of this technical report.

Figure 2: West-facing lookback view along the Hyundai's trajectory.

Figure 3: East-facing trajectory view approximately 46 m (150 ft) west of the point of impact.

Pre-Crash

The 61-year-old male driver was operating the Hyundai eastbound on the interstate. He was restrained by the vehicle's 3-point lap and shoulder seat belt. The driver reported that he had become fatigued and was in the process of exiting the interstate at the time of the crash. He stated that he had reduced the speed of the Hyundai after exiting the interstate and was traveling approximately 48 to 56 km/h (30 to 35 mph) when a deer entered his travel path from left to right. The driver further stated that he steered left in an attempt to avoid the animal, which caused the vehicle to depart the road.

The SCI Investigator observed during the SCI scene inspection that the location of the vehicle's left roadside departure was 19.6 m (64.3 ft) from the end terminal. The tire marks indicated that the driver counter-steered to the right and applied the brakes. As a result of this maneuver, the Hyundai initiated a clockwise yaw. **Figure 4** is an east-facing view along the trajectory of the Hyundai at the road departure. The yaw trajectory is denoted by the cones in the image. The blue and yellow cones denote the left front tire mark and the left rear tire mark, respectively. The dark straight skid mark in the foreground of the image was not related to this crash.

Figure 4: East-facing image showing the yaw marks along the Hyundai's trajectory.

Crash

The left front corner of the Hyundai struck a polymer delineator (Event 1) that was located on the roadside 10.4 m (34.1 ft) from the end terminal. A black scuff mark on the delineator evidenced the contact with the left front tire. The vehicle passed over the delineator and continued on its eastward yawing trajectory.

The front plane/left aspect of the Hyundai then struck the SKT end terminal (Event 2, **Figure 5**). Forces associated with the impact caused the vehicle's seat belt pretensioner to actuate and the front air bag to deploy. The Hyundai's engagement with the end terminal displaced the SKT impact head along the guardrail and extruded 6.0 m (19.8 ft) of the W-beam. During the engagement, the Hyundai initiated a counterclockwise rotation due to the offset of the impact force. The vehicle slid to final rest in the roadway, facing eastward.

Figure 5: East-facing trajectory view of the Hyundai at the point of impact with the end treatment.

Post-Crash

Passers-by reported the crash to the emergency response system. The police, fire department, and emergency medical service (EMS) personnel responded to the crash. The driver waited for assistance to arrive and then exited the vehicle under his own power. The driver was transported to a hospital as a precaution for police-reported possible (C-level) injuries. The Hyundai was removed and transported to the yard of a local tow facility, where it was located at the time of the SCI inspection.

SKT END TERMINAL AND GUARDRAIL

The SKT End Terminal was an energy absorbing end treatment used to terminate W-beam guardrail systems as shown by the exemplar installation in **Figure 6**. The SKT installation was 15 m (50 ft) in length and consisted of an SKT end terminal, two hinged posts at post locations 1 and 2, an anchor cable, and six standard steel posts at post locations 3-8 that supported the W-beam with a composite block-out and carriage bolt. The SKT installation was manufactured by Road Systems, Inc., and met the requirements for NCHRP 350 Test Level 3. The manufacturer's literature and installation manuals can be found at http://roadsystems.com/skt.html.

Figure 6: Image showing an exemplar SKT installation.

The struck guardrail was a tangent system installed in the 82 m (269 ft) radius curve of the ramp. The height of the W-beam measured 72 cm (28.8 in) at an undamaged section of the beam between Post 5 and 6. The Hyundai struck the 51 x 51 cm (20.0 x 20.0 in) impact face of the end terminal (**Figure 7**) originally located at Post 1. Direct contact damage to the impact face measured 33 x 51 cm (13.0 x 20.0 in), width by height, referenced to its lower left corner. The force of the impact displaced the end terminal east to between Posts 4 and 5 (**Figure 8**), which extruded 6.0 m (19.8 ft) of the W-beam. The extruded W-beam curled toward the field side, away from the roadway.

Figure 7: Image showing the struck end terminal and the extruded W-beam.

Figure 8: Side view of the location of the displaced end terminal.

Posts 1 to 4 of the installation were damaged during the crash along with 7.4 m (25.4 ft) of W-beam. Damage to the installation required replacement of the W-beam to the splice at Post 5. The deformed guardrail was inspected and documented through measurements and photographs. A diagram showing the deformed guardrail is included at the end of this report. The FHWA Guardrail Form documenting the crash and installation is included at the end of this report as **Appendix A**.

Post 1 consisted of a 15 x 15 cm (6.0 x 6.0 in) upper box-beam that was attached via a hinge bolt to the lower post section that was embedded into the ground. The hinged bolt was (correctly) positioned on the upstream side of the post. The end terminal was attached to the box-beam by two shear bolts. The force of the impact overloaded the two shear bolts, thus allowing the displacement of the end terminal. The impact force also caused the lower aspect of the box-beam to shear at the hinged connection. In this crash, the box-beam separated from the lower section and was displaced to the northeast. The cable anchor, originally attached between Post 1 and the W-beam, separated during the impact and was also displaced onto the north road side.

Post 2 consisted of two I-beam elements that were connected by a hinge bolt located approximately at ground level. This hinge bolt was correctly positioned on the downstream side of the post. The foundation post was embedded into the ground. The hinged upper section of Post 2 rotated 90 degrees to the east during the crash. At this post, the W-beam was originally bolted to an open slot in the upper aspect of the I-beam flange. The bolt released (slid) from the slot as the I-beam rotated to the east.

Posts 3 through 5 of the installation were 15 x 10 cm (6 x 4 in) I-beams and prior to the crash supported the W-beam with a composite block-out and carriage bolt. The posts had weakening holes positioned approximately 3 cm (1 in) above ground level. During the crash, the heads of these bolts at Post 3 and 4 pulled through the W-beam by deformation of the slot in the rail. The composite block-outs remained attached to the posts and the bolts were deformed. Posts 3 and 4 deformed by shearing at the weakening holes and bending at ground level in the direction of the Hyundai's travel. Post 3 was bent approximately 40 degrees and Post 4 was bent approximately 10 degrees. There was no deformation at Post 5 and beyond. The repair of the guardrail necessitated replacement of the W-beam to the splice at Post 5.

2002 HYUNDAI SONATA

Description

The 2002 Hyundai Sonata 4-door sedan (**Figure 9**) was manufactured in January 2002 and was identified by Vehicle Identification Number KMHWF35H62Axxxxxx. It was equipped with the GLS trim package. The driver purchased the vehicle in 2007. The power-train consisted of a 2.7 liter, transverse-mounted, 6-cylinder gasoline engine linked to a 4-speed automatic transmission with console-mounted shifter. Standard equipment included 4-wheel power-assisted disc brakes, electronic brakeforce distribution, traction control, and power-assisted rack-and-pinion steering.

Figure 9: Left front oblique view of the Hyundai.

The gross vehicle weight rating was 1,920 kg (4,233 lb) with gross axle weight ratings of 1,060 kg (2,337 lb) front and 915 kg (2,017 lb) rear. At the time of the crash the Hyundai was configured with Firestone Affinity P205/65R16 all-season radial tires mounted on multi-spoke alloy wheels. The tires were the vehicle-manufacturer-recommended size. Specific tire data at the time of the SCI inspection were as follows.

Position	Tire Identification Number	Measured Tread Depth	Restriction	Damage
LF	1V20 0DB 3115	8 mm (10/32 in)	No	Tire Flat
LR	1V20 0DB 3715	8 mm (10/32 in)	No	None
RR	1V20 0DB 3115	8 mm (10/32 in)	No	None
RF	1V20 0DB 3115	8 mm (10/32 in)	No	None

The interior of the Hyundai was configured for seating of up to five occupants, with front row bucket seats and a three-passenger rear bench seat. All seating surfaces were cloth. The front row and the second row left and right seats were equipped with adjustable head restraints. The driver's head restraint was adjusted 6 cm (2.5 in) above the seat back at the time of the SCI inspection. Manual restraint was provided by 3-point lap and shoulder seat belts for the five seat positions. The front seat belts used retractor pretensioners. Supplemental restraint consisted of advanced front air bags for the driver and front row right positions and front row seat-mounted side impact air bags.

Exterior Damage

The exterior damage to the Hyundai (**Figure 10**) was located on the vehicle's front plane, consistent with Events 1 and 2 of the crash sequence. Any damage potentially associated with contact to the delineator was considered negligible due to the yielding properties of the object and was masked by the overlapping impact damage related to the end terminal. The estimated collision deformation classification (CDC) for Event 1 was 12FLLN1.

Damage from the end terminal began at the extreme left end of the front bumper reinforcement. Direct contact began 51 cm (20.0 in) left of center and extended 35 cm (13.8 in) to the left front corner. The impact force was absorbed by the deformation of the soft unsupported structures at the corner. The bumper fascia fractured and separated. There was no crush to the left frame rail, but the left front fender was crushed and shifted rearward. Although the left front tire was cut and aired out, there was no change in the left wheelbase dimension.

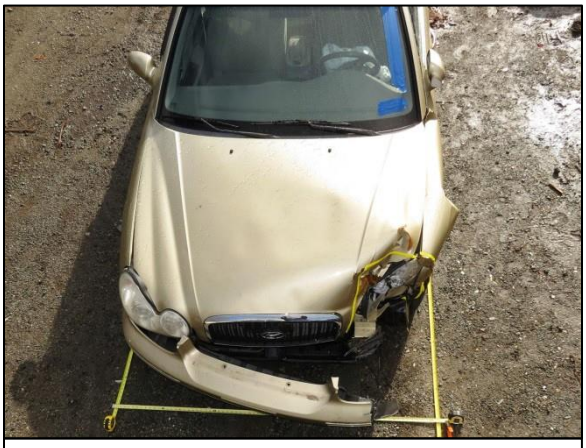


Figure 10: Overhead view showing the Hyundai's frontal damage.

A residual crush profile along the elevation of the bumper reinforcement produced the following resultant measurements: C1 = 43 cm (17.0 in), C2 = 42 cm (16.5 in), C3 = 0, C4 = 0, C5 = 0, C6 = 0. The Collision Deformation Classification (CDC) assigned to this damage pattern was 12FLEE2.

Due to the yielding properties of the guardrail, the miss-match of stiffness coefficients and the impact dynamics, a thorough analysis of this impact was beyond the scope of the WinSMASH model. However, for comparison purposes the severity of the impact (delta V) was estimated by the WinSMASH Barrier Algorithm. The total delta V was 30 km/h (19 mph), with longitudinal and lateral components of -30 km/h (-19 mph) and 0 km/h, respectively. The barrier equivalent speed (BES) was 30 km/h (19 mph). These results were considered borderline.

All doors remained closed during the crash and were operational post-crash. There was no damage to the windshield or window glazing.

Event Data Recorder

The 2002 Hyundai Sonata was not equipped with an event data recorder (EDR) due to its age. Therefore, no such data could be imaged for this investigation.

Interior Damage

Damage to the interior of the Hyundai consisted of the deployment of the driver air bag. There was no other damage or intrusion associated to the exterior forces of the crash (**Figure 11**). There were no contacts to the components of the interior that could be attributed to the kinematics of the belted driver. At the time of the SCI inspection, the driver's seat was adjusted to the full-rear track position with the seatback slightly reclined. The horizontal distance from the seatback to the center hub of the seat wheel measured 67 cm (26.3 in). There was no discernable deformation to the steering wheel rim, nor was there any apparent loading of the shear capsules.

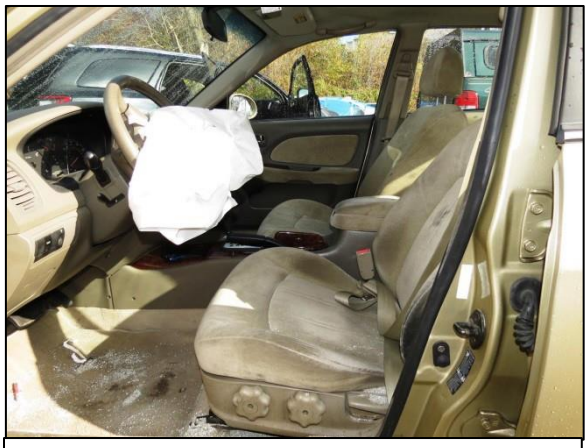


Figure 11: Left interior view of the Hyundai's front row.

Manual Restraint Systems

The Hyundai was equipped with manual 3-point lap and shoulder seat belts for the five designated seating positions. All seat belt systems consisted of continuous loop webbings and sliding latch plates. The driver's seat belt retracted onto an emergency locking retractor (ELR) while the remaining four systems retracted onto switchable ELR/automatic locking retractors. Both front belt systems were configured with adjustable D-rings. At the time of the crash, the driver's D-ring was adjusted to the full-up position. The front seat belts were equipped with retractor pretensioners.

The driver's pretensioner actuated during the crash, which locked the webbing in the used position (**Figure 12**). The extended length of the webbing measured 187 cm (73.8 in). Examination of the webbing and latch plate revealed indicators of historical use. There was no specific crash related evidence. The SCI inspection determined that the driver was restrained by the manual seat belt at the time of the crash.

Figure 12: Interior image of the Hyundai showing the driver seat belt.

Supplemental Restraint Systems

The Hyundai was equipped with four air bags to provide supplemental crash protection in frontal and side impact crashes. The air bag systems consisted of advanced frontal air bags for the driver and front right occupant positions and front seat-mounted side impact air bags. Only the driver's frontal air bag deployed in the crash. The Hyundai Sonata was equipped with a passenger presence detection system (weight sensor). This sensor suppressed the deployment of the front air bag if the weight in the front row right seat was less than 30 kg (66 lb), and suppressed the deployment of the side impact air bag if the weight was less than 15 kg (33 lb).

At the time of the SCI inspection, the driver air bag was observed to have deployed as a result of the crash. It had deployed from its module located in the center hub of the steering wheel rim without damage. In its deflated state, the air bag measured 61 cm (24.0 in) in diameter (**Figure 13**). The air bag was tethered internally and was vented by two ports located on the back side of the air bag in the 10 o'clock and 2 o'clock sectors. There was no discernable occupant contact evidence on the Hyundai's deployed driver air bag.

Figure 13: Interior image of the Hyundai showing the deployed driver air bag.

2002 HYUNDAI SONATA OCCUPANT

Driver Demographics

Age / Sex:	61 years/male
Height:	193 cm (76 in)
Weight:	127 kg (280 lb)
Eyewear:	None
Seat Type:	Bucket seat with adjustable head restraint
Seat Track Position:	Full rear
Manual Restraint Usage:	3-point lap and shoulder seat belt
Usage Source:	SCI inspection, PAR
Air Bags:	Front and seat-mounted side impact air bags available; Front air bag deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Exited under own power
Transport From Scene:	Ambulance to local hospital
Medical Treatment:	Evaluated and released

Driver Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component	IPC Confidence Level
1	None	N/A	N/A	N/A

Source: Driver interview.

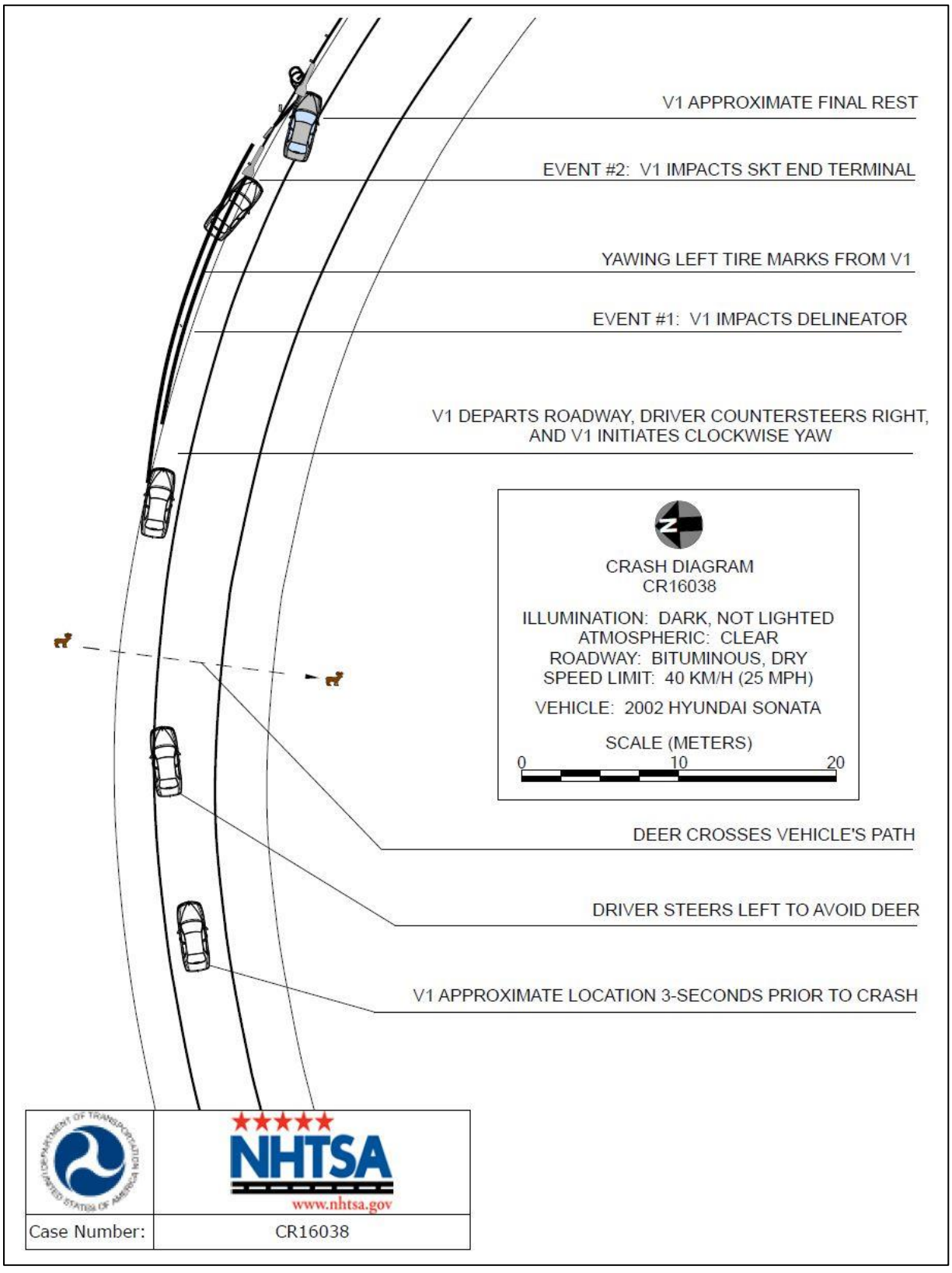
Driver Kinematics

The driver of the Hyundai was seated with the driver seat adjusted to the full rear track position. He was restrained by the vehicle's manual seat belt system. The Hyundai was traveling east on the exit ramp at a driver reported speed of 48 to 56 km/h (30 to 35 mph). The driver reported that a deer encroached and then crossed his path of travel which necessitated an avoidance maneuver. The driver steered left, and then counter-steered to the right and applied the brakes as the vehicle departed the left side of the road. The vehicle began to yaw clockwise.

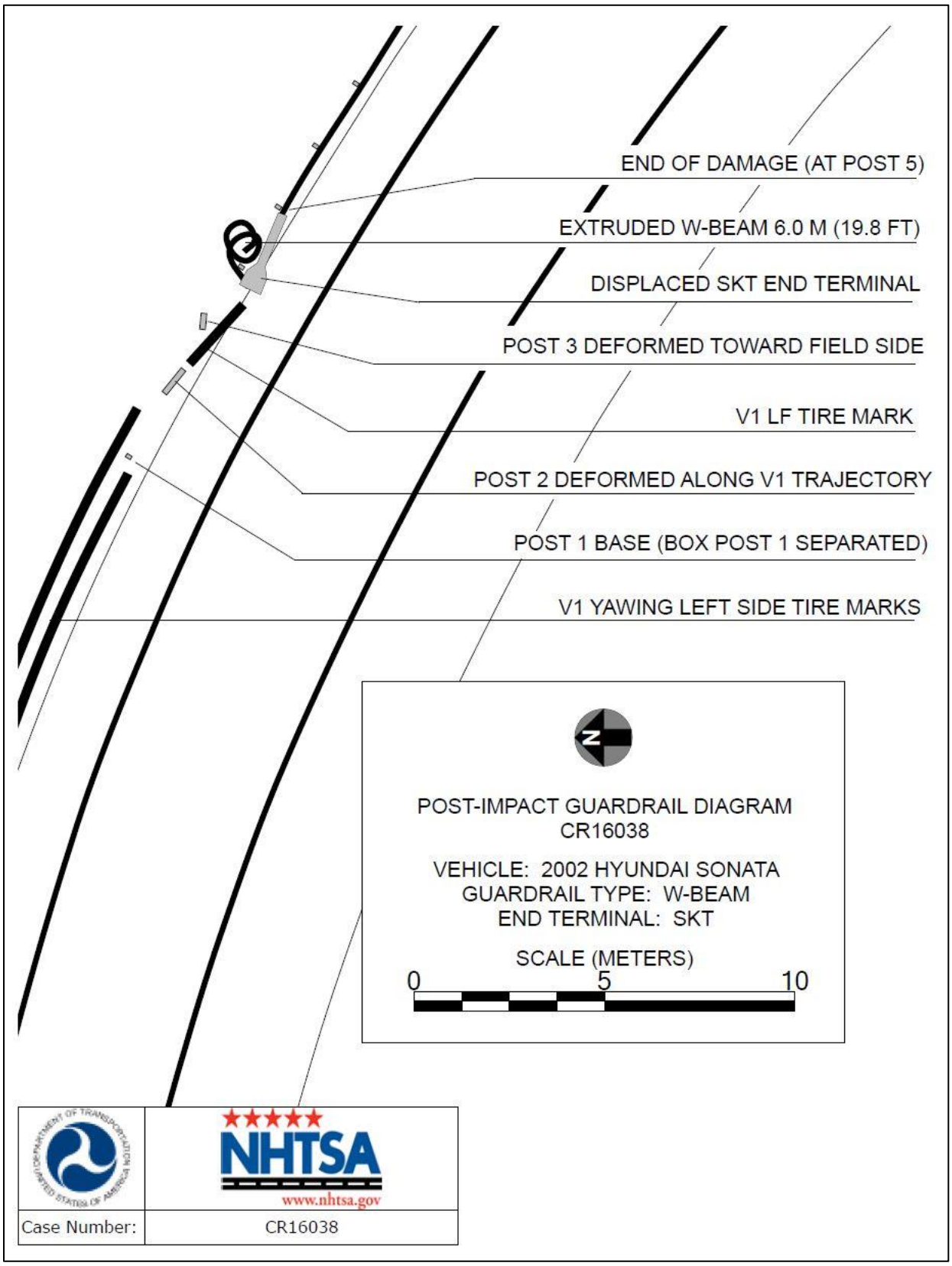
The front left corner of the vehicle struck a delineator and then the end terminal. The seat belt pretensioner actuated and the driver air bag deployed as a result of the impact. The driver responded to the 12 o'clock direction of the impact force with a forward trajectory and loaded the seat belt with his torso and the driver air bag with his chest and head. The driver reported that his face contacted the deployed air bag without injury. The use of the manual seat belt and the deployed driver air bag allowed the driver to ride down the force of the crash without injury.

As the vehicle came to rest, the driver rebounded back into his seat. He exited the vehicle under his own power and initially refused medical attention. The police requested medical transport for an evaluation of a possible head injury due to the presence of the deployed air bag. The driver was transported by ambulance to a local hospital where he was evaluated and released without injury.

CRASH DIAGRAM



POST-IMPACT GUARDRAIL DIAGRAM



APPENDIX A:

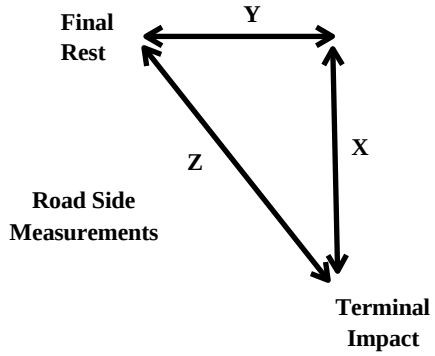
FEDERAL HIGHWAY ADMINISTRATION GUARDRAIL FORMS

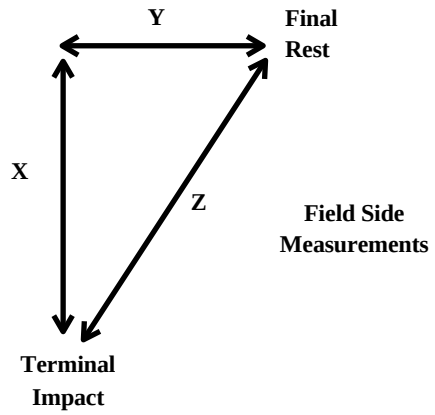
Case No.: CR16038

PREPOPULATED DATA (BY OTHERS)			
Date of Crash	November 2016	**Time of Crash (Military)**	Daytime
Case Number	CR16038	**State**	PA
Traffic Route	Limited access	**Direction (Southbound = SB)**	EB
Ambient Conditions (at time of crash)			
Temperature (°F)	45°	**Lighting**	Daylight
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)	25 mph (*SCI estimated*)
Est. distance (straight line) from terminal impact to COM final rest position (ft.)	Z = 14.5 ft ☒Road side ❒Field Side
Est. distance (longitudinal) along guardrail from terminal impact to COM final resting location (ft.)	X = 14.1 ft
Est. distance (normal) from either 1. the white paint line; or 2. roadway/shoulder/pavement edge to COM rest position (ft.)	Y = 3.3 ft
Super elevation	☒greater than +2% ❒-2% ❒ NONE or FLAT
Curve Radius (ft.)	285 ft

KEY:
COM - Center of Mass of Vehicle
Distance Measurements





Case No.: CR16038

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	❒AASHTO Type A	❒AASHTO Type B	❒AASHTO Type C	❒AASHTO Type D	❒AASHTO Type E	
	❒Yes	❒AASHTO Type F	❒AASHTO Type G	❒AASHTO Type H			
Curb Height: N/A							

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		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	-	-	-	-	-	-	-	-	-
1	Steel	6 x 6	None	N/A	No	N/A	7 ft 7 in	N/A	6 ft 4 in
2	Steel	6 x 4	None	N/A	No	N/A	7 ft 2 in	N/A	6 ft 2 in

Case No.: CR16038

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		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	Steel	6 x 4	Composite	3.8x7.5x14	No	N/A	7 ft 3 in	N/A	6 ft 4 in
4	Steel	6 x 4	Composite	3.8x7.5x14	No	N/A	7 ft 0 in	N/A	6 ft 4 in
5	Steel	6 x 4	Composite	3.8x7.5x14	No	N/A	6 ft 10 in	N/A	6 ft 4 in
6	-	-	-	-	-	-	-	-	-

Additional Comments:

NONE

Case No.: CR16038

EXTRUDER			
Feeder Channel Width at impact head	❒4inches ❒5 inches ☒Other - 6.5" tapers to 4.5"		
Guide Chute Exit Height (in.)	20 in		
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.)	19.7 ft
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.]	Total = 24.8 ft *[19.7 ft (extruded) + 5.1 ft (within terminal)]*		

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: N/A
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	N/A		

ALL-SYSTEM PERFORMANCE ENVIRONMENT			
SIDESLOPE	**50 ft in advance of Post 1**	**At Post 1**	**50 ft Past Post 1**
Percent - %	3.5%	Level	12%
Adjacent Lane Width (ft)	12.8 ft		
Lane Type (NAS EDS Variable: Sur. Type)	Asphalt		
Shoulder Type	Asphalt		
Shoulder Width (ft)	5.8 ft		
Guardrail Height (in)	28.5 in (*measured between Posts 5 and 6*)		

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VEHICLE INFORMATION		
Vehicle Type (NHTSA Input)	2002 Hyundai Sonata	
Vehicle Identification Number (VIN)	KMHWF35H62Axxxxxx	
Vehicle Mass (NASS var.: veh.wgt)	3,247 lb	
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	N/A	
Collision Deformation Classification	12FLLN1, 12FLEE2	
Delta-V	15-25 mph (Estimated)	
Occupant Compartment Penetration of rail	☒No	❒Yes; Describe: N/A
Did the Vehicle Rollover?	❒Yes ☒No	
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)	N/A	
Rollover Type, Terhune Scale, (NASS EDS variable: rolintyp)	N/A	

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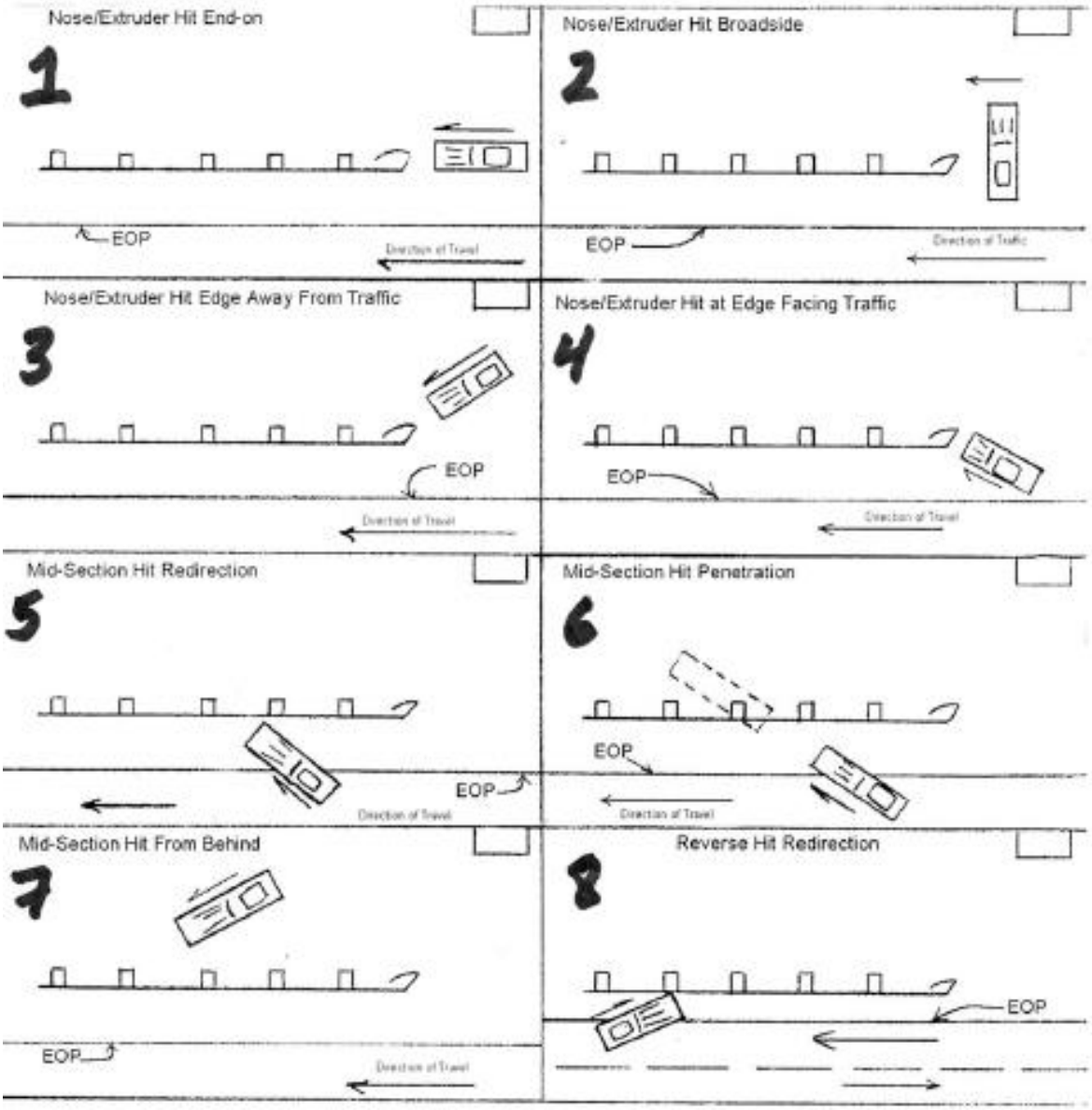

DOT HS 812 733
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**National Highway
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