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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 side impact crash of a 54-passenger 2012 IC Corporation CE-300 school bus that resulted in the fatality of a belted 10-year-old female student and an unbelted 51-year-old female teacher. At the time of the crash, 38 students and 7 adults, including the belted 77-year-old male driver, occupied the bus and were traveling on a field trip during their school day. The school bus had missed a turn along the route, and the driver was re-routing the bus's travel when the crash occurred. The school bus entered the westbound lanes of a three-lane divided interstate highway and immediately initiated a left turn across the travel lanes toward a median crossover. During this maneuver, the school bus was struck on its left plane, near the rear axle, by the front of a loaded 2013 Kenworth heavy-duty dump truck. The bus then rotated roughly 200 degrees counterclockwise off the roadway and struck a guardrail system with its left plane, as the body of the bus separated from the frame and tipped over. The school bus was equipped with a 3-point lap and shoulder seat belt for the driver and with color-coded lap belts for all 54 passenger positions. After investigation into what was deemed an illegal U-turn, the driver pleaded guilty to two counts of reckless vehicular homicide, five counts of assault by auto, and endangering the welfare of children. He was sentenced to 10 years in prison, according to media reports.

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Background

This report documents the side impact crash of a 54-passenger 2012 IC Corporation CE-300 school bus (Figure 1) that resulted in the fatality of a belted 10-year-old female student and an unbelted 51-year-old female teacher. At the time of the crash, 38 students and 7 adults, including the belted 77-year-old male driver, occupied the bus on a field trip during their school day. The school bus had missed a turn along the route, and the driver was re-routing the bus's travel when the crash occurred. The school bus entered the westbound lanes of a three-lane, divided interstate highway and immediately began a left turn across the travel lanes toward a median crossover. During this maneuver, the school bus was struck on its left plane near the rear axle by the front of a loaded 2013 Kenworth heavy-duty dump truck. The bus then rotated approximately 200 degrees counterclockwise off the roadway and struck a guardrail with its left plane. The body of the bus separated from the chassis and tipped over. The school bus had a 3-point lap and shoulder seat belt for the driver and color-coded lap belts for all 54 passenger positions.

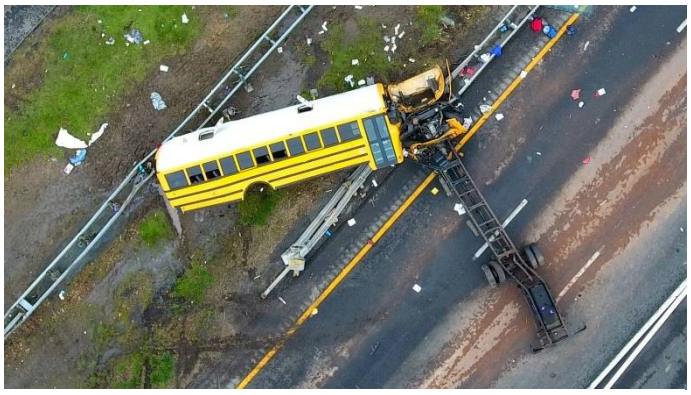


Figure 1. Overhead view of the crashed school bus (Andre Malok/NJ Advance Media via AP)

The crash was identified by the National Highway Traffic Safety Administration through news media reports in May 2018. Further research was requested, and the notification was forwarded to the Special Crash Investigations group, which assigned an on-site investigation to the SCI team at Crash Research & Analysis, Inc., the same day. The SCI team contacted the investigating law enforcement agency and obtained cooperation for an onsite inspection that occurred in May 2018. The on-site portion of this investigation included a detailed examination of the school bus to document its interior and exterior damage, to assess its manual restraint systems, and to determine related areas of occupant contact and sources of occupant injury. An exterior inspection of the involved truck was also conducted. The crash site was examined and documented using photographs and a total station mapping system.

Crash information and pertinent documentation was requested from the investigating law enforcement agency and the county prosecutor's office. After investigation, the driver of the school bus pleaded guilty to 2 counts of reckless vehicular homicide, 2 counts of reckless vehicular homicide, 5 counts of assault by auto and endangering the welfare of children. He was sentenced to 10 years in prison, according to media reports. Prosecutors agreed to dismiss 20 additional charges of assault by auto in exchange for the plea agreement.

Due to the complex criminal nature of this case and the many child victims, the county prosecutor only released redacted copies of the official records, preventing the identification of the student passengers. Autopsy reports were obtained for the two fatally injured passengers. Of the 44 passengers, 24 students sustained serious bodily injuries, and 12 sustained reported injuries that involved soft tissue, a nasal fracture, and possible head injuries. Two students were not injured.

School District, Students, and Employees

The New Jersey municipal school district had a total student population of roughly 3,800 students and provided daily transportation of roughly 2,800 students. The district operated a fleet of 21 buses, vans, and 4-door sedans. The involved school bus, an IC Corporation CE-300, was purchased new in 2012 along with two other similar model buses. The bus passed an annual safety inspection in December 2017 and had a routine maintenance in March 2018.

The 77-year-old driver held a current and valid commercial driver's license. He had been employed as a custodian and then became a part-time/substitute school bus driver in 2013. In 2016, he became a contract driver. He was employed as a full-time driver eligible for 5 hours of driving per day on a split-shift basis. He completed two bus runs in the morning and two runs in the afternoon, transporting elementary and high school students. The driver had been assigned to the involved school bus for roughly 2 years and was responsible for cleanliness on the bus and reporting issues associated with safety and maintenance. He completed video training for harassment in the workplace and blood-borne pathogens. This calendar year, this driver completed two driving-specific training videos pertaining to school bus evacuation drills and defensive driving.

On this particular field trip, the driver was required to sign up for the trip based on seniority and availability. He was one of the three drivers providing transport to this annual destination for middle-school students on the day of the crash. He was not the lead driver and was positioned as the second driver in the three-bus caravan. The buses were not equipped with GPS navigation systems, nor did the school district provide these units to the drivers. Some drivers used their own personal GPS devices or used navigation apps on their cell phones. On this trip, this driver did not have any GPS navigation assistance. The lead driver of the three-bus caravan knew the directions to the field trip location and communicated with the other two drivers via the onboard CB radios.

Thirty-eight 5th grade middle school students (age 10–11), six adults, and the driver were aboard the school bus at the time of the crash. The six adults were all school teachers or classroom aids. A seating chart for the passengers was obtained and is included in this report (identifying information redacted). The 51-year-old female teacher ejected in the crash was seated on the right side aisle seat of row 11. She was not restrained by the manual lap belt. The fatally injured belted 10-year-old female was seated on the right side window seat of row 8.

Summary

Crash Site

The crash occurred in the westbound lanes of a divided, limited-access roadway during the morning hours (Figure 2). In the vicinity of the crash was an interchange where an entrance ramp merged into the westbound lanes from the north. A median crossover was located immediately south of the end of the gore of the entrance ramp. Weather conditions in the suburban locale as reported by the National Weather Service included clear skies with a temperature of 28ºC (82ºF), a 66-percent relative humidity, and a 32 km/h (20 mph) easterly wind. The police crash report listed the environmental conditions as daylight, cloudy, and wet.

The entrance ramp to the limited access roadway was a single 4.9 m (16.1 ft) wide travel lane, with a single solid yellow left lane line and a single solid white right lane line. There were no shoulders along the entrance ramp. The travel lanes for the east/west interstate roadway were divided by a 16.0 m (52.5 ft) wide depressed grass median. The westbound portion of the roadway had three lanes; the left (inboard), center, and right (outboard) travel lanes were all 3.8 m (12.5 ft) wide. Single broken white lines, a single solid yellow median line, and a single solid white fog line delineated the travel lanes. A narrow 1.4 m (4.6 ft) shoulder supported the left lane, while a 3.7 m (12.1 ft) shoulder supported the right lane. In the area of the crash was an 11.2 m (36.7 ft) wide crossover that bisected the median. The crossover was provided for emergency vehicle use with signage indicating no turns. All roadway and shoulder surfaces were asphalt. Speed was regulated by a posted limit of 105 km/h (65 mph). Figure 3 shows a west-facing view of the limited access roadway for the Kenworth truck's pre-crash travel trajectory. A crash diagram is included at the end of this report.

Figure 2. East-facing view of the crash site on the westbound lanes of the interstate (image taken from an overpass located immediately west of the area of impact)

Figure 3. Westbound pre-crash trajectory view of the Kenworth (image obtained as a screen capture from an SCI GoPro video)

Pre-Crash

This crash occurred during a middle school field trip as three school buses transported students and adults to a historical destination approximately 72 km (45 miles) from the school. In addition to the driver, thirty-eight 5th-grade students and six adults occupied the school bus. The trip

route involved approximately 64 km (40 miles) of travel along an interstate highway and 8 km (5 miles) of State and local roadways. After the caravan of buses exited the interstate, two buses missed a turn from a State roadway onto a local roadway that would have taken them toward their destination. This required the two buses to reroute their trip. The third bus continued heading for the destination.

During the process of being rerouted, although the drivers of the two buses were in communication with each other, they missed the turn onto the local roadway a second time and became separated. The driver of the bus involved in the crash stopped his bus in a painted gore area on the state roadway, as the leading bus rerouted itself and turned around. When interviewed by law enforcement investigators, the driver stated that while he was stopped (facing east), he saw the lead bus heading west, back toward him, and he believed that by traveling forward he would loop around and be following the rerouted travel path of that lead bus.

As the bus traveled forward on the three-lane State roadway, the roadway diverged in a Y-configuration (Figure 4). The school bus took the right lane that served as an entrance ramp onto the interstate. Two overhead signs along the school bus's path declared that the right lane led onto the westbound interstate highway. The ramp was approximately 285 m (935 ft) long, curved right with a heading change of 80 degrees, and had a positive grade to meet the interstate. As the school bus continued along the ramp toward its merge point with the westbound lanes (Figure 5), a raised, triangular concrete gore extended from the roadside grass. A road sign declaring "No Turns" was located at the gore. For undetermined reasons, the driver of the school bus turned left at the end of the concrete gore and headed toward the median crossover. During post-crash inspection, it was observed that the speedometer was stuck at 27 km/h (17 mph). This value was consistent with the speed of a school bus executing a 90-degree turn, based on SCI experience.

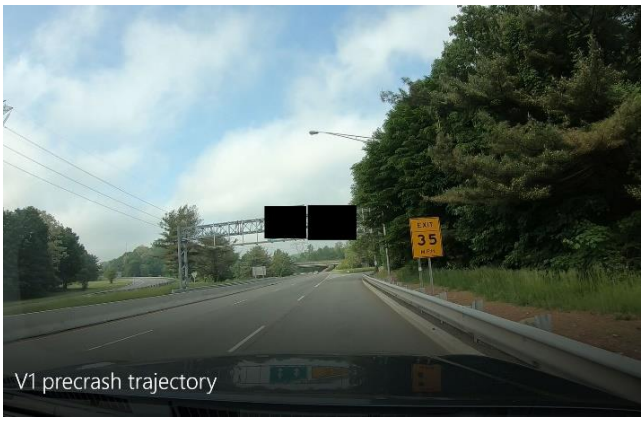


Figure 4. Pre-crash trajectory of the school bus at the entry point for the westbound interstate entrance ramp (image obtained as a screen capture from an SCI GoPro video)

Figure 5. West-facing view of the entrance ramp to the limited access roadway for the pre-crash travel trajectory of the school bus

The Kenworth was westbound in the center lane of the interstate traveling at a speed of 109 km/h (68 mph), and the brakes were "on" at impact. These values were recorded by the bus's engine control module. The bus's engine control modules were removed by the investigating law

enforcement agency and imaged post-inspection by the manufacturer. The above results were shared verbally with SCI. A commercial vehicle inspection conducted by the police determined that there were no violations. The Kenworth dump truck was loaded at the time of the crash with soil and weighed 35,398 kg (78,050 lb). No pre-crash tire marks were observed at the scene related to the truck's trajectory.

Crash

The school bus was crossing the westbound lanes in a near-perpendicular orientation at impact (Event 1). The forward aspect of the school bus was just entering the median crossover and due to its overall length, the aft aspect of the vehicle was in the center lane. Without the time and distance to avoid the bus, the front plane of the Kenworth struck the left plane of the school bus (Figure 6) at an impact speed of 109 km/h (68 mph). The centerline of the Kenworth was located roughly 56 cm (22.0 in) aft of the school bus's rear axle at impact.

Figure 6. Left side view of the school bus body showing the location of the deformation and locations of the impacts (Events 1, 2, and 3)

The impact energy and momentum of the Kenworth engaging the school bus aft of its center of gravity caused the school bus to rotate violently counterclockwise as it was displaced west by the impact force. The school bus rotated counterclockwise roughly 260 degrees over an approximate distance of 23 m (75 ft), and the lower left A- to B-pillar area of the bus body struck and rode over a guardrail located in the median (Event 2).

The force of the initial impact and subsequent deformation of the bus's ladder frame caused a separation of the school bus body from the chassis. As the bus body interacted with the guardrail, the frame of the bus continued to rotate and completely separated. The frame rotated back out into the interstate travel lane. Arcing tire marks attributed to the rear axle of the bus were observed in the on-scene news images and denoted the rotating trajectory. At rest, the frame of the bus was located 31.5 m (103.3 ft) west of the area of the initial impact, and it had rotated roughly 360 degrees.

Now separated from the frame (refer to Figure 1, page 1), the school bus body tipped to the left as it interacted with the median guardrail. The upper rear aspect of the left plane contacted a

second guardrail located in the median and came to rest. At rest, the bus body was tipped approximately 60 degrees to the left, in contact with the south-most guardrail.

The Kenworth continued westward from the initial impact, and based on a spill pattern of the truck's load that was observed in the on-scene news photos, the trajectory of the Kenworth was directed roughly 5 degrees to the right of the roadway's heading. The Kenworth continued to the west and began an arcing counterclockwise trajectory due to the damage sustained at the left front axle. The truck engaged the guardrail located in the center median with its left plane roughly 122 m (400 ft) from the initial impact and then came to an uncontrolled stop facing west in the left lane roughly 160 m (525 ft) from the impact.

Post-Crash

Professional and emergency services responded to the crash site. The interstate was closed, and traffic was rerouted during the protracted rescue efforts. At the initial impact, an unbelted 51-year-old female teacher was ejected through the left rearmost window of the school bus onto the road surface. She was reportedly run over by one or more vehicles and was fatally injured. A belted 10-year-old female seated in row 8 on the right side of the bus in the area of impact was also fatally injured. Due to its orientation at rest, the able-bodied occupants of the school bus exited the bus body through emergency roof exits and the windows along the left plane. The rear exit door was jammed shut. Some passengers were assisted from the bus due to perceived injuries. Of the 46 involved people (including both drivers), 42 sustained injuries that ranged from minor to life-threatening, and 2 people were fatally injured.

2012 IC CE-300 School Bus

Description

The 2012 IC Corporation CE-300 series 54-passenger conventional bus (Figure 7) chassis was manufactured with body-on-ladder frame construction. It was built on May 10, 2012, and was identified by Vehicle Identification Number 4DRBUAAN5CBxxxxxx. IC Corporation is a component of International Navistar.

Figure 7. Right side view of an exemplar 2012 IC CE330 school bus

The overall length of the vehicle was 11.1 m (437.0 in) with a 645 cm (253.9 in) wheelbase. The school bus was powered by a 7.6-liter diesel engine linked to an Allison automatic transmission. The service brakes were air drum brakes at both axles. The gross vehicle weight rating was 18,378 kg (31,000 lb), with gross axle weight ratings of 4,536 kg (10,000 lb) in front and 9,525 kg (21,000 lb) in rear. The school bus manufacturer-recommended tire size was 10Rx22.5 for both axles, with cold tire pressures of 758 kPa (110 PSI) for the front axle and 689 kPa (100 PSI) for the rear axle. At the time of the crash, the school bus was equipped with Goodyear tires of the recommended size at both axles, with Model G661 HSA tires on the steer axle and Model G622 RSD tires on the drive axle. The specific tire data at the time of the SCI inspection are identified in the following table:

Position	Tire Identification Number	Measured Tread Depth	Restricted	Damage
LF	MC3N E50W 3014	2 mm (3/32 in)	No	None
LR Outer	MC3N 620W 3614	4 mm (5/32 in)	No	Outer sidewall cut
LR Inner	MC3N 620W 3614	5 mm (6/32 in)	No	None
RR Outer	MC3N 620W 3614	5 mm (6/32 in)	No	None
RR Inner	MC3N 620W 3614	3 mm (4/32 in)	No	None
RF	MC3N ALOW 1411	3 mm (4/32 in)	No	None

DOT regulations require at least 3 mm (4/32 in) tread on the front tires of a school bus. All other tires must have a tread depth greater than 1 mm (2/32 in).

School Bus Body Exterior

The school bus body was manufactured by Wolfington Body Company and labeled as a MAXX Force DT body with a seating capacity of 54 occupants plus the driver. The school bus body was constructed of riveted aluminum body panels with four equally spaced longitudinal steel rub rails (painted black) that extended from the sill to the beltline. It had two center-closing, vertically hinged doors that were electrically operated. The opened width of the doors was 88 cm (34.6 in). A keyed exterior switch was located forward of the door. This allowed the occupant compartment to be locked and secured while the vehicle was parked. Both steel-framed doors had two tempered glazing panels that were gasket-mounted in the frames. The laminated windshield consisted of a flat, single, glazing panel with two wing-type panels that filled the contour between the windshield and the upper A-pillars. The windshield was gasket-mounted.

The left plane of the school bus contained a double-pane sliding window at the driver's position between the A-pillar and the B-pillar. The occupant compartment was symmetrically configured with 11 windows, one for each seat row. All occupant compartment windows consisted of two panels that were 33 cm (13.0 in) in height, with a sliding upper panel with manual slide locks at the top of the frame and a fixed lower panel. The row 1 and row 11 windows were 83 cm (32.7 in) in width, while rows 2-10 were 60 cm (23.6 in) in width. All glazing was AS2 tempered. Four emergency exit windows were incorporated into the body at left pillars F-G and J-K and right D-E and H-I-pillars. (These windows are addressed in detail in the Emergency Exit section of this report).

A rear right-hinged emergency exit door was configured in the center back plane of the bus body. This 88 cm (34.6 in) wide door was at floor height and was latched closed by handles on both the interior and exterior portions of the body.

The school bus roof was constructed of eight full-width aluminum panels with forward overlap and double-row riveted seams. Centered in the roof were two emergency roof exits located between pillars D and E and J and K. The left plane of the bus body sustained impact damage that was translated to the roof at the aft aspect of the unit. There was no body panel separation and no rivet separation as the entire structure of the body remained intact.

The left plane of the school bus sustained two regions of damage directly related to the events of the crash. The Event 1 direct contact damage resultant to the impact with the Kenworth began at the G-pillar (Figure 8) that was located 66 cm (26.0 in) forward of the rear axle position. The direct contact damage from the G- to H-pillar consisted of red paint transfer and minor deformation. Significant deformation was located between the H-pillar and the L-pillar in the region of direct impact with the front plane of the Kenworth. This area of direct contact extended vertically to the elevation of the top of the windows and wrapped onto the roof. Red paint transfer from the Kenworth was observed on the roof above the K-pillar (Figure 9).

Figure 8. Left side view of the school bus body deformation

Figure 9. Overhead view showing the left plane deformation of the school bus body and red paint transfer on the roof

The crush profile was measured at the sill, beltline, and roof elevations using the total station. The lateral deformation at the beltline was considered the most representative profile of the vehicle to vehicle interaction and was as follows: C1 = 5 cm (2.0 in), C2 = 22 cm (8.7 in), C3 = 46 cm (18.1 in), C4 = 43 cm (16.9 in), C5 = 3 cm (1.2 in), and C6 = 0. The combined width of the direct and induced damage pattern from the G-pillar to the rear plane measured 436 cm (171.7 in). The maximum crush was 61 cm (24.0 in) and was located 89 cm (35.0 in) aft of the rear axle. The maximum lateral crush at the sill measured 70 cm (27.6 in) and was located immediately aft of the wheel opening. The Truck Deformation Classification assigned to this damage pattern was 09LBAW4.

The maximum lateral roof deformation measured 24 cm (9.4 in). The roof deformation was not entirely attributable to the Event 1 impact with the Kenworth. Overlapping damage from the roof's impact to the guardrail after the bus body's separation from the frame (Event 3) was present in the profile.

Figure 10. Left side view of the bus body showing damage attributed to Event 2

A second pattern of contact damage was present on the left plane below the B-pillar. The contact pattern was approximately rectangular and measured 152 cm x 86 cm (59.8 in x 33.9 in). The pattern began 41 cm (16.1 in) rearward of the A-pillar (Figure 10). The damage consisted of body panel abrasions, sheet metal tearing, and paint transfer. The damage was related to the bus body's impact with the northmost guardrail located in the median adjacent to the westbound lanes. The on-scene police investigators observed red paint transfer on the guardrail related to direct contact with the stop sign attached to the bus body. The Truck Deformation Classification assigned to this damage pattern was 09LZEW1.

The ladder frame of the chassis was constructed of two 11 m (36.1 ft) long structural steel C-channels. Each channel measured 25 cm x 7 cm (10.0 in x 3.0 in) with a thickness of x 6 mm (0.25 in). Seven reinforced lateral cross members supported the 88 cm (34.6 in) width of the frame. Inspection of the ladder frame revealed that the structure was deformed in an elongated S-pattern (Figures 11 and 12). The maximum lateral deformation measured 45 cm (17.7 in) and was located 100 cm (39.4 in) aft of the left rear axle position. The force of the impact and subsequent deformation skewed the rear axle with a 4 cm (1.6 in) forward displacement of the left rear axle position and a 7 cm (2.8 in) rearward displacement of the right rear position.

Figure 11. Oblique left side view of the deformation of the ladder frame bus chassis

Figure 12. Forward-looking longitudinal view of the deformed bus ladder frame

Fuel System

The diesel fuel system used a steel fuel tank that was mounted in the frame of the chassis aft of the rear axle in the area of impact. Three lateral straps secured the tank to the frame. The overall dimensions of the fuel tank were 183 cm (72.0 in) in length, 61 cm (24.0 in) in width, and 38 cm (15.0 in) in height. The top of the fuel tank was configured with the sending unit and fuel lines, a 5 cm (1.8 in) diameter gooseneck for the filler tube located 41 cm (16.1 in) aft of the forward edge of the tank and an angled fitting located 28 cm (11.0 in) aft of the referenced edge of the tank for a 2 cm (0.8 in) vent/supply line. The filler tube and vent line were separated from the tank at the level of the gooseneck and fitting. There was no fuel leakage at the crash site. The tow operator stated that the fuel tank was nearly full at the time of the crash and that his company pumped the tank dry prior to towing the school bus from the crash site.

The fuel tank was protected by a fabricated safety cage (Figure 13) constructed of welded 5 cm x 10 cm (2.0 in x 4.0 in) structural steel tubing 5 mm (3/16 in) thick. The cage consisted of three vertical mounts that were bolted to the outer aspects of the frame with three lateral cross members spanning the width of the cage at the bottom aspect and two diagonal supports originating from the left center vertical mount to the right fore and aft vertical mounting supports. The only damage to the cage was minor deformation to the edge of the forward cross member. The overall shape of the cage was not compromised, and the fuel tank was not damaged, having been located in the initial impact zone of the vehicle-to-vehicle crash. The frame at the location of the fuel tank and safety cage was deformed to the right; however, it retained its original 88 cm (34.6 in) width.

Figure 13. Right oblique view of the bus's fuel tank and surrounding safety cage

The fuel fill cap and tube were located on the right plane of the school bus body aft of the rear axle location. The forward-hinged fuel fill door was labeled "Diesel Fuel" and had a mechanical latch. It remained intact and closed.

School Bus Body Interior

The interior of the bus body had a forward-left, standard-positioned driver seat and controls and seating for 54 passengers. The driver's seat was a high-back bucket seat with an integrated head restraint on a suspension base with a fold-down, right-side armrest. The seat frame was adjustable fore and aft with an adjustable (recline) seat back feature. Figure 14 is a forward-looking view of the bus interior from row 6. Figure 15 is a rear-looking view of the bus interior from row 3.

The interior had 11 rows of seats with 10 three-occupant seats on the left side and a two-occupant seat at the left side of row 11. This short 11th row seat accommodated egress through the rear emergency door. The right side of the school bus contained 11 rows of two-occupant seats. The bus used the compartmentalization concept, with closely spaced seat cushions to the forward seat backs and high, fully padded seatbacks.

The seat frames were tubular steel with welded joints. Each seat was mounted to the exterior wall of the bus body with two legs supporting the inboard aspect of the seat, bolted to the floor.

The fully padded seat cushions used a semi-circular clip that engaged the forward frame tube seat. The aft aspect of the seat was friction-fitted against the seat back. A spring-loaded locking pin located on the underside at the inboard aft aspect of the seat cushion secured the cushion to the inboard lateral seat frame. All seat and seat back surfaces were vinyl.

Figure 14. Forward-looking view of the bus interior from row 6

Figure 15. Rear-looking view of the bus interior from row 3

The sidewalls of the interior bus body consisted of unfinished aluminum panels with a 10 cm (3.9 in) padded rail that extended the length of the body, mounted immediately below the window frames. This padded panel had an average of two screw fasteners at its mid-point at each seat row. The thickness of the foam-based padding was 2 cm (0.8 in) and was covered by vinyl. The roof side rails were covered with formed aluminum trim panels that concealed wiring harnesses for interior lights and speakers. The ceiling of the bus consisted of painted aluminum panels. Although the bus body was intruded, its integrity remained intact. There was no tearing or separation of the body panels.

Figure 16. Rear-looking view of the bus interior showing the maximum intrusion at row 8 of the school bus

Figure 17. Forward-looking view along the left interior wall of the bus

The left plane/rear aspect of the school bus's sidewall intruded as a result of the impact (Figures 16 and 17). The intrusion began behind row 6 between the G-pillar and the H-pillar. The sidewall intrusion measured 26 cm (10.3 in), 51 cm (20.0 in), 36 cm (14.3 in), and 6 cm (2.3 in) in rows 7 through 10, respectively. There was no measureable intrusion at row 11. The right sidewall was bowed out at rows 8 and 9 approximately 18 cm (7.1 in). The impact force buckled the floor and caused it to intrude vertically in rows 8 through 10. The magnitude of the intrusion measured 30 cm (11.8 in) at row 8, 15 cm (5.9 in) at row 9, and 7 cm (2.8 in) at row 10.

Glazing

The windshield of the IC school bus was AS1 laminated glass and was gasket-mounted in the body of the bus, with two wing-type windows wrapping to the upper A-pillars. The entire windshield separated from the bus body and was fractured, lying on the roadside.

The driver's side window between the left A-pillar and the B-pillar was a laminated sliding window, whereas the aft panel slid forward in the track. At the time of the SCI inspection, the window was open, and the fixed forward panel was fractured but intact.

The side planes of the school bus had 11 windows along its length. All windows were AS3 tempered glass. Based on the position of the frames, all left side windows were closed at the time of the crash. The lower glazing panels were disintegrated at seat rows 1-3 and row 9. Both glazing panels were fractured at seat rows 7, 8, 10, and 11. The horizontal window frames at left seat row 11 were completely separated as this was the ejection portal for the right row 11 adult occupant. The windows at seat rows 5 and 9 were emergency exit windows and are detailed in the Emergency Exits section of this report. Both left emergency window exits were open at the time of the SCI inspection.

The right plane of the school bus contained the loading door and matching glazing for the 11 seat rows. All four loading door glazing panels remained intact. Of the 11 side windows, 10 windows were closed at the time of the SCI inspection, while the upper window at row 9 was opened 17 cm (6.5 in). Both right emergency row window exits at rows 3 and 7 were open. Right side glazing damage involved disintegration of the lower panels at seat rows 5, 6, 9, and 10.

Emergency Exits

The school bus had seven emergency exits: four window exits, two roof exits, and the rear-door exit. The side window emergency exits were located between pillars F-G and J-K on the left plane and D-E and H-I on the right plane. The side window exits consisted of dual-pane glazing panels in an aluminum frame with an operable upper panel. The upper panel could be opened from top to bottom for ventilation. The egress aspect of the window used a red handle latch at the mid-aspect of the aft pillar. The handle required a forward rotation of 90 degrees to release the locking handle from the latch plate. A forward-mounted hinge allowed the emergency window to open outward from back to front. Overall dimensions of these window exits were 60 cm (23.6 in) horizontally and 66 cm (26.0 in) vertically.

At the time of the SCI inspection, the left window exit between pillars F-G was unlatched and partially opened. Both glazing panels were closed and intact. The aft left window exit (pillars J-

K) was located in the impact zone of the school bus and was found unlatched and opened. The fixed lower glazing panel was disintegrated, while the upper panel remained closed and intact. Both right window emergency exits were unlatched and closed against their pillars. An on-scene image of the school bus body at final rest showed both right-side emergency window exits as closed.

The roof exits were centered in the roof between pillars D-E and J-K. The composite exit panels were square with dimensions of 57 cm (22.4 in). Both were hinged at the forward aspect and opened outward and forward. The roof emergency exits were clearly labeled EMERGENCY EXIT. A lever-type latch mechanism locked and released the exit. A counterclockwise turn of 90 degrees released the locking latch. At the scene of the crash and during the SCI inspection, both emergency roof exits were unlatched and opened. There was no damage to either exit.

The rear emergency exit consisted of a vertically hinged door with an overall height of 140 cm (55.1 in) and a width of 88 cm (34.6 in). The door was hinged at the right plane, with a mechanical latch operable by an interior and exterior lever. In the closed and latched position, the lever was vertically oriented. A directional arrow pointing in the recessed pocket of the latch lever upward indicated the direction to rotate the lever to open the door. Rotating the lever to a horizontal position opened the door. At the time of the SCI inspection, the door was closed and jammed against the left pillar, with the lever latch in the open position.

The rear door contained two tempered glazing panels that were gasket-mounted. Both glazing panels and gaskets were separated from the emergency door and were presumed to have disintegrated from the non-horizontal impact with the median barrier guardrail end treatment.

Bus Radio and Camera System

The bus had a CB radio mounted to the top left aspect of the upper instrument panel. This radio was used by the driver to communicate with other bus drivers and the bus terminal operator on an as-needed basis.

The bus interior had a video surveillance system that consisted of four cameras and an onboard hard drive. The system was secure from driver and student tampering. A forward camera was mounted to the top of the instrument panel directly forward of the driver's position and captured video of the bus's travel path. A second camera was mounted to the left roof side rail area over the driver's seat and recorded video of activity at the right side loading door. A third camera was mounted to the center front bulkhead above the windshield and captured video of the occupant compartment looking rearward. The fourth camera was mounted to the rear bulkhead above the emergency door and was directed forward to capture video of the occupant compartment. The system was powered by the bus's 12-volt battery.

The hard drive was removed by law enforcement prior to the SCI investigation. The police reported that the camera system captured and recorded the pre-crash activities of the field trip. However, the loss of electrical power prevented a recording of any data after the impact.

Manual Restraint Systems

A manual 3-point lap and shoulder seat belt was provided for the driver's position with a fixed height D-ring, B-pillar-mounted emergency locking retractor, and a lightweight locking latch plate. The cable buckle stalk was mounted to the floor of the bus body. The shoulder portion of the webbing was extended at the time of the SCI inspection and had been cut by the first responders in order to assist the driver from the vehicle. The driver was belted at the time of the crash based on the observations of the driver's seat belt system during the inspection.

New Jersey is one of the seven States that require seat belts for all passengers on school buses. The legislation was passed in 1992, requiring all new school buses to have seat belts. The New Jersey law also requires students to wear seat belts. The school district of this involved bus also had a "must wear" seat belt policy. A list of bus rules was posted on the front bulkhead of the involved bus, and the third bullet states: "You Must Wear Seat Belts at All Times." A school district official interviewed by the SCI team during this on-site investigation reinforced the district policy of "must wear" seat belts; however, there is no requirement for the driver to enforce, inspect, or confirm proper adjustment of the seat belts. The State law relieves the driver and the school district of liability from improper adjustment of seat belts. No safety education or drills were offered to students regarding seat belt use.

The involved school bus, manufactured and delivered to the school district, was fully equipped with 2-point adjustable lap belts for the 54 passenger positions. The seat belts were bolted to the aft cross member of the seat cushion frame and extended over the top of the seat cushion. All belts were color coded to simplify matching components for each seat belt system. The seat belts for the left-side, three-occupant seats were configured with red seat belts for the outboard position, blue for the center position, and orange for the aisle position. The right two-occupant seats were configured with red seat belts for the outer position and orange for the aisle position.

The original lap belts installed in this school bus were labeled as ASCP (brand-named) and consisted of lightweight locking (cinch bar) latch plates, with an end release button located at the top of the buckle. The latch plate had two polymer fingers that extended from the buckle assembly to the center of the latch plate tab. The school district bus mechanic stated that when these fingers fractured from the latch plates, he replaced the seat belt system with an aftermarket brand. His reason for replacing the seat belt systems was that these fractured fingers prevent the cinch bar from locking the belt webbing. At the time of the SCI investigation, he had replaced over 300 seat belts on his fleet of school buses for this reason. The replacement seat belts are labeled as AMSAFE (brand-named) and are configured with a lightweight locking latch plate and a push-button release on the face of the buckle. On the involved school bus in this crash, 19 seat belts had been replaced with the AMSAFE seat belts.

The SCI investigators inspected all 54 lap belts in the school bus. There was no typical occupant loading evidence to any of the belt systems. This typical evidence can include gathering of the webbing in the latch plate, frictional abrasions on the webbing from interaction with the latch plate, clothing fabric transfers, scuff marks on the webbing, or waffling/cupping of the webbing from occupant engagement. At the inspection, it was observed that 18 latch plates of the 54 seat belts were adjusted at the end [or in 7 cm (2.8 in) of the end] of the webbing (Figure 18). Due to

the lack of loading evidence and the varying adjustments of the latch plates, seat belt use could not be definitively determined for every occupant.

Figure 18. Observed condition and adjustment of the seat belts at row 1 left seat

Rescue personnel cut four of the seat belts during the removal of the occupants, indicative of seat belt use at those positions. On the left side of the school bus, it was observed that the webbing of the row 10/aisle position was cut, with its latch plate remaining buckled, and the row 11/aisle webbing was cut, with its latch plate remaining buckled. On the right side of the bus, the seat belt webbings at the aisle positions of both rows 9 and 10 were cut, with the respective latch plates at both positions remaining buckled.

Interior Contact Evidence

The interior surfaces of the school bus contained several areas of physical evidence. The driver was restrained by the manual 3-point lap and shoulder seat belt system. The only area of residual contact evidence from the driver was a forward deflection and fracture of the right third of the overhead rearview mirror. The following table identifies the observed physical contact evidence by seat rows:

Seat Row	Left side	Right Side
1	Blood on roof side rail trim.	None
2	Blood on roof side rail trim and C-pillar.	None
3	Blood on the back of Row 2 seatback, mid-center aspect. Blood on mid area of seatback, occupant side, blood on side rail trim. Blood on aluminum side wall.	None
4	Blood on aluminum side wall. Blood and debris on closed glazing.	None
5	Dent and blood on aluminum side wall.	None
6	Aluminum side wall dented.	None
7	None	None
8	None, area of maximum intrusion.	None
9	Blood on right outer aspect of seatback.	None

Seat Row	Left side	Right Side
10	Side rail dented, hair on upper window frame, blood on seatback.	Body fluid top of Row 10
11	Blood on side panel, blood on the back of Row 10 seatback, head contact to upper M-pillar and side rail junction with hair and blood.	Blood on roof side rail at interior light

2012 IC CE-300 Occupant

Driver Demographics

Age/sex:	77 years/male
Height:	175 cm (69 in)
Weight:	91 kg (201 lb)
Eyewear:	Prescription eyeglasses
Seat type:	Forward-facing, suspension-mounted bucket seat
Seat track position:	Unknown
Manual restraint usage:	3-point lap and shoulder seat belt
Usage source:	Vehicle inspection
Air bags:	Not equipped
Alcohol/drug data:	None reported
Egress from vehicle:	Assisted from vehicle by passersby prior to first responders
Transport from scene:	Ambulance to a hospital

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Unknown	Unknown	Unknown	Unknown

Driver Kinematics

The driver of the school bus was seated in the high-back suspension base bucket seat with the track adjusted rearward. He was restrained by the manual 3-point lap and shoulder seat belt system. Seat belt use was determined by the cut status of the shoulder belt webbing. There was no specific loading evidence on the seat belt system. At the initial impact with the Kenworth, the driver responded laterally left and continued on that trajectory as the bus was rotated rapidly counterclockwise. His left body probably contacted the left side interior of the driver's compartment without leaving evidence of contact. As the bus body separated from the chassis and overturned onto the guardrail end treatment, the driver loaded the seat belt system that held him in position. His right upper extremity probably contacted the large rearview mirror, deflecting the right aspect forward and fracturing the mirror glass. Passersby assisted the driver from the bus via the windshield opening. Due to the criminal elements of this case, the driver's medical records were not released.

Row 11 Right Occupant (CISS-Web Occupant 2, Seat D5)

Age/sex:	51 years/female
Height:	160 cm (63 in)
Weight:	95 kg (210 lb)
Eyewear:	None
Seat type:	School bus bench
Seat track position:	Not adjustable
Manual restraint usage:	None
Usage source:	Vehicle inspection

Air bags: Not equipped
Alcohol/drug data: None
Egress from vehicle: Ejected, fatal injuries
Transport from scene: Ambulance to a hospital

Row 11 Right Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Open comminuted fracturing of frontal bone also involving the right side with detachment of external table fragments and exposure of cranial cavity	150406.4	Tire of other vehicle	Certain
2	Comminuted fracturing of anterior cranial fossa with fragmentation of orbits, orbit roofs, and displacement of eyeballs; fracturing of left middle fossa	150206.4	Tire of other vehicle	Certain
3	Cortical lacerations over tip of right frontal lobe	140688.3	Tire of other vehicle	Certain
4	Patchy, scanty subarachnoid hemorrhage predominantly over lateral aspect of left hemisphere	140693.2	Tire of other vehicle	Certain
5	Flail chest: all ribs fractured anteriorly and posteriorly; multiple lateral ribs fractured bilaterally	450214.5	Tire of other vehicle	Certain
6	Lacerations of intercostal muscles caused by splintered ribs	410600.1	Injury caused by injury (Injury 5)	Certain
7	Abdominal aorta 1 inch tear that involves the lumen of the vessel and adventitia associated with fracture of T9 vertebra	520202.4	Tire of other vehicle	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
8	Iliac arteries and large arteries of the pelvis laceration, rupturing, associated with open book comminuted fracture of pelvis	520608.4	Tire of other vehicle	Certain
9	Bilateral patchy lung contusions, max depth of 1 inch	441411.3	Tire of other vehicle	Certain
10	Superficial lacerations of hilar region bilaterally with involvement of small caliber blood vessels	441451.4	Tire of other vehicle	Certain
11	Right hemothorax	442200.3	Tire of other vehicle	Certain
12	Left hemothorax	442200.3	Tire of other vehicle	Certain
13	Fracture at level of T4 with splintering of vertebra and separation of fragments; laceration of spinal cord at T4 associated with fracture	610414.4	Tire of other vehicle	Certain
14	Fracture at level of T9 with splintering of vertebra and separation of fragments; laceration of spinal cord at T9 associated with fracture	610414.4	Tire of other vehicle	Certain
15	Open open-book type comminuted fracture of pelvis – symphysis pubis, right iliac bone, and both sacroiliac joints with several inches of separation bilaterally	856162.4	Tire of other vehicle	Certain
16	Bladder rupture associated with pelvis fracture	540640.3	Tire of other vehicle	Certain
17	Open fracture of upper portion of left femur below intertrochanteric line	853152.3	Tire of other vehicle	Certain
18	Splintering of distal left femur	853331.3	Tire of other vehicle	Certain
19	Comminuted fracture of distal right femur	853331.3	Tire of other vehicle	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
20	Open fracture of right tibia	854001.3	Tire of other vehicle	Certain
21	Open fracture of right distal radius	752312.3	Tire of other vehicle	Certain
22	Open fracture of right ulna	753201.3	Tire of other vehicle	Certain
23	Right mid humerus fracture	751221.2	Tire of other vehicle	Certain
24	Open fracture of right carpal bone	752401.2	Tire of other vehicle	Certain
25	Left mid humerus fracture	751221.2	Tire of other vehicle	Certain
26	Open fracture of left knee joint	874089.1	Tire of other vehicle	Certain
27	Sternum fracture, NFS	450804.2	Tire of other vehicle	Certain
28	Right mid clavicle fracture	750621.2	Tire of other vehicle	Certain
29	Multiple scattered superficial lacerations over anterior right hepatic lobe; outer upper corner of lobe has through and through laceration; pulpification of margins	541822.2	Tire of other vehicle	Certain
30	Multiple superficial capsular lacerations through diaphragmatic and hilar surfaces of spleen	544212.2	Tire of other vehicle	Certain
31	Small intestine patchy serosal hemorrhage	541410.2	Tire of other vehicle	Certain
32	Large intestine patchy serosal hemorrhage	540810.2	Tire of other vehicle	Certain
33	Mesentery has 2 ½ inch linear though and through laceration	542020.2	Tire of other vehicle	Certain
34	Endometrial mucosa has patchy hemorrhage	545210.1	Tire of other vehicle	Certain
35	Left parietal 2 inch avulsion laceration down to muscle; left occipital region 2 inch linear full thickness laceration to subcutaneous tissue	110804.2	Tire of other vehicle	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
36	Scanty patchy hemorrhage of left temporalis muscle	110402.1	Tire of other vehicle	Certain
37	Right eyelid bruised	210402.1	Unknown	Unknown
38	Left eyelid bruised	210402.1	Unknown	Unknown
39	Dorsal nose abrasion	210202.1	Road surface	Probable
40	Right ear abrasion	210202.1	Road surface	Probable
41	Left ear abrasion	210202.1	Road Surface	Probable
42	Left neck impact abrasions 3 x 1 inch	310202.1	Road surface	Probable
43	Contusions over left lower anterior chest	410402.1	Tire of other vehicle	Certain
44	Abrasions over left lower anterior chest	410202.1	Tire of other vehicle	Certain
45	Contusions to right abdomen and flank	510402.1	Tire of other vehicle	Certain
46	Abrasions to left side of abdomen	510202.1	Tire of other vehicle	Certain
47	Contusion to back of right hand	710402.1	Tire of other vehicle	Certain
48	Abrasions to back of right hand	710202.1	Road surface	Probable
49	Abrasions to right arm	710202.1	Road surface	Probable
50	Abrasions to right forearm	710202.1	Road surface	Probable
51	Posterior left arm extensive dicing injuries 7 ½ x 4 inch	710202.1	Bus window glazing	Probable
52	Dicing injuries from left elbow to posterior medial forearm 6 x 3 inch	710202.1	Bus window glazing	Probable
53	Dicing injuries to left hand	710202.1	Bus window glazing	Probable
54	Contusion to left hand	710402.1	Left side interior of bus	Possible
55	Superficial abrasions over right mid back	410202.1	Road surface	Probable
56	Superficial abrasions over back of right shoulder	710202.1	Road surface	Probable
57	Right thigh superficial laceration 2 ¼ x 1/3 incn	810602.1	Bus window frame	Possible
58	Left leg bruising	810402.1	Road surface	Probable
59	Left leg abrasions	810202.1	Road surface	Probable
60	Left ankle abrasion	810202.1	Road surface	Probable
61	Left foot bruising	810402.1	Road surface	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
62	Left big toenail partially detached	810802.1	Road surface	Probable
63	Contusion over right upper buttock	810402.1	Road surface	Probable
64	Contusion over left upper buttock	810402.1	Road surface	Probable
65	Abrasion over right upper buttock	810202.1	Road surface	Probable
66	Abrasion over right upper buttock	810202.1	Road surface	Probable
67	Shoulder contusion	710402.1	Tire of other vehicle	Certain

Source: Autopsy report (internal).

Row 11 Right Occupant Kinematics

This occupant was reportedly seated in the 11th-row, right-side aisle seat. She was not wearing the available lap belt. At impact with the Kenworth, she responded to the 9 o'clock direction of the force of the crash and subsequent counterclockwise rotation of the bus with a left trajectory. She was displaced across the width of the vehicle and struck the upper aspect of the M-pillar, evidenced by hair and blood (Figure 19). Although injury probably occurred from this contact, it was masked by subsequent contact. The force of the impact and violent centrifugal force of the rotation ejected the occupant through the window opening. She sustained dicing injuries of the left arm and hand from the disintegrated window glazing. The law enforcement investigators indicated that she was ejected onto the roadway, where she likely interacted with other passing motor vehicles. Contact with the road surface resulted in numerous soft tissue injures. Her subsequent contact with the tires of the other vehicles resulted in many injuries of the head, torso, and extremities. She was pronounced deceased at the scene.

Figure 19. Blood and hair evidence observed at the left M-pillar of the school bus

Row 8 Right Window Seat Occupant (CISS-Web Occupant 3, Seat A6)

Age/sex:	10 years/female
Height:	142 cm (56 in)
Weight:	32 kg (70 lb)
Eyewear:	None
Seat type:	School bus bench
Seat track position:	Not adjustable
Manual restraint usage:	Lap belt, worn extremely loose
Usage source:	Vehicle inspection
Air bags:	Not equipped
Alcohol/drug data:	None
Egress from vehicle:	Assisted by EMS due to perceived serious injury
Transport from scene:	Ambulance to a hospital

Row 8 Right Window Seat Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Open depressed fracture of right frontal bone measuring 2 ½ x 1 ½ inch	150408.4	Intruding left side bus interior	Certain
2	Cortical laceration over right frontal lobe, 1 ½ x 1 inch	140686.4	Intruding left side bus interior	Certain
3	Subdural hemorrhage over convexity of both cerebral hemispheres, <10 cc	140654.4	Intruding left side bus interior	Certain
4	Brain swelling, NFS	140660.3	Intruding left side bus interior	Certain
5	Patchy right subarachnoid hemorrhage	140693.2	Intruding left side bus interior	Certain
6	Patchy left subarachnoid hemorrhage	140693.2	Intruding left side bus interior	Certain
7	Lung contusions: patchy right upper and lower lobe, patchy left upper lobe	441411.3	Intruding left side bus interior	Certain
8	Right hemothorax, 300 cc of blood, caused by rib fractures	442200.3	Intruding left side bus interior	Certain
9	Right rib fractures: anterolateral 1st, posterolateral 6, 7, 8, and posterior 8 and 9	450203.3	Intruding left side bus interior	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
10	Rupture of parietal pleura, caused by rib fractures	441800.2	Intruding left side bus interior	Certain
11	Laceration to right hemidiaphragm	440604.2	Intruding left side bus interior	Certain
12	Large complex through and through laceration to upper portion of right hepatic lobe, 5 x 2 inch with a depth of 1-1/4 inch	541824.3	Intruding left side bus interior	Certain
13	Right forehead laceration to subcutaneous muscle, 1-1/2 inch; small superficial linear laceration to center and left forehead,1/2 inch	210602.1	Intruding left side bus interior	Certain
14	Center and left forehead abrasions	210202.1	Intruding left side bus interior	Certain
15	Left cheek abrasions	210202.1	Intruding left side bus interior	Certain
16	Left mandibular abrasions	210202.1	Intruding left side bus interior	Certain
17	Inner lip lacerations – upper frenulum and lower mucosal laceration, 1 x 1/3 inch	243099.1	Intruding left side bus interior	Certain
18	Soft tissue hemorrhage over apex of right chest	410402.1	Intruding left side bus interior	Certain
19	Impact/friction abrasion to right chest, 6 x 4 inch	410202.1	Intruding left side bus interior	Certain
20	Superficial 1 inch laceration to right breast	410602.1	Intruding left side bus interior	Certain
21	Contusion to right lateral back	410402.1	Displaced left side bus seat back	Probable
22	Soft tissue hemorrhage over posterior right flank	510402.1	Displaced left side bus seat back	Probable
23	Right abdomen abrasion 2 x 1 inch	510202.1	Displaced left side bus seat back	Probable
24	Contusion to lateral upper right arm 3-1/2 x 1 inch	710402.1	Forward seat back	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
25	Dicing injuries to knuckles of left hand	710202.1	Disintegrated bus glazing	Probable
26	Contusions to left anterior thigh	810402.1	Other position seat back	Possible
27	Abrasions to left anterior thigh	810202.1	Other position seat back	Possible
28	Contusion to left knee	810402.1	Other position seat back	Possible
29	Contusion to left pretibial region	810402.1	Other position seat back	Possible
30	Abrasions over right anterior lower thigh, 3 x 1-3/4 inch	810202.1	Other position seat back	Possible
31	Contusion to right kneecap, 1-1/3 inch diameter	810402.1	Other position seat back	Possible
32	Right foot abrasion	810202.1	Underside of bus seat	Probable
33	Left foot abrasion	810202.1	Underside of bus seat	Probable

Source: Autopsy report (internal).

Row 8 Right Window Seat Occupant Kinematics

The police report stated that this female passenger was seated in the right-side, 8th-row window seat. The abrasions and contusion to her lower extremities suggest that the seat belt may have been in use. However, at the inspection, the lap belt for this position was found unbuckled, with the latch plate at the end of the webbing (Figure 20). If this seat belt had been in use, the observed position indicated that the seat belt would have been worn extremely loose around her pelvis.

At impact, she responded to the 9 o'clock direction of the force of the crash and subsequent counterclockwise rotation of the bus by moving laterally to her left. Her lower extremities probably interacted with the seat back forward of her position, resulting in the identified abrasions and contusions. Her head and torso struck the intruding left side structure of the bus, resulting in multiple injuries of these body regions. Hair strands were observed at the junction of the upper window and roof side rail panel (Figure 21); however, it is unknown if this contact was associated with this passenger. She was assisted from the bus, due to perceived serious injury, and transported to a hospital by ambulance, where she was pronounced deceased.

Figure 20. Observed condition of the row 8 right seat belts

Figure 21. Hair observed at the junction of the left upper window and side rail at row 10

Other Student and Adult Passengers

The other student and adult passengers of the school bus sustained varieties of injuries that ranged from soft tissue to life-threatening. All occupants were transported to nearby hospitals. Many were treated and released within hours of the crash; however, some required hospitalization. Due to the redacted reports, minor ages of the occupants, and privacy concerns, these occupants were not identified; therefore, complete medical data are not available, and these occupants are not coded in the CISS-Web database. The following table is a seating chart of occupied seats and generic injury data by position. This was gleaned from a combination of reports obtained from the county prosecutor's office. Seat belt use was not identified in any of the official records.

	Left Seats				**Right Seats**	
Row	**Window**	**Center**	**Aisle**		**Aisle**	**Window**
1	Adult, serious bodily injury	Not occupied	Adult female, nasal bone fracture	**Center Aisle**	Not occupied	Adult male, serious bodily injury
2	Student, contusions and/or head injury	Not occupied	Adult female, serious bodily injury		Student, contusions and/or head injury	Not occupied
3	Student, lacerations and/or contusions	Student, Not injured	Student, serious bodily injury		Student, lacerations, and/or head injury	Student, serious bodily injury
4	Student, free fluid (unspecified)	Student, back pain and/or contusions	Student, serious bodily injury		Not occupied	Student, contusions and/or head injury (seat belt buckled)

	Left Seats				Right Seats	
Row	**Window**	**Center**	**Aisle**		**Aisle**	**Window**
5	Student, contusions, bodily pain	Student, abrasions and/or lacerations	Student, serious bodily injury		Student, serious bodily injury	Student, Not injured
6	Student, contusions	Not occupied	Adult female, serious bodily injury		Student, serious bodily injury	Student, serious bodily injury
7	Student, serious bodily injury	Not occupied	Student, serious bodily injury		Not occupied	Student, serious bodily injury
8	Student, serious bodily injury	Not occupied	Student, serious bodily injury		Student, abrasions and/or free fluid	**10-year-old female fatality**
9	Student, serious bodily injury	Student, lacerations, pain, and/or head injury	Student, contusions		Student, serious bodily injury (belt webbing cut, buckled)	Student, sprains, contusions/ abrasions
10	Student, serious bodily injury	Student, contusions and/or head injury	Student, serious bodily injury (belt webbing cut, buckled)		Student, serious bodily injury (belt webbing cut, buckled)	Student, serious bodily injury
11	Student, serious bodily injury (belt webbing cut, buckled)	Student, serious bodily injury	NO SEAT		**51-year-old female fatality**	Not occupied

2013 Kenworth T800 Straight Truck

Description

The 2013 Kenworth T800 straight truck (Figure 22) was a dump truck manufactured by the Kenworth Truck Company, Kirkland, Washington, in March 2013 as an incomplete vehicle and was identified by the VIN 1NKDX4TX8EJxxxxxx. The Class 8 heavy-duty, chassis-cab vehicle was constructed on a 559 cm (220.1 in) wheelbase with a tag-axle and a day cab. The tandem-rear drive train was powered by a 6-cylinder, 15.0-liter, turbo-diesel engine. The secondary manufacture included the addition of a 5.5 m (18.0 ft) steel dump body. The dump body was manufactured and installed by Beau-Roc Inc., also known as Les Ateliers Beau-Roc Inc., of Vars, Ontario, Canada. At the time of the crash, the dump body was laden with dirt. The total weight of the loaded Kenworth was 35,403 kg (78,050 lb). There were no New Jersey Department of Transportation violations identified during the post-crash commercial vehicle inspection of the Kenworth, which was conducted by the New Jersey State Police.

Figure 22. Right side view of the Kenworth

Figure 23. Front view showing the impact damage of the Kenworth

Exterior Damage

The exterior damage to the Kenworth consisted of front plane deformation consistent with the school bus impact (Event 1) and left plane damage associated with its contact with the left guardrail (Event 4) as it traveled to final rest. The front direct contact damage (Figure 23) extended laterally across the truck's entire 244 cm (96.1 in) end width and vertically 267 cm (105.1 in) to the windshield header. Its impact and interaction with the bus fractured the fiberglass hood and deformed the steel bumper rearward and down. Deformation was measured at the forward end of the truck frame rails and along the steel bumper (as a reference). The longitudinal deformation of the left and right frame rails measured 17 cm (6.7 in) and 29 cm (11.4 in), respectively. The radiator had separated during the impact and was missing. The truck's engine was displaced rearward roughly 61 cm (24.0 in) and had intruded into the center and right aspects of the day cab. The left front tire debeaded and separated from the rim. This axle position was displaced rearward by the impact force, which also caused a separation of the steering shaft. The left front wheel rim contacted the fuel tank mounted below the left door into the cab. The Truck Deformation Classification assigned to this damage pattern was 12FDAW6.

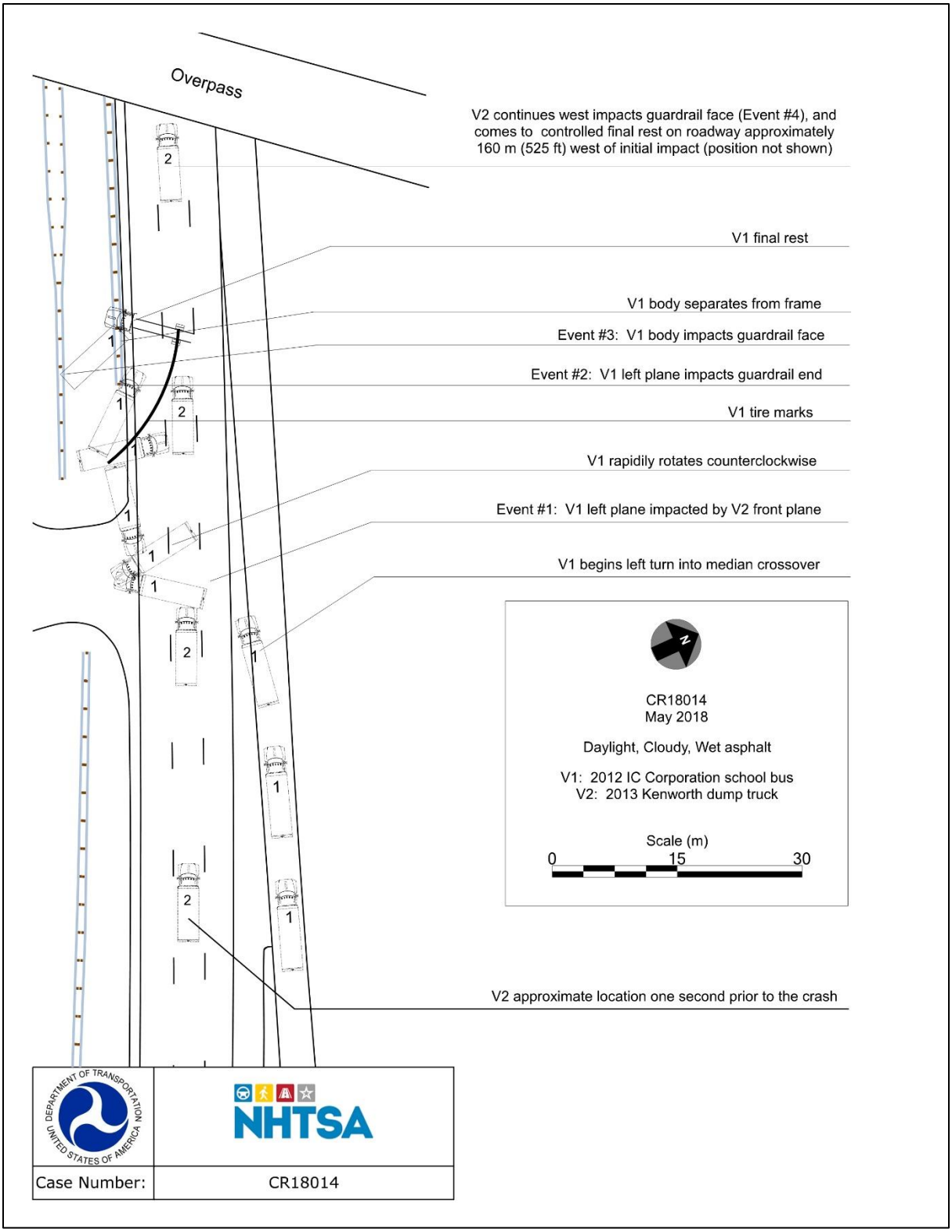
The extent of left plane damage (Figure 24) and its height were consistent with the secondary contact to the guardrail as the Kenworth traveled to its uncontrolled final rest. Swiping contact, abrasions, and sheet metal snagging along the left plane were noted over an approximately 439 cm (173 in) length. The tag axle was displaced 8 cm (3.1 in) rearward from the contact. The Truck Deformation Classification assigned to this damage pattern was 12LDES9.

Figure 24. View showing the left plane damage of the Kenworth that extended rearward to the tag axle

Occupant Data

The Kenworth driver was operating the truck in the course of his employment and had a valid commercial driver's license. The police reported that he was belted at the time of the crash, and that he was injured. The extent and nature of his injuries are unknown.

Crash Diagram



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