

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE HEAVY TRUCK REAR IMPACT GUARD CRASH INVESTIGATION
SCI CASE NO.: CA09070**

**VEHICLE: FREIGHTLINER TRACTOR W/ 2009 UTILITY FLATBED TRAILER
LOCATION: NEW JERSEY**

CRASH DATE: OCTOBER, 2009

Contract No. DTNH22-07-C-00043

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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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<i>16. Abstract</i> <p>This on-site investigation focused on the rear impact guard that was installed on a 2009 Utility flatbed trailer that was involved in a front-to-rear crash with a 2006 Ford Taurus. The crash occurred on an interstate highway. The tractor trailer was westbound in the left lane moving at a slow rate of speed. The Ford Taurus was also westbound and was traveling at or near the 105 km/h (65 mph) speed limit. The front plane of the Ford sustained severe impact damage that extended rearward to the front axle location. The unrestrained 52-year-old male driver of the Ford sustained fatal blunt force traumatic injuries and was pronounced deceased at the scene.</p> <p>The crash was identified through an on-line news article by the Calspan Special Crash Investigations (SCI) team on Friday, October 9, 2009. Telephone contact and cooperation with the police investigator was established on Tuesday October 13, 2009 and details of the crash were obtained. Those details were forwarded to the National Highway Traffic Safety Administration (NHTSA) and an on-site investigation of the crash was assigned the same day. The on-site portion of the investigation took place on October 15 and 16, 2009 and involved the inspection and documentation of the involved vehicles with specific focus on the underride guard of the trailer and the frontal crush to the Ford Taurus. The crash site was also documented.</p>			
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LOCATION: NEW JERSEY
CRASH DATE: OCTOBER, 2009**

BACKGROUND

This on-site investigation focused on the rear impact guard that was installed on a 2009 Utility flatbed trailer (**Figure 1**) that was involved in a front-to-rear crash with a 2006 Ford Taurus. The crash occurred on an interstate highway. The tractor trailer was westbound in the left lane moving at a slow rate of speed. The Ford Taurus was also westbound and was traveling at or near the 105 km/h (65 mph) speed limit. The front plane of the Ford sustained severe impact damage that extended rearward to the front axle location. The unrestrained 52-year-old male driver of the Ford sustained fatal blunt force traumatic injuries and was pronounced deceased at the scene.



Figure 1: Rear oblique view of the Utility trailer and the deformed rear impact guard.

The crash was identified through an on-line news article by the Calspan Special Crash Investigations (SCI) team on Friday, October 9, 2009. Telephone contact and cooperation with the police investigator was established on Tuesday October 13, 2009 and details of the crash were obtained. Those details were forwarded to the National Highway Traffic Safety Administration (NHTSA) and an on-site investigation of the crash was assigned the same day. The on-site portion of the investigation took place on October 15 and 16, 2009 and involved the inspection and documentation of the involved vehicles with specific focus on the underride guard of the trailer and the frontal crush to the Ford Taurus. The crash site was also documented.

SUMMARY

VEHICLE DATA

Freightliner Tractor/2009 Utility Flatbed Trailer

The struck vehicle in this investigation was a dual-axle, flatbed trailer manufactured by the Utility Trailer Manufacturing Company in January 2009. The trailer was identified by the Vehicle Identification Number (VIN): 1UYFS248X9A (production sequence deleted) and was being pulled by a 2003 Freightliner tractor. At the time of the crash, the tractor trailer was hauling trash from New York to Ohio and was operating in the left center lane at an unknown slow speed. The gross weight of the tractor trailer combination was approximately 31,752 kg (70,000 lb).

The Utility flatbed trailer (**Figure 2**) was 14.6 m (48 ft) in length, 257 cm (101 in) in width, and had a measured (loaded) deck height of 127 cm (49.8 in). The trailer was manufactured with a steel frame, oak decking and was configured with a spread dual-axle rear suspension. The distance between the axles measured 3 m (10 ft). The trailer's rear overhang (distance from the center of the rear most axle to the back plane) measured 0.7 m (2.3 ft). The longitudinal frame rails of the trailer were constructed from 41 x 10 cm (16 x 4 in) steel I-beams. The thickness of the beams measured 13 mm (0.5 in). The width between the frame rails of the trailer measured 112 cm (44 in).



Figure 2: Front right oblique view of the trailer.

The rear impact guard (**Figure 3**) was constructed by the Utility Trailer Manufacturing Company in January 2008. A manufacturer's label was attached to the forward aspect of the guard. The guard was a steel weldment that was joined directly to the ends of the trailer's longitudinal frame rails. The two vertical support sections of the guard were comprised of 41 cm x 10 cm (16 in x 4 in), length by width, plates welded to the frame rails. Each vertical support was reinforced by a tapered I-beam section that formed a gusset welded to the lower surface of the frame rail. **Figure 4** is a left lateral view of the inboard aspect of the right vertical support gusset. The I-beam gusset measured 28 cm x 10 cm (11 in x 4 in), width by depth, and tapered to 10 cm (4 in) in depth over a length of 20 cm (8 in). The thickness of the material measured 13 mm (0.5 in). The lower end of each I-beam gusset was welded to a horizontal box-beam bumper that measured 244 cm (96 in) in length. The box-beam was comprised of a U-shaped channel that was welded closed into a rectangular cross-section by a steel plate. The beam measured 10 cm x 11 cm (4 in x 4.3 in), width by height. The height (above the ground) of the bumper's top surface measured 50 cm (20 in). **Figure 5** is a diagram of the trailer depicting the pre-crash configuration of the rear impact guard (end-view and side-view).



Figure 3: Rear view of the center aspect of the deformed rear impact guard.

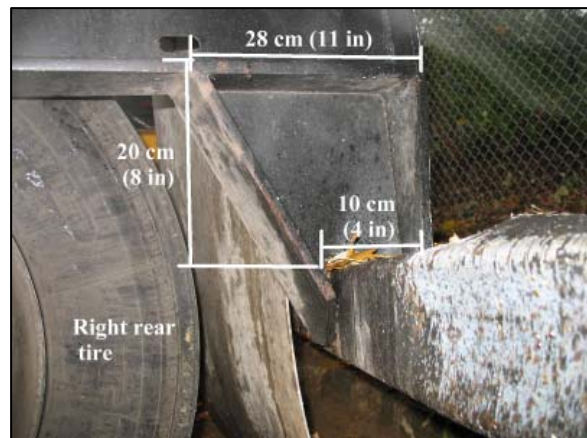


Figure 4: Lateral view of the inboard aspect of the right vertical support.

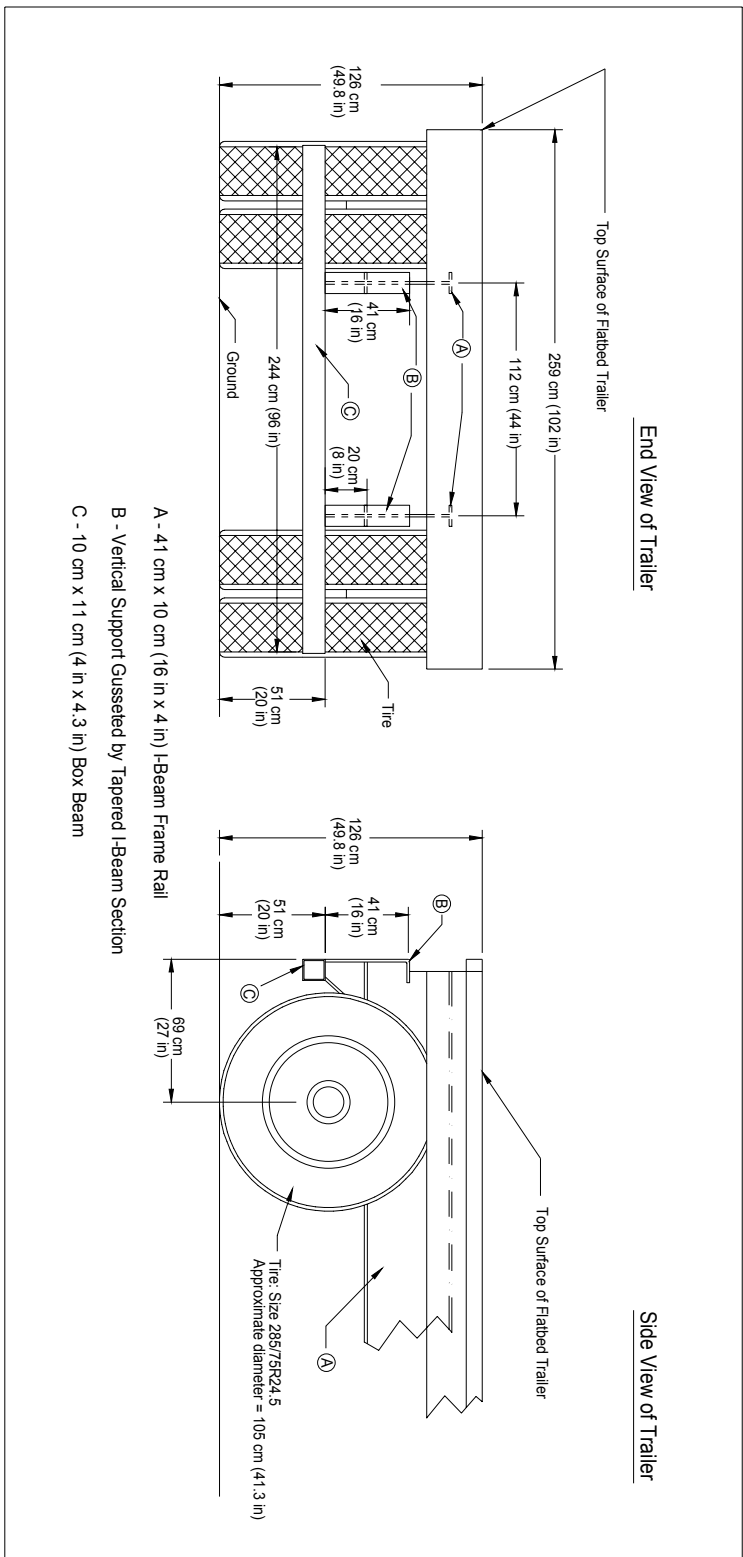


Figure 5: Schematic of the pre-crash configuration of the rear impact guard.

2006 Ford Taurus

The 2006 Ford Taurus was manufactured in December 2005 and was identified by the VIN: 1FAFP53U86A (production sequence deleted). The 4-door, front-wheel drive sedan was equipped with the SE level trim package and was powered by a 3.0-liter, V6 engine linked to a 4-speed automatic transmission. The brakes were a front disc/rear drum system. The vehicle was equipped with manual 3-point lap and shoulder safety belts in the outboard positions of the front row and in all three second row seat positions. The front safety belts were equipped with buckle pretensioners. The front row center position consisted of a flip and fold center console that was equipped with a lap belt. The air bag system consisted of Certified Advanced 208-Compliant (CAC) air bags for the driver and front right passenger positions. The driver air bag deployed as a result of the crash. The deployment of the front right air bag was suppressed due to the unoccupied status of the front right seat. The Ford was not equipped with side impact air bags. The vehicle did not have Event Data Recorder (EDR) compatible with the Bosch Crash Data Retrieval scan tool. The tires were Kelly Navigator P215/60R16 mounted on OEM alloy rims. The tires were the size recommended by the vehicle manufacturer. The recommended cold tire pressure was 207 kPa (30 PSI) front and rear. The specific measured tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Tread Depth	Restricted	Damage
LF	Tire flat	4 mm (5/32 in)	Yes	Side wall cut
LR	Tire flat	2 mm (3/32 in)	No	None
RF	165 kPa (24 PSI)	4 mm (5/32 in)	Yes	None
RR	159 kPa (23 PSI)	2 mm (3/32 in)	No	None

CRASH SITE

The crash occurred during the morning hours of October 2009 on the westbound lanes of an interstate highway in a rural setting. At the time of the crash, it was dark and the weather was not a factor. The westbound interstate highway was comprised of five 3.7 m (12 ft) wide lanes and had a large radius right curve. In the vicinity of the crash site, the highway had a positive grade of 3.8 percent. The impact occurred in lane 2 (second lane from the left). The speed limit in the area of the crash was 105 km/h (65 mph). **Figure 6** is a westbound trajectory view approaching the area of the crash. A schematic of the crash is attached to the end of this report as **Figure 15**.



Figure 6: Westbound trajectory view approaching the area of the crash.

CRASH SEQUENCE

Pre-Crash

The tractor trailer was westbound driven by a 51-year-old male. Approximately 1.6 km (1 mile) east of the crash site, the tractor trailer driver stopped on the left side of the interstate, at a

median crossover, to ask directions from a stopped New Jersey State Trooper. He re-entered the tractor and continued his westbound travel in the lane 2. There was a positive grade and the tractor was operating at an unknown speed below the interstate speed limit. The 2006 Ford Taurus was driven by a 52-year-old unrestrained male. The unrestrained driver was operating the vehicle west and was approaching the slower moving tractor trailer.

Crash

The front plane of the Ford struck the rear impact guard attached to the back plane of the trailer. The impact was biased to the left of the trailer. The centerline of the Ford was offset 23 cm (9 in) to the left of the trailer's centerline. The force of the impact deformed the center aspect of the horizontal box-beam bumper into a U-shaped pattern. The Ford pitched down and underrode the box-beam bumper. The left uni-body frame rail of the Ford struck the left rear trailer tires and crushed rearward. The rim of the inboard dual tire was deformed and the tire aired out. The right uni-body frame rail underrode the center of the rear impact guard. There was no longitudinal deformation of the right frame rail. The Ford's structure and components above the level of the right frame crushed rearward. The vertical supports of the rear impact guard sustained minimal deformation. The force of the impact caused the driver CAC air bag to deploy.

The severity of the crash (delta-V) was calculated utilizing the Barrier Algorithm of the WinSMASH program. The Barrier Equivalent Speed was 55.0 km/h (34.2 mph). This calculated value under-estimated the severity of the impact due to the rigid barrier assumptions of the Barrier Algorithm.

Post-Crash

The crash disabled the Ford and the vehicle came to rest facing westbound on the interstate. The left rear quarter of the stopped Ford was then impacted by two other westbound vehicles in two separate impacts.

The tractor trailer continued travelling westbound an unknown distance and then stopped. The driver of a New Jersey Department of Transportation (NJDOT) "Help" Truck observed the slow-moving tractor trailer stop on the interstate. The NJDOT driver positioned his truck behind the stopped tractor trailer and activated his flashers to alert any approaching traffic to the hazard. The driver of the tractor trailer exited his vehicle, examined the rear damage, and reportedly tried to leave the scene. The tractor trailer was detained by the NJDOT driver until the arrival of the police. Ambulance personnel also responded to the crash site.

The driver of the Ford was pronounced deceased at the scene. He sustained blunt force thoracic trauma due to his unrestrained contact with the steering column and forward interior. The tractor trailer driver was not injured.

EXTERIOR DAMAGE

2009 Utility Flatbed Trailer

The trailer's rear impact guard sustained moderate damage as a result of the impact. **Figure 7** is a left oblique view of the rear impact guard. **Figure 8** is an overhead view of the deformation of

the center aspect of the guard. The direct contact began at the rear impact guard's right vertical support and extended 160 cm (63 in) to the left across the bumper's unsupported center section, the left vertical support and the left outboard aspect of the bumper. A reference line parallel to the rear plane of the trailer was established and a profile of the deformed horizontal box-beam bumper was measured. The bumper deformed in a U-shaped pattern. The bumper was not deformed outside the region of direct contact; rather the bumper deflected rearward outboard of the vertical supports resulting in a negative deflection value at the C1, C5 and C6 locations. The measurement protocol requires that these negative crush values are listed as zero. The residual profile of the bumper was as follows: C1 = 0, C2 = 3 cm (1.0 in), C3 = 15 cm (5.9 in), C4 = 16 cm (6.3 in), C5 = 0, C6 = 0. The maximum deflection measured 24 cm (9.5 in) and was located 7 cm (2.9 in) right of the centerline. Additional measurements relative to the reference line were taken at the welded junction of the bumper and each vertical support. The forward deflection of the left vertical support measured 2 cm (0.8 in). The forward deflection of the right vertical support measured 3 cm (1.1 in). These deflections resulted from minor bending and torsion of the vertical tapered I-beam sections.



Figure 7: Left rear oblique view of the rear impact guard.



Figure 8: Overhead view of the deformation of the center aspect of the guard.

Figure 9 is an oblique view of the inner left rear dual tire. The left aspect of the Ford's front structure impacted the tire and rim resulting in deformation to the wheel rim. The inboard left rear tire was aired out. There did not appear to be any damage to the components of the left rear suspension. The trailer forward aspects of the trailer and the tractor were not damaged.



Figure 9: View of the deformed inboard left rear wheel rim.

2006 Ford Taurus

The Ford Taurus sustained severe frontal damage as a result of the underride crash. **Figure 10** is the front view of the Ford. The imprint of the trailer's left vertical support was observed on the left aspect of the deformed hood. **Figures 11 and 12** are the left and right lateral views of the Ford, respectively. The direct contact damage sustained by the Ford extended across the entire 168 cm (66 in) end-width. The left aspect of the bumper fascia was fractured and the entire cover had separated from the vehicle. The left end of the bumper reinforcement beam had separated from the frame. The outboard 22 cm (8.5 in) of the beam exhibited direct impact damage; the remainder of the beam was not damaged. The left uni-body frame rail was crushed rearward 53 cm (20.8 in) from contact with the left rear wheel/tire of the trailer. The right frame rail underrode the center aspect of the rear impact guard and was not damaged. The components and vehicle structure above the level of the right frame rail sheared away from the frame and crushed rearward. Crush profiles were measured along the leading edge of the hood and along the lower engine cradle to document the extent of damage to the Ford. The average of these profiles was used as input values into the WinSMASH model in order to determine the severity of the crash. The average crush was as follows: C1 = 63 cm (24.8 in), C2 = 44 cm (17.3 in), C3 = 44 cm (17.3 in), C4 = 37 cm (14.6 in), C5 = 34 cm (13.4 in), C6 = 36 cm (14.2 in). The maximum crush (not averaged) measured 73 cm (28.7 in) and was located at the left front corner of the hood. The left front tire/wheel was crushed rearward into the aft aspect of the wheelhouse at the lower A-pillar. The left wheelbase was reduced 18 cm (7.0 in). The right wheelbase dimension was unchanged. The lower aspect of the windshield was fractured by the rearward crush of the hood. The front left door was opened by extrication and would not close due to body deformation. The rear left and both right doors remained closed during the crash and were operational at the time of the SCI inspection. The front left, rear left, and front right glazing was disintegrated. The right rear and backlight glazing were intact. The Collision Deformation Classification (CDC) was 12FDEW3.



Figure 10: Front view of the Ford.

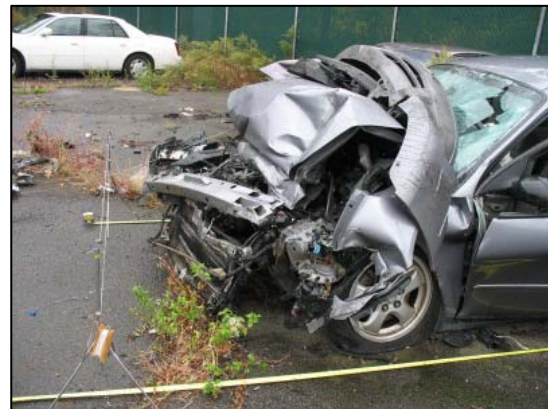


Figure 11: Left lateral view of the extent of crush to the Ford.



Figure 12: Right lateral view of the extent of crush.

INTERIOR DAMAGE

2006 Ford Taurus

The interior damage to the Ford consisted of minor intrusion of the instrument panel and toe pan, multiple points of interior occupant contact from the unrestrained driver, and the deployment of the CAC driver air bag. The documented intrusion of the Ford is listed in the following table. The magnitude was uniform across the width of the vehicle.

Position	Component	Magnitude	Direction
Row 1 Left	Instrument Panel	5 cm (2.0 in)	Longitudinal
Row 1 Center	Instrument Panel	4 cm (1.5 in)	Longitudinal
Row 1 Right	Instrument Panel	5 cm (2.0 in)	Longitudinal
Row 1 Left	Toe Pan	11 cm (4.2 in)	Longitudinal
Row 1 Right	Toe Pan	11 cm (4.5 in)	Longitudinal

The steering column rotated upward and the four-spoke steering wheel rim was deformed forward as a result of loading from the unrestrained driver, (**Figure 13**). The steering column had rotated vertically 50 degrees. The right (inboard) steering column shear capsule completely fractured and released from the instrument panel. The upper sector of the steering wheel rim penetrated and holed the windshield. The hole measured 56 cm x 48 cm (22 in x 19 in). The upper rim protruded approximately 5 cm (2 in) beyond the plane of the laminate. The lower sector of the steering wheel rim was deformed 9 cm (3.5 in).



Figure 13: View of the steering assembly deformation.

The driver seat was located in a full-rear track position. The seat back was relined 12 degrees aft of vertical. The head restraint was adjusted 8 cm (3 in) above full-down. The horizontal distance from the seat back to the driver air bag module measured (33.5 in). This distance was measured 61 cm (24.0 in) above the seat bight. Exemplar vehicle measurements indicate the horizontal distance from the seat back to the center of the steering wheel rim increased 13 cm (5.0 in) as a result of the driver loading.

Figure 14 is a view depicting the driver's interior contacts. The driver's lower extremities contacted the bolster panel evidenced by deformation to the metal structure of the lower instrument panel. The left lower extremity contact was located 25 cm (10 in) left of the steering column and 53 cm (21 in) above the floor. The contact was approximately 15 cm (6 in) in width and 18 cm (7 in) in depth. The right lower extremity contact was located 25 cm (10 in) right of



Figure 14: View of the driver interior contacts.

the steering column and 56 cm (22 in) above the floor. The depth of this contact measured 14 cm (5.5 in). The base of the steering column exhibited scuffing contact from interaction with the driver's abdomen and pelvis. The scuffed area measured 10 cm x 13 cm (4 in x 5 in) and extended downward onto the bolster panel. A 10 cm (4 in) diameter area of body fluid was located on headliner 53 cm (21 in) right of the side rail and 28 cm (11 in) rear of the windshield header. An 8 cm (3 in) wide region of spatter extended rearward from this contact to the dome light.

MANUAL RESTRAINT SYSTEMS

2006 Ford Taurus

The driver's manual restraint system consisted of continuous loop webbing, a sliding latch plate, an adjustable D-ring, a buckle pretensioner, and an Emergency Locking Retractor (ELR). At initial inspection, the webbing was stowed on the retractor and the retractor was operational. Examination of the webbing and latch plate was unremarkable for crash related evidence of use. The D-ring was adjusted to a mid-position and was not abraded. The buckle pretensioner did not actuate in the crash. Base on the observations of the SCI interior inspection, it was determined that the driver was unrestrained at the time of the crash.

AIR BAG SYSTEM

2006 Ford Taurus

The frontal air bag system in the Ford consisted of dual-stage CAC air bags for the driver and front right passenger. The vehicle manufacturer has certified that the frontal air bags in the Ford Taurus were compliant with the advanced air bag requirements of the Federal Motor Vehicle Safety Standard No. 208. The driver air bag deployed from its module that was located in the center hub of the steering wheel rim as a result of the underride impact. The H-configuration module cover flaps were asymmetrical. The upper flap was rectangular and measured 21 cm x 6 cm (8.2 in x 2.5 in). The semi-circular lower flap measured 21 cm x 10 cm (8.2 in x 4.0 in). There was no occupant contact to the cover flaps. The deployed driver air bag measured 56 cm (22 in) in its deflated state. It was tethered by two straps and vented by two ports in the 1 and 11 o'clock sectors. Multiple small spatters of post-crash body fluid were noted on the face of the air bag. A 3 cm (1 in) cut of the air bag fabric was located on the face of the air bag in the 11 o'clock sector. A 10 cm (4 in) fabric cut was located on the back side of the bag in the 10 o'clock sector.

The deployment of the front right passenger air was suppressed due to the unoccupied status of the front right passenger seat.

OCCUPANT DEMOGRAPHICS

2003 Freightliner Tractor

	Driver
Age/Sex:	51-year-old / Male
Height:	Unknown
Weight:	Unknown
Injury:	None

2006 Ford Taurus

	Driver
Age/Sex:	52-year-old / Male
Height:	178 cm (70 in) estimated by police investigator
Weight:	136 kg (300 lb) estimated by police investigator
Seat Track Position:	Full-rear track
Safety Belt Usage:	Unrestrained
Usage Source:	SCI vehicle inspection
Egress from Vehicle:	Removed by first responders
Type of Medical Treatment:	None, deceased at the scene

DRIVER INJURIES

2006 Ford Taurus

<i>Injury</i>	<i>Injury Severity (AIS 90/Update 98)</i>	<i>Injury Source</i>
Blunt force chest trauma	Unknown (415099.7,0)	Steering Assembly (probable)

Source: Police report

DRIVER KINEMATICS

2006 Ford Taurus

The 52-year-old driver was seated in a full-rear track position and was unrestrained. At impact, the driver air bag deployed. The driver initiated a forward trajectory in response to the 12 o'clock direction of the impact force. The driver contacted the deployed air bag with his head and chest and loaded through the air bag due to his unrestrained condition. The driver's lower extremities contacted and loaded the knee bolster and lower instrument panel.

The driver's chest and abdomen loading of the steering column and steering wheel rim displaced those components forward. The right shear capsule fractured and the steering column rotated to a near vertical position. The driver came into greater contact with the base of the column and steering wheel rim, as evidenced by the identified scuffs at the base of the column and the deformation of the lower sector of the rim. During the rebound phase, the driver responded with an upward and rearward pattern. His head contacted the headliner evidenced by the large circular region of body fluid and spatter directed rearward toward the dome light. He then rebounded rearward into his seat and came to rest where he expired.

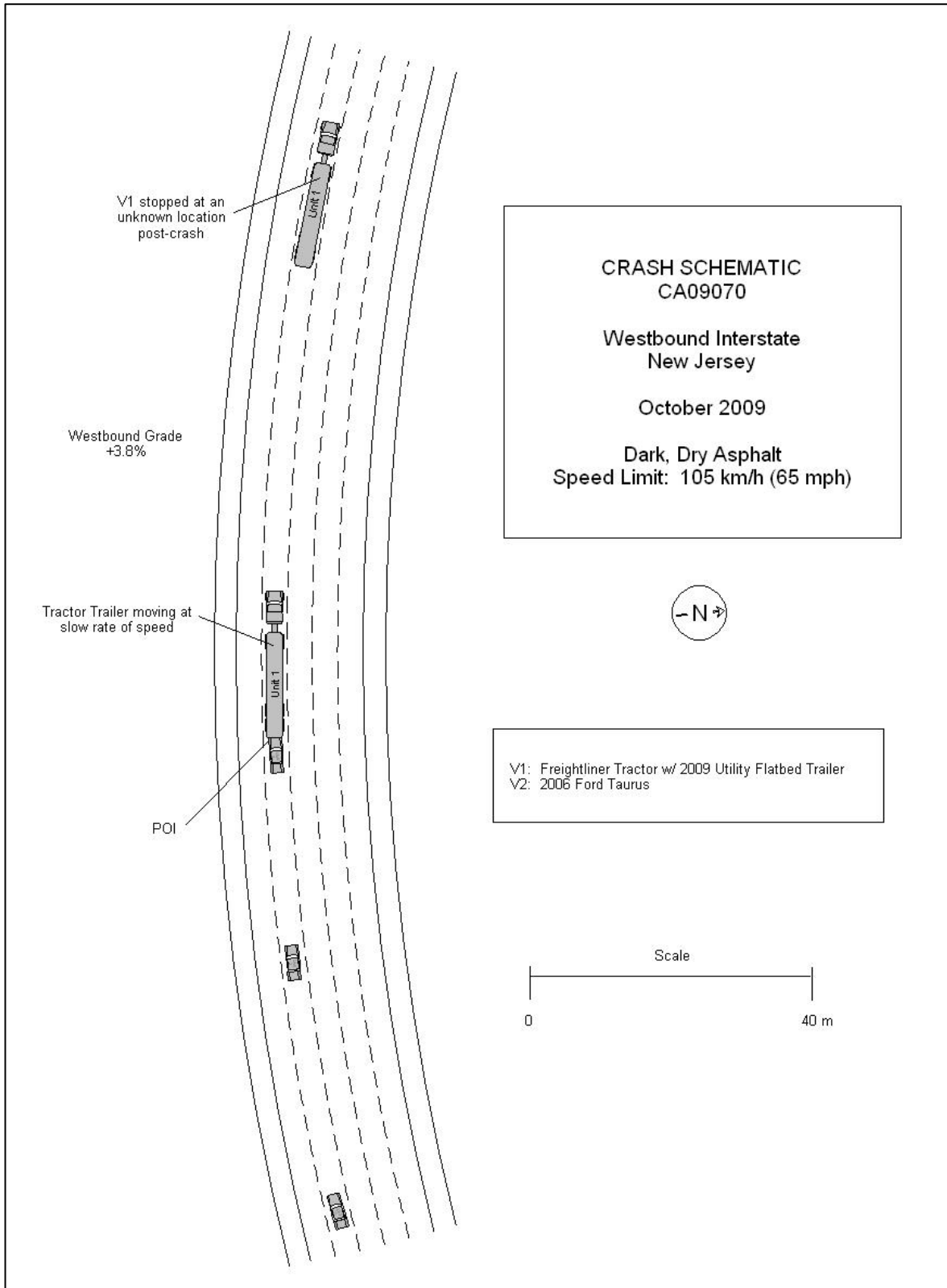


Figure 15: Crash schematic.