



U.S. Department  
of Transportation

**National Highway  
Traffic Safety  
Administration**



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DOT HS 813 284

May 2022

**Special Crash Investigations:  
On-Site School Bus Crash  
Investigation;  
Vehicle: 2013 Thomas Type D  
School Bus;  
Location: Tennessee;  
Crash Date: October 2020**

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Suggested APA Format Citation:

Crash Research & Analysis, Inc. (2022, May). *Special Crash Investigations: On-site school bus crash investigation; Vehicle: 2013 Thomas Type D School Bus; Location: Tennessee; Crash Date: October 2020* (Report No. DOT HS 813 284). National Highway Traffic Safety Administration.

## Technical Report Documentation Page

<b>1. Report No.</b> DOT HS 813 284	<b>2. Government Accession No.</b>	<b>3. Recipient's Catalog No.</b>	
<b>4. Title and Subtitle</b> Special Crash Investigations: On-Site School Bus Crash Investigation; Vehicle: 2013 Thomas Type D School Bus; Location: Tennessee; Crash Date: October 2020		<b>5. Report Date</b> May 2022	
		<b>6. Performing Organization Code</b>	
<b>7. Author</b> Crash Research & Analysis, Inc.		<b>8. Performing Organization Report No.</b> CR20032	
<b>9. Performing Organization Name and Address</b> Crash Research & Analysis, Inc. PO Box 302 Elma, NY 14059		<b>10. Work Unit No. (TRAIS)</b>	
		<b>11. Contract or Grant No.</b> 693JJ919C000004	
<b>12. Sponsoring Agency Name and Address</b> National Highway Traffic Safety Administration 1200 New Jersey Avenue SE Washington, DC 20590		<b>13. Type of Report and Period Covered</b> Technical Report	
		<b>14. Sponsoring Agency Code</b>	
<b>15. Supplementary Notes</b>  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.			
<b>16. Abstract</b>  This report documents the angled crash of a 2013 Thomas Saf-T-Liner HDX, Type D school bus and a 2018 Freightliner M2 utility "boom" truck. The crash resulted in fatal injuries to the 53-year-old female bus driver and the 7-year-old female first row left occupant, as well as critical A-level injuries to five additional students. The crash occurred in the southbound lane of a two-lane, undivided State highway. The school bus had a capacity for 78 passengers and was not equipped with seat belts, except for the driver. Thirty-three students, ranging in age from 6 to 17, occupied the bus. The bus was traveling south and was negotiating a slight left curve. The Freightliner was traveling north on a straight section of the roadway and approaching the same curve. During its travel, the Freightliner drifted to the right, and the right side tires dropped off the east roadside. The truck driver oversteered to the left while correcting the vehicle's trajectory, and the truck traveled across the centerline in a counterclockwise yaw. The front plane of the bus struck the right plane of the Freightliner. The bus driver and first row left/left passenger sustained fatal injuries and were pronounced deceased at the scene. Five passengers sustained police-reported "A" (incapacitating) injuries and were transported by helicopter to a hospital. Eight passengers sustained police-reported "B" (non-incapacitating) injuries. Three were transported by ambulance to a hospital, and the rest were transported by private vehicles. Four passengers had police-reported "C" (possible) injuries but were not transported by ambulance, and it is unknown if they sought medical treatment. Fourteen passengers were not injured and did not seek treatment. One passenger had an unknown injury status.			
<b>17. Key Words</b>  school bus, fatalities, intrusion, utility truck		<b>18. Distribution Statement</b>  This document is available to the public from the DOT, BTS, National Transportation Library, Repository & Open Science Access Portal, <a href="https://rosap.ntl.bts.gov">rosap.ntl.bts.gov</a> .	
<b>19. Security Classif. (of this report)</b> Unclassified	<b>20. Security Classif. (of this page)</b> Unclassified	<b>21. No. of Pages</b> 50	<b>22. Price</b>

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**Special Crash Investigations**  
**On-Site School Bus Crash Investigation**  
**Case Number: CR20032**  
**Vehicle: 2013 Thomas Type D School Bus**  
**Location: Tennessee**  
**Crash Date: October 2020**

## Background

This report documents the angled crash of a 2013 Thomas Saf-T-Liner HDX, Type D school bus and a 2018 Freightliner M2 utility truck (Figure 1). The crash resulted in fatal injuries to the 53-year-old female bus driver and the 7-year-old female first row left passenger, as well as critical A-level injuries to five additional students. The State police documentation reported that the driver and 33 students (34 people in all) occupied the bus at the time of the crash. The crash occurred in October 2020 and was investigated by a State police agency. The Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc. notified the National Highway Traffic Safety Administration of the crash in October 2020. It was assigned for investigation in the same month. The team contacted the investigating police agency and established cooperation to inspect the vehicles. Both vehicles were being held by the State police agency and were inspected in November 2020. The scene inspection was also completed in November 2020. The National Transportation Safety Board conducted a parallel investigation.



*Figure 1. On-scene police image of the school bus and utility truck at final rest*

The crash occurred in the southbound lane of a two-lane, undivided State highway. The school bus had a capacity for 78 passengers and was not equipped with seat belts, except for the driver. Thirty-three student passengers, ranging in age from 6 to 17, occupied the bus. The bus was traveling south and was negotiating a slight left curve. The Freightliner utility truck, also known as a “boom” truck, was traveling north on a straight section of the roadway and was approaching the same curve. During its travel, the Freightliner drifted to the right, and the right side tires dropped off the east roadside. The truck driver oversteered to the left while correcting the vehicle’s trajectory, and the truck traveled across the centerline in a counterclockwise yaw. The front plane of the bus struck the right plane of the Freightliner. The bus driver and first row left/left passenger sustained fatal injuries and were pronounced deceased at the scene. Five

passengers sustained police-reported “A” (incapacitating) injuries and were transported by helicopters to hospitals. Eight passengers sustained police-reported “B” (non-incapacitating) injuries; three of them were transported by ambulances to hospitals, and the remainder were transported by private vehicles. Four passengers had police-reported “C” (possible) injuries but were not transported by ambulance. It is unknown if they sought medical treatment. Fourteen passengers were not injured and did not seek treatment. One passenger had an unknown injury status.

The SCI on-site investigation consisted of inspection of the bus to document and measure exterior damage to the bus structure, including the body attachment points on the frame. Interior inspection included assessment of the bus’s seating systems, documentation of intrusions, and identification of occupant contacts. An exterior inspection of the Freightliner utility truck was also conducted. The crash site was photographed and mapped by the Nikon total station during the SCI inspection.

Crash information and pertinent documentation were requested from the investigating law enforcement agency and the school. The bus was equipped with four video cameras, a forward-facing camera with vehicle speed and GPS-location, and three cameras that monitored the seating area. The videos were viewed by the SCI team and captured the pre-trip loading and trip activities leading up to the crash. The interior cameras showed some of the passengers moving to a variety of different seated and standing positions throughout the duration of the trip. These videos were used to determine occupant kinematics.

Through the course of the SCI investigation, it was determined that the positions of the occupants at impact generally correlated to the seriousness of their injuries. The driver and those passengers closer to the front of the bus sustained the most serious injuries while those toward the rear of the bus sustained minor or no injuries. Seated passengers were passively restrained via “compartmentalization,” keeping the students in their seating areas. The onboard videos showed the displacement of standing and out-of-position passengers due to the force of the pre-crash braking and impact.

## **School District Information**

### **Demographics**

The school district consisted of one high school, one middle school, and two elementary schools, with a total of 1,724 students in pre-K through 12th grade. The transportation department consisted of a director of school safety, a transportation supervisor/mechanic, and a transportation technician. There were 20 buses that operated daily routes, and all buses were owned and operated by the school district. Each bus route consisted of a mix of elementary, middle, and high school students. There were no aides or attendants on a bus unless there was a special-needs student on that route. For this bus route, there was no bus attendant present.

### **Policies Regarding Training, Safety, and Discipline**

According to the school district, each driver is trained annually at the start of the school year, during a required district in-service. Topics include student discipline procedures, assigned seating, and enforcement of bus rules and policies. Safe operations and rider safety are also addressed at the State in-service and safety training held in the fall of each school year. In addition, school principals board each bus at the beginning of each year and talk to the students about following rules and policies, as well as discipline procedures. Bus discipline is coded in a Student Information System and reviewed by district staff throughout the school year. Drivers receive performance evaluations annually and student discipline (the safety of riders) is addressed in each driver's evaluation. If a driver is not meeting expectations, the district provides refresher training on student discipline, which requires a second evaluation. The district impresses upon its drivers the importance of reporting student safety violations to the school principal and the need to work with school administration to correct any problematic behaviors. These incidents are documented at the school level.

## Summary

### Crash Site

This crash occurred during the afternoon hours in a rural area. The weather conditions included partly cloudy skies with no wind and a temperature of 23 °C (73 °F), according to the local weather reports. The roadway (Figure 2) was dry, level, bituminous, and oriented in a general north/south direction with one lane in each direction, both 3.4 m (11.2 ft) wide. The road was curved left for southbound traffic. South of the crash site, the east shoulder was 30 cm (11.8 in) wide, and the west shoulder was 1.0 m (3.3 ft) wide. North of the crash site, the shoulders were approximately 50 cm (20 in) wide. Roadway markings consisted of solid white edge lines and a double yellow centerline, and there were rumble strips on both edges of the roadway. A driveway and mailbox were located on the west side of the road at the apex of the curve. The speed limit was 89 km/h (55 mph). The bus's pre-crash roadway had a superelevation of +4.4% to the west. A crash diagram is included at the end of this report.



*Figure 2. South view of the bus's approach to the point of impact*

### Pre-Crash

The crash occurred during the daily afternoon bus run for the 33 elementary-to-high school age students. The 53-year-old female driver of the bus was a full-time employee and carried a class B commercial driver's license with a "P" endorsement that allowed the driver to operate a vehicle carrying 16 or more people and an "S" endorsement to drive a school bus. She had driven for the current school district for over three years. There were no adult monitors, and there were no COVID-19-type seating restrictions for social distancing.

The bus was traveling south (Figure 2), and the driver was intending to negotiate the left curve. The forward-looking video indicated a speed range of 77 to 74 km/h (48 to 46 mph) at 10-second to 1-second pre-crash intervals (Figure 3). The Freightliner was traveling north, and the driver was intending to continue straight ahead, approaching the same curve. Approaching the curve, the Freightliner drifted to the right, and its right wheels traveled off the east road edge, along the downslope of the ditch, at a negative grade of 1.6 percent (Figure 4). After approximately 26 m (85 ft) of off-road travel, the driver steered left, and the right front tire returned to the roadway. This resulted in an oversteer condition, and the Freightliner began to yaw counterclockwise and

crossed the centerline broadside, directly in the path of the bus. The bus driver steered right, attempting to avoid the crash.



*Figure 3. Bus video of the truck just prior to impact (bus speed = 74 km/h [46 mph])*



*Figure 4. North view of the Freightliner's pre-crash travel path*

## **Crash**

The front right corner of the Freightliner struck and fractured a wooden mailbox post (Event 1) on the west side of the roadway. This had no effect on the trajectory of the vehicle. The front plane of the bus struck the right plane (equipment box) of the Freightliner (Event 2). As a result of the impact, the bus rotated clockwise approximately 20 degrees and came to rest facing west, with the right front wheel on the west roadside and the left rear wheels on the centerline. The Freightliner rotated slightly counterclockwise after the bus impact and continued its northwesterly trajectory, coming to final rest facing north at a tree line just north of a gravel driveway adjacent to the roadway.

## **Post-Crash**

Police were notified of the crash and arrived within 20 minutes. Rescue personnel also responded to the scene. The driver and first row left/left passenger were fatally injured and pronounced deceased at the scene. These occupants were entrapped, extricated, and removed through the front end of the bus. All other passengers exited or were assisted through the emergency door on the left side at row 8. Five of the passengers sustained police-reported “A” (incapacitating) injuries and were flown by helicopters to hospitals. Eight passengers sustained police-reported “B” (non-incapacitating) injuries. Of these passengers, three were transported to a hospital by

ambulances and the other five privately. Four passengers sustained police-reported “C” (possible) injuries, but their transport and treatment statuses are unknown. Fourteen passengers did not sustain any police-reported injuries and did not seek treatment. One non-transported passenger’s injury status is unknown. Both vehicles were towed due to damage.

## 2013 Thomas SAF-T-Liner HDX, Type D School Bus

### Description

The bus was a rear-wheel-drive, flat-front school bus (Figure 5), Vehicle Identification Number 1T7YR4E22D1xxxxxx, manufactured in June 2012, and equipped with an 8.9-liter, 6-cylinder, rear-mounted diesel engine. Seating capacity was for 78 occupants, excluding the driver. It was not equipped with seat belts except for the driver position. The overall length of the bus was 1,118 cm (440.2 in), and the wheelbase was 605 cm (238.2 in). The information placard stated the vehicle's gross vehicle weight rating as 14,969 kg (33,000 lb), with gross axle weight ratings of 5,987 kg (13,200 lb) front and 9,525 kg (21,000 lb) rear.

The vehicle manufacturer's recommended tire size was 11R22.5 for all tires. The vehicle was equipped with General RA tires of the recommended size on all six wheels. All tires were in good condition, with a minimum of 11 mm (14/32 in) of tread. The bus had passed all State inspections and was declared mechanically sound. The latest inspection was three weeks prior to this crash.



Figure 5. Exemplar Thomas Saf-T-Liner HDX

### School Bus Exterior

The school bus body was constructed of riveted aluminum body panels with four longitudinal, intermittently spaced rub rails (painted black), from the sill to the beltline and extended the length of the bus. The right entry door was electrically operated and consisted of two vertically hinged glass panels. The windshield was AS-3 laminated and consisted of two glazing panels.

The left plane of the bus contained an AS-2 tempered, double pane horizontally sliding window at the driver's position between the A-pillar and the B-pillar and 13 rows of double paned windows, each with a sliding upper panel. All passenger row glazing was AS-3, with original tinting. The right plane of the bus had 13 rows of the same windows. Row 8 left was an emergency door with fixed glazing, and there were emergency window exits at rows 4 left, 6 right, and 12 right. The backlight was also an emergency exit, and there were centered roof emergency exits at rows 4 and 11.

## Exterior Damage

The entire front plane of the bus sustained direct damage during contact with the Freightliner (Figure 6). The direct damage extended across the entire 217 cm (85.4 in) front end-width and 323 cm (127 in) height. The crush measurements were documented along the front panel above the frame rails and the Field L was 217 cm (85.4 in). The residual crush values were C1 = 90 cm (35.4 in), C2 = 91 cm (35.8 in), C3 = 92 cm (36.2 in), C4 = 88 cm (34.6 in), C5 = 80 cm (31.5 in), and C6 = 86 cm (33.9 in). The maximum residual crush was 92 cm (36.2 in) and was located at the left front corner. The WinSMASH program could not be used to determine velocity change because both vehicles involved in this crash were out of scope for the program. The truck deformation classification (TDC) for this impact was 11FDAW9 (340 degrees).



*Figure 6. Front plane damage of the bus*

The body of the bus was supported by horizontal ribs under the floor. There were 25 ribs from the front of the bus to the back of the storage compartment, which was located between the rear wheels. The number of ribs behind the storage compartment could not be determined due to the engine, transmission, and other components mounted to the rear aspect of the undercarriage. The ribs extended the width of the body and rested on the frame rails atop a rubber separation disk. Pinch flanges bolted to the ribs secured the body to the frame rails at ribs 4, 5, and 6 (Figure 7) in the forward section and ribs 17 to 20 and 22 to 25 in the storage compartment section (middle of the bus). Only two flanges could be noted in the rear section of the bus due to limited visibility. Most flanges throughout the bus were slightly displaced, but only the left flanges at ribs 4, 5, and 6 were completely separated from the left frame rail (Figure 8). Lateral floor buckling on the interior of the bus occurred at the driver's seat area and at the first row of passenger seats (Figure 9).



Figure 7. Right frame rail at RF wheel, ribs with and without flanges

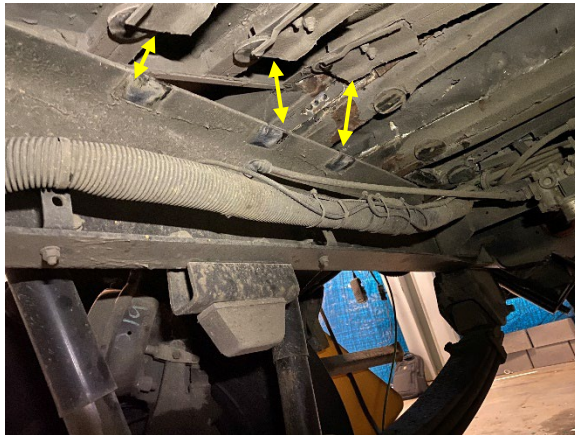


Figure 8. Left frame rail at LF wheel (note rib/flange lateral and vertical displacement and separation)



Figure 9. On-scene police image showing lateral lines of floor buckling at driver's seat and second row

During the inspection, it was noted that the first 12 ribs experienced between 1 cm (0.4 in) and 10 cm (3.9 in) of lateral shift to the right. The first 17 ribs also experienced between 0.5 cm (0.25 in) and 12 cm (4.7 in) of shift upward (see Figure 7).

## School Bus Interior

The bus had a cloth-covered forward-left-positioned driver's seat. The driver's seat was a high-back bucket seat with an integrated head restraint, adjustable armrest on the left side, and a lap and shoulder seat belt. The seat had an undetermined longitudinal adjustment. The bus interior was configured with 13 rows of 3-occupant, vinyl-covered bench seats arranged in two columns with a center aisle (Figure 10). The center aisle was 35 cm (13.8 in) wide.



*Figure 10. Interior of exemplary bus*

The bus used the compartmentalization concept, with closely spaced seat cushions to the forward seatbacks and tall, fully padded vinyl seatbacks. Each seat cushion measured 40 cm (15.7 in) deep, 98 cm (38.6 in) wide, with a seatback 73 cm (28.7 in) in height and angled 11 degrees aft of vertical. The distance from the front of the seat cushion to the base of each seatback was 20 cm (7.9 in), and the distance between the tops of each seatback was 59 cm (23.2 in). The seat frames were tubular steel, and each seat frame was mounted to the interior wall of the bus body, with two legs anchored to the floor to support the inboard aspect.

## Interior Damage

The front of the bus sustained severe intrusion damage (Figure 11) from the impact with the Freightliner. Figure 12 is a right-looking image of the driver's area in an exemplar bus for comparison. Table 1 presents the intruded component, location, magnitude of intrusion, and direction of intrusion.



Figure 11. Intrusion to the driver area and the first row (note the proximity of bulkhead to the shoulder belt D-ring anchor compared to the exemplary in Figure 12)

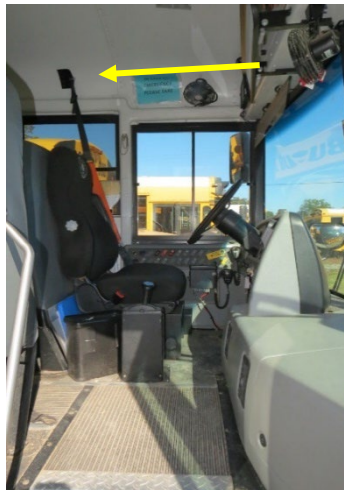


Figure 12. Exemplar bus driver's area

Table 1. Interior Intrusion Values

Row	Position	Component	Intrusion Value	Direction
Row 1	Left	Bulkhead	119 cm (47.2 in)	Longitudinal
Row 1	Left	A-pillar	120 cm (47.2 in)	Longitudinal
Row 1	Center	Bulkhead	110 cm (43.3 in)	Longitudinal
Row 1	Center	Instrument Panel	100 cm (39.4 in)	Longitudinal
Row 1	Right	Instrument Panel	99 cm (39.0 in)	Longitudinal
Row 1	Right	Bulkhead	92 cm (37.0 in)	Longitudinal
Row 1	Left	Instrument Panel	90 cm (35.4 in)	Longitudinal
Row 1	Right	A-pillar	87 cm (34.3 in)	Longitudinal
Row 1	Left	Steering assembly	72 cm (28.3 in)	Longitudinal
Row 1	Left	B-pillar	46 cm (18.1 in)	Longitudinal
Row 1	Left	Driver seat assembly	36 cm (14 in) est.	Longitudinal

Row	Position	Component	Intrusion Value	Direction
Row 1	Left	Partition	36 cm (14 in) est.	Longitudinal
Row 1	Left	Roof side rail	24 cm (9.4 in)	Vertical
Row 1	Right	Partition	20 cm (8 in) est.	Longitudinal

The force of the crash resulted in significant crush and intrusion of the bulkhead, instrument panel, and front structures. The buckling of the floor and roof panels extended rearward to row 2. The steering column intruded rearward 72 cm (28.3 in). The lower half sector of the rim was deformed 21 cm (8.3 in) forward, toward the hub by contact with the driver.

The driver seat and the partition forward of row 1 left intruded rearward approximately 36 cm (14 in). This deformed the forward/horizontal aspect of the row 2 seat frame approximately 16 cm (6 in). Also, the distance between the seat cushions between rows 1 and 2 were significantly reduced. During the impact the left wall buckled outward creating a void at the outboard edge of the partition. The 7-year-old female seated at this position responded to the crash force with a forward and left trajectory.

She likely struck the left edge of the padded partition (Figure 13) and the left sidewall with her head. At final rest, she was entrapped between the partition and the left sidewall.



*Figure 13. Padded partition between the driver's seatback and the first row, left seat*

The structures of the right A-pillar crushed and intruded longitudinally. The right entry door and entry stairs were eliminated by the deformation. At inspection, the right A-and B-pillars were in contact with each other. The right aspect of the instrument panel was in contact with the right partition.

The windshield glazing was in place and holed from impact forces. The front door and both glazings at seat positions 1 and 2 left and 1 right were disintegrated from the impact. Row 3 left's glazings and row 4 right's top glazing were disintegrated, though likely occurred post-crash.

All of the bench seat anchors remained secured to the floor. Many of the seatbacks were deformed in a forward direction as a result of occupant loading (Figure 14). Ten of the seat cushions separated from their rear bracket attachments (Figure 15).



*Figure 14. Damage to row 12 left seatback from row 13 left occupant contacts*



*Figure 15. Holes (L) on the bottom of the seat cushion that tore away from the bracket (R)*

### **Manual Restraint Systems**

The driver's position was equipped with a manual 3-point lap and shoulder seat belt. The restraint consisted of continuous-loop webbing that was housed in a retractor attached to the wall on the left side of the driver. The D-ring hung from a ceiling mount on an adjustable length of webbing. The receiver-buckle was attached to the right side of the seat frame on a flexible stalk. The light-weight locking latch plate was still buckled at the time of inspection, indicative of restraint use. The webbing was cut in two places during the extrication of the driver by rescue

personnel. Inspection of the belt system revealed waffling/stretching of the webbing, but no specific load marks. None of the passenger seats were equipped with seat belts.

## Bus Occupant Data

The following table presents the age, gender, police-reported injury severity, and CISSWeb seat position of the 34 occupants documented by the police investigation. “\*” indicates medical information obtained for the occupants.

Row	Left Seats			Center	Right Seats		
	Window	Center	Aisle	Aisle	Aisle	Center	Window
Driver	53-year-old; female; fatal (1)*						
1	7-year-old female; fatal (2)*	8-year-old female; A-injuries (3)*	Not occupied		Not occupied	Not occupied	9-year-old male; A-injuries (4)*
2	8-year-old male; A-injuries (5)*	Not occupied	Not occupied		Not occupied	Not occupied	Not occupied
3	8-year-old male; not injured (6)	7-year-old male; not injured (7)	8-year-old male; A-injuries (8)*		8-year-old male; B-injuries (9)*	6-year-old male; B-injuries (10)*	8-year-old male; C-injuries (11)
4	10-year-old male; not injured (12)	Not occupied	Not occupied		10-year-old female; C-injuries (13)	Not occupied	12-year-old female; unknown if injured (14)
5	10-year-old male; B-injuries (15)*	Not occupied	Not occupied		Not occupied	Not occupied	11-year-old female; not injured (16)
6	11-year-old male; not injured (17)	Not occupied	10-year-old female; C-injuries (18)		Not occupied	12-year-old female; not injured (19)	12-year-old female; B-injuries (20)*
7	Not occupied	Not occupied	12-year-old female; B-injuries (21)*		10-year-old female; not injured (22)	Not occupied	9-year-old female; not injured (23)
8	9-year-old female; not injured (24)	13-year-old female; B-injuries (25)	Not occupied		12-year-old male; not injured (26)	Not occupied	Not occupied
9	Not occupied	Not occupied	Not occupied		7-year-old male; not injured (27)	Not occupied	Not occupied
10	Not occupied	Not occupied	Not occupied		Not occupied	Not occupied	15-year-old female; A-injuries (28)*

Row	Left Seats			Center	Right Seats		
	Window	Center	Aisle	Aisle	Aisle	Center	Window
11	Not occupied	Not occupied	Not occupied		Not occupied	17-year-old male; not injured (29)	Not occupied
12	Not occupied	Not occupied	13-year-old male; not injured (30)		Not occupied	Not occupied	Not occupied
13	17-year-old female; B-injuries (31)*	Not occupied	15-year-old male; not injured (32)		14-year-old female; B-injuries (33)	Not occupied	15-year-old male; B-injuries (34)*

### Driver Demographics (CISSWEB Occupant #1, Seat 11)

Age/sex: 53 years/female  
 Height: 152 cm (60 in)  
 Weight: 87 kg (191 lb)  
 Eyewear: Unknown  
 Seat type: Bucket seat with integral head restraint  
 Seat track position: Unknown  
 Manual restraint usage: Lap and shoulder seat belt  
 Usage source: SCI vehicle inspection, police crash report  
 Air bags: None  
 Alcohol/drug data: BAC=0; negative for illegal drugs; positive for several prescription medications  
 Egress from vehicle: Fatal before removed  
 Transport from scene: Transported by ground ambulance to a hospital  
 Medical treatment: None

### Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Endocardium has multiple lacerations measuring up to ½ inches in length and ¼ inch in depth; right atrial appendage has lacerations up to 1 inch in length; right atrium has lacerations measuring up to ½ inch; right ventricle has scattered full-thickness lacerations up	441016.6	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
(Cont.)	to ½ inch; anterior left atrium has multiple partial-thickness lacerations up to ½ inch			
2	Aorta has multiple partial-thickness lacerations of the intima measuring up to ½ inch in length	420202.4	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
3	Pericardial sac has extensive lacerations with displacement of the heart	441602.2	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
4	Rib fractures/flail chest: Right anterior 2-5, anterolateral 1-9, posterior 2-3, lateral 7 <sup>th</sup> ; Left anterior 2-5, lateral 2-9	450214.5	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Front – Steering wheel (combination of rim and hub/spoke)	Possible Certain
5	Right hemothorax (400 mL)	442200.3	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Front – Steering wheel (combination of rim and hub/spoke)	Possible Certain
6	Left hemothorax (300 mL)	442200.3	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Front – Steering wheel (combination of rim and hub/spoke)	Possible Certain
7	Left lung has laceration to lower lobe, up to 1 inch in length and 1/8 inch in depth	441431.3	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Front – Steering wheel	Possible Certain

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
(Cont.)			(combination of rim and hub/spoke)	
8	Left lung has multiple contusions measuring up to ½ inch	441407.2	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Front – Steering wheel (combination of rim and hub/spoke)	Possible Certain
9	Transverse sternum fracture	450804.2	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Front – Steering wheel (combination of rim and hub/spoke)	Possible Certain
10	Liver has multiple lacerations measuring up to 2 inches in length and ½ inch depth	541822.2	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
11	Spleen has multiple lacerations measuring up to 4 inches in length and 1/8 inch depth	544222.2	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
12	Open fracture of left ulna/forearm	752214.3	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
13	Open fracture of distal left radius	752312.3	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
14	Open fracture of distal right femur, NFS	853332.3	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
15	Open fracture of distal left femur, NFS	853332.3	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
16	Open fracture of right tibia, NFS	854001.3	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
17	Open fracture of left tibia, NFS	854001.3	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
18	Open fracture of right patella, NFS	854501.2	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
19	Open fracture of left patella, NFS	854501.2	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
20	Open fracture of right fibula, NFS	854442.2	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
21	Open fracture of left fibula, NFS	854442.2	Isolated IPC Front – Left instrument panel (includes knee bolster)	Certain
22	Extensive deformity of left ankle with extensive soft tissue and muscle injury	852002.2	Isolated Floor – Floor (including toe pan)	Certain
23	Gaping full-thickness laceration to left lateral eyebrow/side of face, 2 x ½ inch in length and	210604.2	Isolated IPC Primary: Front – Windshield	Probable Possible

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
(Cont.)	depth of ¼ inch, exposing underlying soft tissue		Alternate: Front – Other front object (specify): forward bulkhead	
24	Left deep scalp and subgaleal hemorrhage	110402.1	Isolated Front – Other front object (specify): forward bulkhead	Possible
25	Linear irregular lacerations to left forehead, 4 x 4 inch area	210602.1	Isolated Front – Windshield	Probable
26	Inferior chin lacerations measuring up to ¼ inch	210602.1	Isolated Front – Windshield	Probable
27	Right chin contusions, measuring up to ½ inch	210402.1	Isolated Front – Windshield	Probable
28	Anterior chin has 3 linear abrasions measuring up to ¼ inch	210202.1	Isolated Front – Windshield	Probable
29	Linear irregular abrasions to left forehead, 4 x 4 inch area	210202.1	Isolated Front – Windshield	Probable
30	Scattered nose abrasions	210202.1	Isolated Front – Windshield	Probable
31	Lateral right breast has 6 ½ x 2 ¼ inch area of superficial lacerations, measuring up to 2 ½ inches in greatest dimension	410602.1	Isolated Interior – Shoulder portion of belt restraint	Possible
32	Lateral right breast has 6 ½ x 2 ¼ inch area of superficial contusions, measuring up to 2 ½ inches in greatest dimension	410402.1	Isolated Interior – Shoulder portion of belt restraint	Possible
33	Right mid back has 2 x 1 inch area of abrasions	410202.1	Isolated Interior – This occupant's seatback	Possible
34	Left lower abdomen has 2 x 2 inch round contusion	510402.1	Unknown	Unknown

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
35	Lateral left flank/chest has 1 ½ x 1 ½ inch area of abraded contusions	510402.1	Unknown	Unknown
36	Medial right upper arm has 1 ½ x 1 inch contusion and 2 x 1 inch contusion	710402.1	Isolated Front – Left instrument panel	Probable
37	Medial right arm has scattered linear abrasions up to ½ inch in length	710202.1	Isolated Front – Left instrument panel	Probable
38	Right posterolateral forearm has 1 inch linear laceration with depth up to ¼ inch	710602.1	Isolated Front – Left instrument panel	Probable
39	Right posterolateral forearm has ½ x ½ inch abrasion	710202.1	Isolated Front – Left instrument panel	Probable
40	Dorsal right hand has superficial lacerations measuring up to 3/8 inch	710602.1	Isolated Front – Windshield	Probable
41	Dorsal right hand has scattered linear abrasions measuring up to ¼ inch and a 3/8 x ¼ inch abrasion	710202.1	Isolated Front – Windshield	Probable
42	Dorsal right hand has contusions up to 2 inches	710402.1	Isolated Front – Left instrument panel	Probable
43	Lateral left upper arm has several linear lacerations, up to 1 ¾ inches in length and 1/8 inch in depth	710602.1	Isolated Front – Windshield	Probable
44	Left forearm has scattered lacerations	710602.1	Isolated Front – Windshield	Probable
45	Left forearm has scattered abrasions up to 4 x 3 inches	710202.1	Isolated Front – Windshield	Probable
46	Posterior left wrist has 1 ¾ inch linear laceration	710602.1	Isolated Front – Windshield	Probable
47	Posterior left wrist has 1 x 1 inch area of contusion	710402.1	Isolated Front – Left instrument panel	Probable

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
48	Dorsal left hand has scattered superficial lacerations up to 1 inch	710602.1	Isolated Front – Windshield	Probable
49	Dorsal left hand has scattered superficial abrasions up to ½ inch	710202.1	Isolated Front – Windshield	Probable
50	Posterior left thigh has scattered contusions measuring up to 1 inch	810402.1	Isolated Interior – This occupant’s seat cushion	Possible
51	Scattered contusions to lower right leg, NFS	810402.1	Isolated Front – Left instrument panel (includes knee bolster)	Probable
52	Scattered contusions to left lower leg, NFS	810402.1	Isolated Front – Left instrument panel (includes knee bolster)	Probable
53	Scattered abrasions to lower right leg, NFS	810202.1	Isolated Front – Left instrument panel (includes knee bolster)	Probable
54	Scattered abrasions to lower left leg, NFS	810202.1	Isolated Front – Left instrument panel (includes knee bolster)	Probable
55	Right ankle contusion, NFS	810402.1	Isolated Floor – Floor (including toe pan)	Probable
56	Left ankle contusion, NFS	810402.1	Isolated Floor – Floor (including toe pan)	Probable
57	Right foot contusion, NFS	810402.1	Isolated Floor – Floor (including toe pan)	Probable
58	Left foot contusion, NFS	810402.1	Isolated Floor – Floor (including toe pan)	Probable

Source: autopsy report (internal).

## Driver Kinematics

The bus driver was seated with an unknown track adjustment with an upright seatback and was restrained by the manual 3-point lap and shoulder seat belt system. Based on the onboard video, the bus was traveling approximately 74 km/h (46 mph), and the driver braked immediately prior to impact with the Freightliner. At final rest, the bus's wheels were turned approximately 30 degrees right, indicative of an evasive steering maneuver.

The driver responded to the initial braking with a forward trajectory and she loaded the seat belt. At impact with the Freightliner, the driver responded to the 11 o'clock impact force as she continued to load the seat belt. Due to the design and configuration of the type-D bus, at impact, the bulkhead, windshield, instrument panel, and steering column began to immediately crush and intrude into the driver's space. The driver's torso loaded the lower aspect of the steering wheel rim, deforming the rim upward and bending the steering wheel spokes. As a result, she sustained lacerations of the endocardium, the aorta, and the pericardium, with rib fractures and flail chest. Additionally, she sustained bilateral hemothoraces, liver and spleen lacerations, left pulmonary contusions and lacerations, and a sternum fracture.

Her knees and lower legs engaged the intruding left lower instrument panel, resulting in fractures, lacerations, abrasions, and contusions. The driver's upper extremities contacted the intruding left instrument panel, causing fractures, lacerations, abrasions, and contusions. The gasket-mounted windshield fractured due to body deformation, separated, and intruded into the driver's space, causing lacerations of the face and upper extremities.

The driver remained in her seat position due to seat belt use and was entrapped in the deformed compartment. She was pronounced deceased at the crash site, and her body was extricated by first responders.

## Row 1 Left, Left Passenger Demographics (CISSWEB Occupant #2, Seat 21)

Age/sex:	7 years/female
Height:	131 cm (51.5 in)
Weight:	26 kg (58 lb)
Eyewear:	None
Seat type:	Bus bench, forward-facing, with high back
Seat track position:	Non-adjustable
Manual restraint usage:	None available
Usage source:	SCI vehicle inspection
Air bags:	None available
Alcohol/drug data:	None
Egress from vehicle:	Fatal before removed
Transport from scene:	Transported by ground ambulance to a hospital
Medical treatment:	None

### Row 1 Left, Left Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Injuries to the thorax, NFS	400099.9	Critical 2-point IPC IPC 1: Left Side – Other left side object (specify): left wall of bus IPC 2: Interior – Other interior object (specify): partition in front of this seat	Certain  Certain

Source: medical examiner's report (external).

### Row 1 Left, Left Passenger Kinematics

This passenger was one of two students in the seat and was on the left aspect of the seat, next to the left wall of the bus. She was not belted; the bus was not equipped with seat belts for the passengers. Based on the bus's video, she was seated with her head initially turned to the left, looking out the window. As the bus braked, her head turned straight ahead and she was displaced forward and slightly to the right and likely contacted the padded partition forward of her position.

At impact with the Freightliner, the bus crushed and deformed. The left wall buckled outward between the left B- and C-pillars adjacent to the partition. The buckling of the wall created a void. The passenger responded to the 11 o'clock direction of impact force with a forward and left trajectory. She was displaced along the left aspect of the partition and into the void. At final rest, she was found entrapped between the left edge of the partition and the left wall of the bus. She was removed through a space at the front of the bus created by rescue personnel and was pronounced deceased at the crash scene. No internal autopsy was conducted, only an external examination. The report lists the cause of death as traumatic asphyxia due to chest compression/wedging. A contributing condition of blunt force trauma was also cited. No other details were provided.

### Row 1 Left, Right Passenger Demographics (CISSWEB Occupant 3, Seat 22)

Age/sex: 8 years/female  
 Height: 133 cm (52 in)  
 Weight: 31 kg (68 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None

Egress from vehicle: Removed through emergency door due to serious injury  
 Transport from scene: Transported by helicopter to a level 1 trauma center  
 Medical treatment: Admitted for 7 days

**Row 1 Left, Right Passenger Injuries**

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
1	Comminuted intertrochanteric fracture of left femur	853151.3	ICS 1: Critical 2-point IPC #1 – Interior – This occupant’s seat cushion #2 – Interior – Other interior objects (specify): partition in front of this seat ICS 2: Isolated IPC Floor – Floor (including toe pan)	Probable Probable Probable
2	Left femoral neck fracture	853161.3	ICS 1: Critical 2-point IPC #1 – Interior – This occupant’s seat cushion #2 – Interior – Other interior objects (specify): partition in front of this seat ICS 2: Isolated IPC Floor – Floor (including toe pan)	Probable Probable Probable
3	Closed comminuted fracture of mid-shaft of left tibia	854271.2	Isolated IPC Interior – This occupant’s seat cushion	Certain
4	Closed fracture of left condylar process of mandible	250603.1	Isolated Interior – This occupant’s seat cushion	Possible
5	Minor abrasion to shin of left leg	810202.1	Isolated Interior – This occupant’s seat cushion	Certain

Source: hospital records.

### Row 1 Left, Right Passenger Kinematics

This passenger was the second of two students sharing this seat and was closest to the aisle. Based on the bus's video, the passenger was kneeling on the seat cushion and facing rearward with her right hand on top of her seatback. She had turned slightly to her left just prior to braking and as the bus braked, she lost her grip on the seatback and was displaced forward into the padded partition. At impact with the Freightliner, she likely remained in contact with the partition as the bus crushed and deformed. The buckling of the floor altered the spacing between the partition and her seat and it is likely that she became wedged between the partition and her own seat cushion. This crushing likely caused the intertrochanteric fracture of her left femur and the left femoral head fracture. It is also possible that the injuries were caused by contact with the floor, which is what the passenger told medical staff. She was flown by helicopter to a level 1 trauma center, where she was admitted for seven days.

### Row 1 Right, Right Passenger Demographics (CISSWEB Occupant #4, Seat 27)

Age/sex: 9 years/male  
 Height: 142 cm (56 in)  
 Weight: 30 kg (66 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward-facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Removed through emergency door due to serious injury  
 Transport from scene: Transported by helicopter to a level 1 trauma center  
 Medical treatment: Admitted for 15 days

### Row 1 Right, Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Contusional hemorrhages of bilateral frontal lobes and left occipital lobe	140620.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
2	Extensive dural laceration that extended from frontal region down to skull base	140688.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
3	Epidural hematoma – right frontal, left temporal	140630.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
4	Open fracture of skull – frontal	150404.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
5	Skull base fractures, NFS	150200.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
6	Stenosis of bilateral intracranial internal carotid artery, consistent with Grade 1 injury	121099.3	Caused by other injury (skull base fracture – injury #6)	Certain
7	Right lung laceration – middle lobe	441430.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
8	Multiple right lung contusions – right upper and middle lobes	441408.3	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
9	Small right pneumothorax	442202.2	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
10	Le Fort II fracture: right frontal bone; right superior medial, and inferior orbital walls; orbital apex; right maxillary sinus, ethmoid sinuses, sphenoid sinus, and pterygomaxillary fissure extending to middle crania fossa; non-displaced fracture of posterior wall of right maxilla; left frontal sinus, carotid, left maxilla, left medial orbital wall, left ethmoid air cells, left inferior maxillary sinus;	250806.2	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
(Cont.)	depression of nasal bridge, Vomer fracture			
11	Left cheek laceration, 3 cm	210602.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
12	Right periorbital bruising	210402.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
13	Left lower neck laceration, NFS	310600.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
14	Left forearm laceration, 6 cm	710602.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
15	Scattered abrasions to left forearm	710202.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
16	Right forearm laceration, 4 cm	710602.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
17	Left arm shallow lacerations	710602.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
18	Left arm abrasions	710202.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain
19	Right frontal scalp contusion	110402.1	Isolated IPC Front – Other frontal object (specify): forward bulkhead	Certain

Source: hospital records.

### Row 1 Right, Right Passenger Kinematics

The row 1 right passenger occupied this seat alone. Based on the bus’s video, the passenger was standing near the right wall of the bus, facing rearward, with his back against the padded partition. His head and neck were visible above the level of the partition. There were several plastic bags of full milk cartons in the seat directly in front of him. He maintained his standing position as the bus’s braking occurred. As the bus driver braked, he turned his head to his right to look forward.

At impact the passenger responded with a forward trajectory and loaded the partition with his torso. As the bus crushed and structures intruded, the passenger’s head contacted the right aspect of the bulkhead, which had intruded longitudinally 94 cm (37 in). At the inspection, the bulkhead was flush with the top of the partition. The passenger sustained an open skull fracture, brain contusions, facial fractures, and lung contusions from the impact to the bulkhead. He was transported by helicopter to a level 1 trauma center, where he was admitted for 15 days.

### Row 2 Left, Left Passenger Demographics (CISSWEB Occupant #5, Seat 31)

Age/sex: 8 years/male  
 Height: Unknown  
 Weight: 30 kg (66 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Removed through emergency door due to serious injury  
 Transport from scene: Transported by helicopter to a level 1 trauma center  
 Medical treatment: Admitted for 4 days

### Row 2 Left, Left Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Displaced unstable pelvic ring fracture: dislocation of pubic symphysis, right sacral ala fracture, right superior pubic ramus fracture. Left sacral fracture, left iliac bone fracture	856161.3	Isolated IPC Interior – Other seating position seatback	Probable
2	Comminuted left acetabulum fracture, both	856271.2	Isolated IPC Interior – Other seating position seatback	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
(Cont.)	anterior and posterior columns			
3	Tiny fracture fragments near medial malleolus of right tibia	854331.2	Isolated IPC Floor – Floor (including toe pan)	Probable
4	Contusion to right ankle	810402.1	Isolated Floor – Floor (including toe pan)	Probable
5	Contusion to left ankle	810402.1	Isolated Floor – Floor (including toe pan)	Probable
6	Abrasion to left ankle	810202.1	Isolated Floor – Floor (including toe pan)	Probable

Source: hospital records.

### Row 2 Left, Left Passenger Kinematics

This passenger occupied the row 2 left seat alone. Based on the bus's video, he was initially standing with his back toward the left side/window of the bus and was talking to the row 2 right passenger. Approximately 10 seconds prior to impact, he sat down or knelt down below the level of the seatback, out of camera view. The bus's braking and the impact displaced him forward and into the seatback in front of him. He sustained a pelvic ring fracture, a left acetabulum fracture, and a fracture to his right tibia. The pelvic and acetabulum fractures were caused by the passenger striking the seatback in front of him, and the leg injuries were probably caused by contact with the floor. He was transported by helicopter to a hospital and underwent surgery for his injuries.

### Row 3 Left, Right Passenger Demographics (CISSWEB Occupant #8, Seat 43)

Age/sex: 8 years/male  
Height: Unknown  
Weight: 35 kg (77 lb)  
Eyewear: None  
Seat type: Bus bench, forward-facing, with high back  
Seat track position: Non-adjustable  
Manual restraint usage: None available  
Usage source: SCI vehicle inspection  
Air bags: None available  
Alcohol/drug data: None  
Egress from vehicle: Removed through emergency door due to serious injury  
Transport from scene: Transported by helicopter to a level 1 trauma center  
Medical treatment: Admitted for 4 days

### Row 3 Left, Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Comminuted right frontal calvarial fracture with depressed component inferiorly up to 0.6 cm	150406.4	Isolated IPC Floor – Floor (including toe pan)	Probable
2	Small subdural hematoma to right frontal lobe	140651.3	Caused by other injury (skull fracture – injury #1)	Probable
3	Laceration to right kidney, Grade 4	541626.4	Isolated IPC Floor – Floor (including toe pan)	Probable
4	Laceration of right lobe of liver, 4.2 x 4 x 5.3 cm, Grade 3	541824.3	Isolated IPC Floor – Floor (including toe pan)	Probable
5	Bilateral pulmonary contusions	441411.3	Isolated IPC Floor – Floor (including toe pan)	Probable
6	Trace right pneumothorax	442202.2	Isolated IPC Floor – Floor (including toe pan)	Probable
7	Trace left pneumothorax	442202.2	Isolated IPC Floor – Floor (including toe pan)	Probable
8	Small pneumomediastinum	442209.2	Isolated IPC Floor – Floor (including toe pan)	Probable
9	Lateral condylar fracture of distal right humerus	751361.2	Isolated IPC Floor – Floor (including toe pan)	Probable
10	Fracture of right radial neck	752151.2	Isolated IPC Floor – Floor (including toe pan)	Probable
11	Proximal right fibula metaphysis fracture	854471.2	Isolated IPC Floor – Floor (including toe pan)	Probable
12	Right scalp hematoma	110402.1	Isolated Floor – Floor (including toe pan)	Probable
13	Abrasion to back	410402.1	Unknown	Unknown
14	Abrasion to right shoulder	710202.1	Isolated Floor – Floor (including toe pan)	Probable

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
15	Bruising to right upper extremity	710402.1	Isolated Floor – Floor (including toe pan)	Probable
16	Bruising to right lower extremity	810402.1	Isolated Floor – Floor (including toe pan)	Probable
17	Bruising to left lower extremity	810402.1	Isolated Floor – Floor (including toe pan)	Probable
18	Ecchymosis to right flank	510402.1	Isolated Floor – Floor (including toe pan)	Probable

Source: hospital records.

### **Row 3 Left, Right Passenger Kinematics**

This passenger occupied the right (aisle) position of this seat and shared it with two other students. Based on the bus’s video, he was seated and looking forward. Two seconds prior to impact, the bus’s braking displaced him forward and onto his feet briefly. He brushed the right end of the second row left seatback with the right side of his face and his chest and rotated 90 degrees counterclockwise into the aisle. He lost footing and fell forward into the aisle.

The impact with the Freightliner projected him farther forward, and his head probably contacted the intruded/buckled structures. He sustained an open skull fracture, lung and kidney contusions, a liver laceration, and a fractured right elbow and fibula. He was transported by helicopter to a hospital, where he underwent surgery for his head injury.

### **Row 3 Right, Left Passenger Demographics (CISSWEB Occupant #9, Seat 45)**

Age/sex: 8 years/male  
Height: Unknown  
Weight: 21 kg (45 lb)  
Eyewear: None  
Seat type: Bus bench, forward-facing, with high back  
Seat track position: Non-adjustable  
Manual restraint usage: None available  
Usage source: SCI vehicle inspection  
Air bags: None available  
Alcohol/drug data: None  
Egress from vehicle: Exited through emergency door  
Transport from scene: Transported by ambulance to a local hospital  
Medical treatment: Treated and released

### Row 3 Right, Left Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Contusion to nose	210402.1	Isolated Interior – Other seating position seatback	Certain
2	Abrasion of right cheek	210202.1	Isolated Interior – Other seating position seatback	Certain
3	Right chest abrasion	410202.1	Isolated Interior – Other seating position seatback	Certain
4	Abrasion to right clavicle	710202.1	Isolated Interior – Other seating position seatback	Certain
5	Contusion to anterior right thigh	810402.1	Isolated Interior – Other seating position seatback	Certain
6	Abrasion to right lower leg	810202.1	Isolated Interior – Other seating position seatback	Certain

Source: emergency room records.

### Row 3 Right, Left Passenger Kinematics

This passenger was the first of three passengers sharing this seat and was closest to the aisle. Based on the bus's video, the passenger was sitting in his seat properly, facing forward. At impact, he translated forward, directly into the seatback in front of him. Video evidence shows his face striking the seatback, which led to contusions and abrasions to his face. Other injuries sustained from contact with the forward seatback include abrasions to his right chest, clavicle, thigh, and lower leg. This passenger was treated and released from the emergency room.

### Row 3 Right, Center Passenger Demographics (CISSWEB Occupant #10, Seat 46)

Age/sex: 6 years/male  
 Height: Unknown  
 Weight: 33 kg (73 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward-facing, with high back  
 Seat track position: Non-adjustable

Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Exited through emergency door  
 Transport from scene: Transported by private vehicle to a local hospital  
 Medical treatment: Treated and released

### Row 3 Right, Center Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Contusion to right lower leg	810402.1	Isolated Interior – Other seating position seatback	Certain
2	Contusion to left lower leg	810402.1	Isolated Interior – Other seating position seatback	Certain

Source: emergency room records.

### Row 3 Right, Center Passenger Kinematics

This passenger was the second of three students sharing this seat and was sitting between two other male students. Based on the bus’s video, it appears that the passenger was sitting in his seat properly, facing forward. At impact, he translated forward and into the seatback in front of him. This passenger sustained contusions to both lower legs due to contact with the forward seatback. He was taken to the hospital by a caregiver and was treated and released from the emergency room.

### Row 5 Left, Left Passenger Demographics (CISSWEB Occupant #15, Seat 61)

Age/sex: 10 years/male  
 Height: Unknown  
 Weight: 61 kg (134 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward-facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Exited through emergency door  
 Transport from scene: Transported by ambulance to a level 1 trauma center  
 Medical treatment: Admitted for 1 day

### Row 5 Left, Left Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Left parietal scalp hematoma, 2-3 cm	110402.1	Isolated Interior – Other seating position seatback	Probable
2	Left parietal scalp abrasion, 2-3 cm	110202.1	Isolated Interior – Other seating position seatback	Probable
3	Contusion to abdominal wall	510402.1	Isolated Interior – Other seating position seatback	Probable
4	Abrasion to abdominal wall	510202.1	Isolated Interior – Other seating position seatback	Probable

Source: hospital records.

### Row 5 Left, Left Passenger Kinematics

This passenger was the only student in this row on the left side of the bus. He was standing in front of his seat, facing toward the aisle, as shown on video. At impact he translated forward, directly into the seatback in front of him, which probably caused the scalp contusion and abrasion, as well as the contusion and abrasion to his abdominal wall. He was kept overnight in the hospital for observation.

### Row 6 Right, Right Passenger Demographics (CISSWEB Occupant #20, Seat 77)

Age/sex: 12 years/female  
 Height: Unknown  
 Weight: 50 kg (110 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward-facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Exited through emergency door  
 Transport from scene: Transported by ambulance to a local hospital  
 Medical treatment: Treated and released

### Row 6 Right, Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Salter-Harris Type 1 physeal fracture of lower end of right tibia	854331.2	Isolated IPC Floor – Floor (including toe pan)	Probable
2	Salter-Harris Type 1 physeal fracture of lower end of right fibula	854441.2	Isolated Floor – Floor (including toe pan)	Probable
3	Sprain of cervical spine ligaments	640278.1	Isolated Interior – Other seating position seatback	Probable
4	Left shin laceration, NFS	810600.1	Isolated Interior – Other seating position seatback	Probable
5	Ecchymosis of right ankle	810402.1	Isolated Floor – Floor (including toe pan)	Probable

Source: emergency room records.

### Row 6 Right, Right Passenger Kinematics

This passenger was seated in this row on the right side of the bus, sitting closest to the window. Her exact posture prior to impact is unknown, but the video appears to show her seated properly, facing forward. She sustained a Salter-Harris Type 1 physeal fracture to her distal right tibia and fibula, most likely due to twisting her ankle on the floor of the bus. Her right ankle was also bruised due to contact with the floor. She sustained cervical strain and an unspecified laceration to her left shin, probably due to contact with the seatback in front of her. This passenger was transported to the hospital by ambulance and was treated and released from the emergency room.

### Row 7 Left, Right Passenger Demographics (CISSWEB Occupant #21, Seat 83)

Age/sex: 12 years/female  
 Height: 160 cm (63 in)  
 Weight: 63 kg (138 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward-facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Exited through emergency door  
 Transport from scene: Transported by private vehicle to a local hospital  
 Medical treatment: Treated and released

### Row 7 Left, Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Mild anterior subluxation of proximal coccyx relative to sacrum	640678.1	Isolated Floor – Floor (including toe pan)	Probable
2	Abrasion to upper right forehead	210202.1	Isolated Interior – Other seating position seatback	Possible

Source: emergency room records.

### Row 7 Left, Right Passenger Kinematics

This passenger was the only student in this row on the left side of the bus, sitting closest to the aisle. Although her posture prior to impact is unknown, the video shows the passenger being thrown forward and toward the floor in front of her seat. She sustained a strain to her coccyx, probably from impact with the floor, and an abrasion to her forehead, possibly from the seatback in front of her. This passenger was transported to the hospital by a private vehicle and was treated and released from the emergency room.

### Row 10 Right, Right Passenger Demographics (CISSWEB Occupant #28, Seat C7)

Age/sex: 15 years/female  
 Height: Unknown  
 Weight: 50 kg (110 lb)  
 Eyewear: None  
 Seat type: Bus bench, forward-facing, with high back  
 Seat track position: Non-adjustable  
 Manual restraint usage: None available  
 Usage source: SCI vehicle inspection  
 Air bags: None available  
 Alcohol/drug data: None  
 Egress from vehicle: Removed through emergency door due to serious injury  
 Transport from scene: Transported by helicopter to a level 1 trauma center  
 Medical treatment: Admitted for 1 day

### Row 10 Right, Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Contusion to right upper lateral and posterior thigh posterolateral	810402.1	Isolated Interior – This occupant’s seat cushion	Probable

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
2	Right posterior hip contusion	810402.1	Isolated Interior – This occupant’s seat cushion	Probable
3	Right posterior hip abrasion	810202.1	Isolated Interior – This occupant’s seat cushion	Probable

Source: hospital records.

### Row 10 Right, Right Passenger Kinematics

This passenger was the only student in this row of the bus, and was sitting on the right side, with her back against the window (facing toward the center aisle). Video shows her sitting sideways with her feet on the seat. At impact, the seat cushion separated from its bracket and pitched down onto the floor. She sustained contusions to her right thigh and hip, probably from impact with the seat cushion as she fell with the cushion. This passenger was transported to a level 1 trauma center and admitted for one day.

### Row 13 Left, Left Passenger Demographics (CISSWEB Occupant #31, Seat G1)

Age/sex: 17 years/female  
Height: 168 cm (66 in)  
Weight: 61 kg (134 lb)  
Eyewear: None  
Seat type: Bus bench, forward-facing, with high back  
Seat track position: Non-adjustable  
Manual restraint usage: None available  
Usage source: SCI vehicle inspection  
Air bags: None available  
Alcohol/drug data: None  
Egress from vehicle: Exited through emergency door  
Transport from scene: Transported by private vehicle to a local hospital  
Medical treatment: Treated and released

### Row 13 Left, Left Passenger Injuries

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
1	Lower lip laceration, 1/3 cm linear, partial thickness	210602.1	Isolated Interior – Other seating position seatback	Certain

<b>Injury No.</b>	<b>Injury</b>	<b>Injury Severity AIS 2015</b>	<b>Involved Physical Component (IPC)</b>	<b>IPC Confidence Level</b>
2	Chest wall contusion	410402.1	Isolated Interior – Other seating position seatback	Certain
3	Back contusion	810202.1	Isolated Interior – This occupant’s seatback	Certain
4	Thoracic spine strain	640478.1	Isolated Interior – Other seating position seatback	Probable

Source: emergency room records.

### **Row 13 Left, Left Passenger Kinematics**

This passenger was seated in the last row closest to the window with her knees initially resting on the seatback in front of her. As the bus began decelerating, this passenger sat up and was then thrown forward into the seatback in front of her. This caused the lower lip laceration due to face contact with the seatback, which forced her lower lip into her teeth. She also sustained a chest contusion from the forward seatback, and while rebounding back into her own seating position, her back contacted her own seatback, causing a back contusion. She also sustained thoracic spine strain, probably due to contact with the forward seatback. This passenger was transported by a private vehicle to a local hospital, where she was treated and released.

### **Row 13 Right, Right Passenger Demographics (CISSWEB Occupant #34, Seat G7)**

Age/sex: 15 years/male  
Height: 170 cm (67 in)  
Weight: 55 kg (121 lb)  
Eyewear: None  
Seat type: Bus bench, forward-facing, with high back  
Seat track position: Non-adjustable  
Manual restraint usage: None available  
Usage source: SCI vehicle inspection  
Air bags: None available  
Alcohol/drug data: None  
Egress from vehicle: Exited through emergency door  
Transport from scene: Transported by private vehicle to a local hospital  
Medical treatment: Treated and released

### Row 13 Right, Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Right elbow laceration	710602.1	Isolated Right Side – Other right side object (specify): Right wall of bus	Probable
2	Right elbow contusion	710402.1	Isolated Right Side – Other right side object (specify): Right wall of bus	Probable
3	Contusion to nose	210402.1	Isolated Interior – Other seating position seatback	Certain

Source: emergency room records.

### Row 13 Right, Right Passenger Kinematics

This passenger was seated in the last row of the bus, on the right side, closest to the window. Video shows the passenger seated properly, and upon deceleration of the bus, he translated forward. Images of the right wall of the bus at this seating position show blood dripping down the wall, most likely from this passenger's elbow laceration. The laceration and contusion likely occurred due to contact with the wall or an exposed screw protruding from the wall. This passenger also sustained a nose contusion from contact with the seatback forward of this seating position. He was transported to a local hospital by a private vehicle, where he was treated and released.

### Remaining Passenger Kinematics Overview

The remaining passengers on the bus, ranging in age from 6 to 17, were either reported as having minor (C-type) injuries, not been injured, or their treatment was unknown.

Based on the bus's videos, the frontal impact displaced all passengers forward and left toward the 11 o'clock direction of force, and the passengers contacted the backs of the seats in front of them. Many of the seatbacks showed contact and damage from these displacements. All passengers who sustained non-fatal injuries exited the bus through the emergency door.

## 2018 Freightliner M2 Utility Truck

The Freightliner was a class 7, 2-axle, medium/heavy truck identified by the Vehicle Identification Number 3ALACXFC4JDxxxxxx and manufactured in May 2017 as a chassis cab/incomplete vehicle. It was outfitted for use as a utility truck for an electrical company. The truck carried a variety of heavy-duty electrical service equipment and was equipped with an overhead “boom” crane. The 4x2 power train consisted of a 6.7-liter, V-6, diesel engine, and the truck was configured on a 458 cm (180.3 in) wheelbase. The gross vehicle weight rating was 14,968 kg (33,000 lb), with axle front and rear axle ratings of 5,443 kg (12,000 lb) and 9,525 kg (21,000 lb), respectively. The vehicle weighed approximately 11,793 kg (26,000 lb) according to the investigating police officer. The manufacturer’s recommended tire size was 11R22.5, and the vehicle was equipped with Michelin XZE2 tires of the recommended size. All tires were in good condition prior to the crash.

### Exterior Damage

The Freightliner sustained direct contact to the front bumper during the impact with the mailbox post (Event 1). Direct damage began 87 cm (34.3 in) right of the center line and extended 22 cm (8.7 in) to the right. The field L was 230 cm (90.6 in) and measurements were taken on the bumper. The crush depth was 2 cm (0.8 in) or less. The WinSMASH program could not be used to determine velocity change because this vehicle is out of scope for the program. The TDC for this event was 02FRLN1 (60 degrees).

The Freightliner sustained direct contact to the right plane during the impact with the bus (Event 2, Figure 16). The right cargo box, rear wheel, crane, and back right corner of the cab were directly damaged. The direct damage began 63 cm (24.8 in) behind the right rear axle and extended 301 cm (118.5 in) forward. The WinSMASH program could not be used on this to determine velocity change because both vehicles are out of scope for the program. The TDC for this event was 02RZAWB.

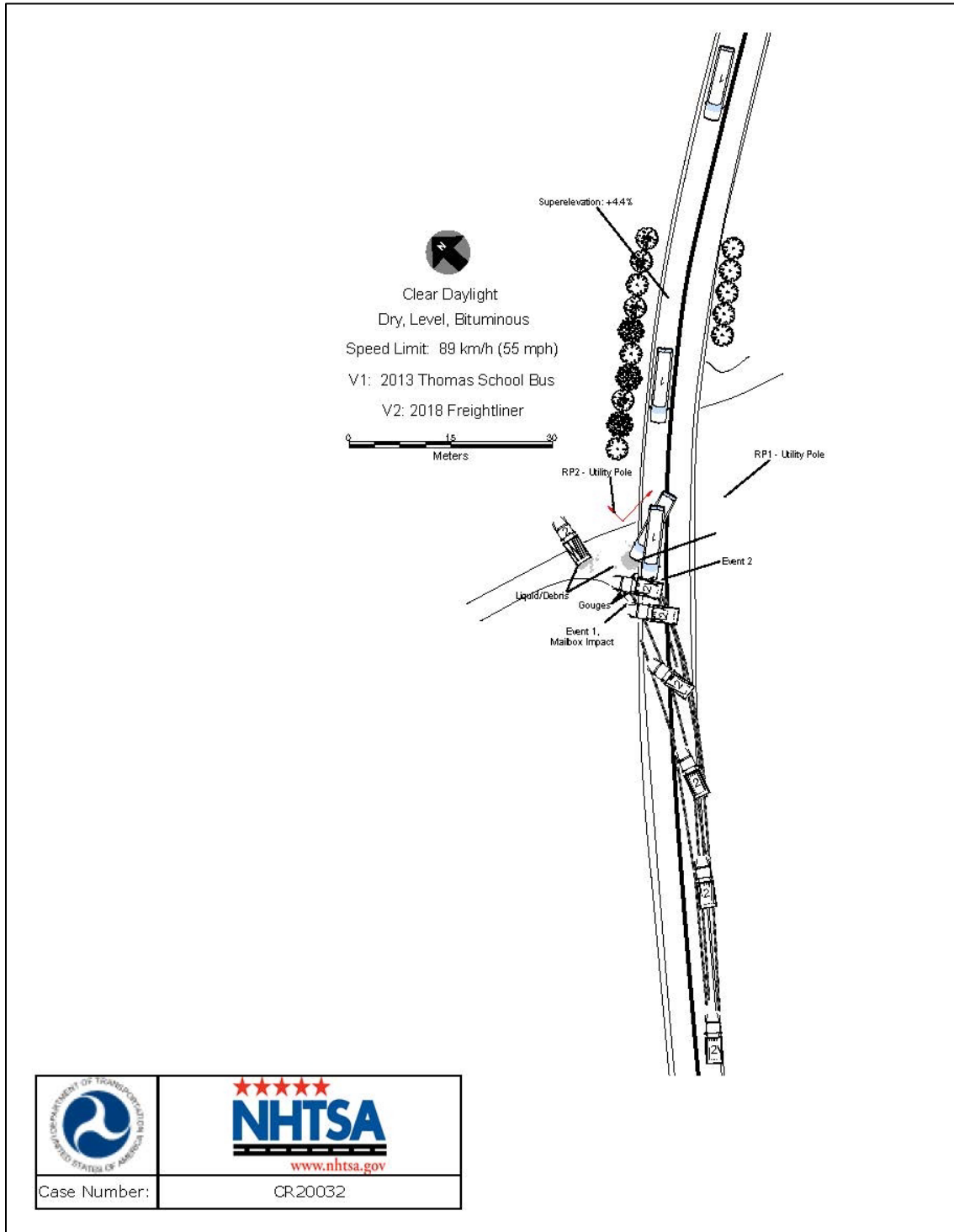


Figure 16. The Freightliner, right plane damage (rear half)

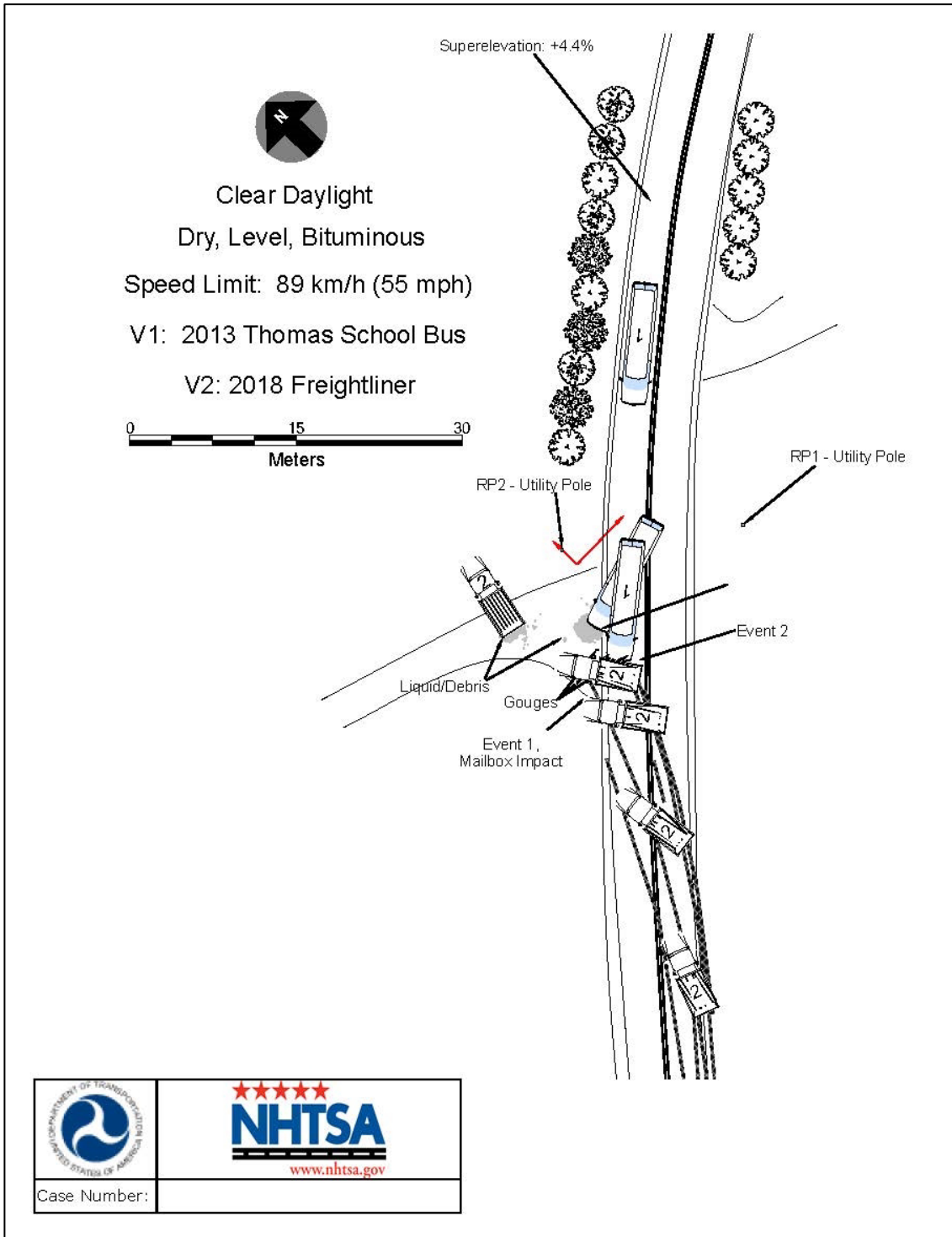
### **Freightliner Occupant Data**

The driver of the Freightliner was a 56-year-old male. It was reported by the police that he was belted at the time of the crash and did not sustain any injuries. He was not transported and did not seek medical treatment.

# Crash Diagram



## Crash Diagram (A Close View)



DOT HS 813 284  
May 2022



U.S. Department  
of Transportation  
**National Highway  
Traffic Safety  
Administration**

