National Transportation Safety Board

Office of Highway Safety

Washington, DC 20594

HWY23FH005

VEHICLE FACTORS

Group Chair's Factual Report

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A. CRASH

Location: Louisville, St. Lawrence County, New York
Date: January 28, 2023
Time: 6:00 a.m. Eastern Standard Time

B. VEHICLE FACTORS GROUP

Group Chair	Jason Zeitler NTSB - Office of Highway Safety 490 L'Enfant Plaza East, S.W., Washington, DC 20594
Group Member	David Pereira NTSB – Special Operations 490 L'Enfant Plaza East, S.W., Washington, DC 20594
Group Member	Investigator Anthony Bissonette New York State Police, Collision Reconstruction Unit B 1097 State Route 83, Ray Brook, NY 12977
Group Member	Investigator Brian Baxter New York Department of Transportation, Motor Carrier 50 Wolf Road, Albany, NY 12232

C. SUMMARY

For a summary of the crash, refer to the Crash Information and Summary Report, in the docket for this investigation.

D. DETAILS OF THE VEHICLE FACTORS INVESTIGATION

The Vehicle Factors Group Chairman's Factual Report is a collection of information regarding the vehicles involved in this collision. This report focuses on details obtained during the examinations of the 2021 Freightliner truck (truck) and the 2013 Micro Bird school bus (bus) that were conducted between January 30 and February 6, 2023.

The New York State Police (NYSP) conducted a preliminary inspection of both vehicles while on scene. Both vehicles remained secured in NYSP's impound lot until they were towed to an indoor secured Department of Transportation (DOT) location adjacent to the NYSP's facility, in Ray Brook, New York, where the vehicles were inspected by NTSB investigators in conjunction with the NYSP. During the inspection of both vehicles, all major mechanical systems were examined, including steering, braking, and suspension systems. The overall collision damage was documented, as well as any damage or anomalies within the major vehicle mechanical systems. Event data recorders and collision mitigation systems were also imaged and will be explored in this report.

E. VEHICLE EXAMINATIONS

1.0 Vehicle #1: 2021 Freightliner M2 106 Chassis and Morgan Box

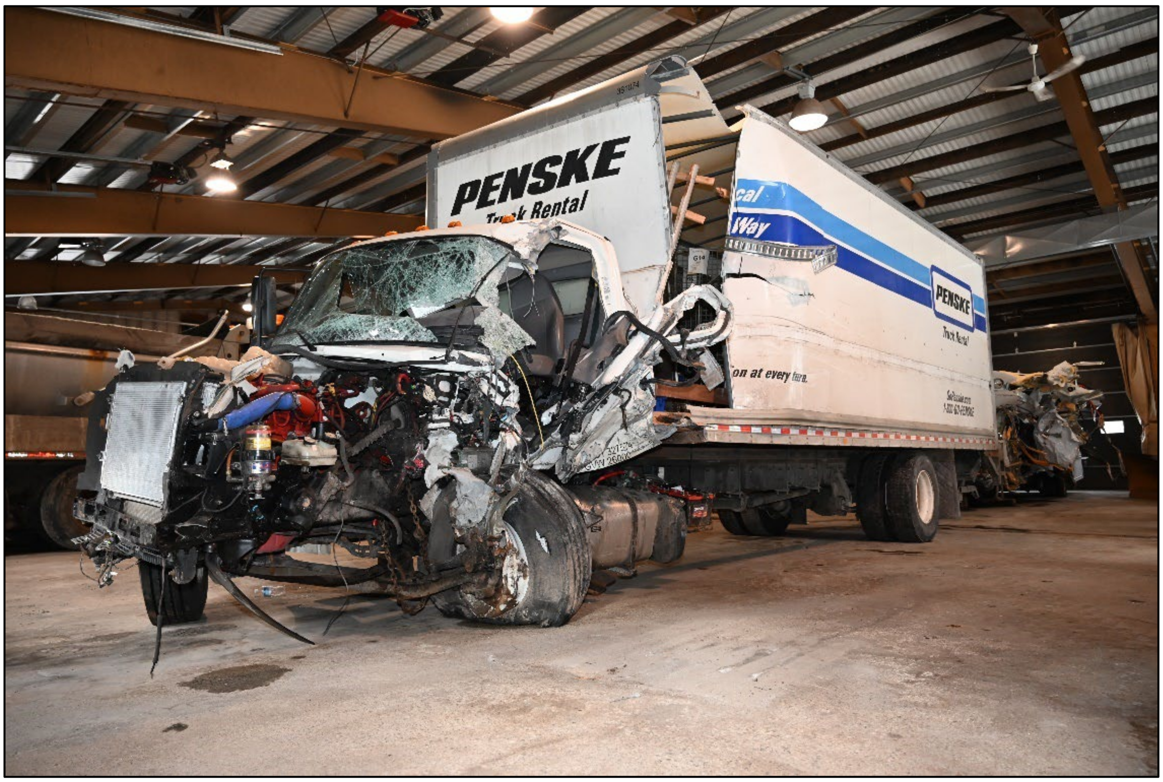

Figure 1: Truck - Subject Freightliner M2 Chassis with Morgan Straight Box

1.1 General Information

Freightliner Chassis[1]:

VIN[2]:	3ALACWFC1MDMS3297
Registration:	V75-377 (MA)
Make:	Freightliner
Model:	M2 106 2-axle conventional chassis (MM106042S)
Model Year:	2021
Date of Manufacture:	August 2020
Mileage:	Unknown due to collision related electrical issues during inspection

[1] See Vehicle Factors Attachment: *Freightliner Build Sheet Document.*

[2] Vehicle Identification Number (VIN).

Curb Weight[3]:	18,292 lbs. (total)
Wheelbase:	270”
GVWR[4]:	26,000 lbs.
GAWR – Axle #1[5]:	10,000 lbs.
GAWR – Axle #2:	19,000 lbs.
Engine:	Cummins Diesel B6.7 220 HP / 2400 RPM
Transmission:	Allison 6-speed 2200 RDS Automatic Transmission
Rear Axle Ratio:	5.22
Steering Gear:	TRW THP-60
Brake Type:	Air-operated drum brakes with antilock braking system (ABS); WABCO 4S/4M system
Collision Avoidance:	WABCO OnGuard Gen 2 Collision Mitigating System

Straight Box:

Make:	Morgan Truck Body, LLC
Model Number:	GVMD1032610
Serial Number:	MCT01490-002
Unit Number:	381074
Model Year:	2020
Date of Manufacture:	September 2020
Retroreflective tape:	DOT-C2 conspicuity tape – Red/White

Rear lift:

Make:	WALTCO Lift Corp.
Model Number:	Placard illegible
Serial Number:	793710
Capacity:	3000 lbs.
Date of Manufacture:	September 2020

1.2 Vehicle Summary

The truck was a two-stage manufactured straight truck, also referred to as a box truck. The first stage consisted of a Freightliner M2 106 conventional chassis, manufactured in August of 2020. The second stage of the truck was a Morgan GVMD1032610 box, which was manufactured in September of 2020. The truck was also equipped with a WALTCO lift, which was manufactured in September of 2020. The

[3] Included an estimated driver’s weight of 250 pounds from Morgan Truck Body, LLC.

[4] Gross Vehicle Weight Rating (GVWR) is the maximum operating weight of a vehicle as specified by the manufacturer including the vehicle's chassis, body, engine, engine fluids, fuel, accessories, driver, passengers, and cargo.

[5] The gross axle weight rating (GAWR) is the maximum distributed weight that may be supported by an axle of a road vehicle.

truck was equipped with event data recorders (EDR) and collision mitigation technologies that will be discussed further in sections 1.15 and 1.16 of this report.

1.3 Terrestrial Laser Scans

The NYSP captured 3D terrestrial laser scans of the damaged truck. The laser scans were processed by the NYSP, and the NTSB was provided with an e57[6] version of the resulting point cloud. The point cloud was comprised of millions of colorized measurement points that could be used to preserve a scaled version of the damaged vehicle and could provide a basis with regards to deformation, impact configuration, speed analysis, and many other analytical computations. A sampling of images of the resulting point cloud for the damaged truck is shown below in Figure 2.

Figure 2: Truck - Scan Images of The Resulting Point Cloud

[6] e57 is a point cloud file format that can be imported into many point cloud capable software packages.

1.4 Damage Description

In this report, "left" refers to the driver's side, and "right" refers to the passenger's side of the vehicle. The truck sustained collision damage to the left-front and left side of the vehicle, affecting major mechanical systems. Damage specific to corresponding vehicle components will be described in greater detail in the appropriate sections of this report.

The interior and exterior of the truck were inspected. The entire width of the windshield was cracked, torn, and damaged. The left A-pillar was damaged and torn from the vehicle. Due to the missing left A-pillar, portions of the windshield wrapped around the left-side of the dashboard. Both the interior and exterior skins of the driver's door were crushed and peeled rearward, exposing the WABCO anti-lock braking system (ABS) electronic control unit (ECU) and the occupant compartment. The driver's side window was broken, and the surrounding window frame was crushed rearward. The fiberglass hood, grille, lower grille, and both headlight assemblies were missing from the front of the vehicle. The WABCO OnGuard radar unit was attached to the lower grille, which had separated from the vehicle. The front portion of the fuel tank was ruptured. The power steering reservoir was cracked and leaking.

The front-left of the Morgan box contained contact damage from the bus and from the rear of the truck's cab. The waist rail, cant rail, and the front-left vertical pillar were severed, which compromised multiple roof bows and integrity of the box, and caused the left-side skin to separate from the front-skin of the box. The exterior horizontal rail located approximately two feet above the waist rail and spanned the entire length of the box, separated from the vehicle.

The cab was displaced counterclockwise. The right-rear of the cab was separated from the front of the box by approximately six inches. The left-rear of the cab contacted the front of the box during the collision sequence and caused forward intrusion to the occupant compartment. The driver's seat was displaced forward underneath the steering wheel. The steering wheel had significant deformation. The left window shield sunshade was damaged and was contacting the dashboard.

1.5 Weights and Measurements

Pre-crash measurements and axle weights can be observed in Table 1. The curb weight includes the Freightliner chassis, Morgan box, and an estimated driver's weight. Inside of the Morgan box were approximately five steel "Cannon Carts" distribution carts that each weighed approximately 187 pounds excluding contents.[7] The contents and cargo included oil and other parts estimated at approximately 200 pounds. The total weight of the contents and cargo with the steel distribution carts was estimated to

[7] Cannonequipment.com – Accessed 08/01/2023.

be approximately 1,135 pounds. The total weight of the vehicle, including cargo, was estimated to be 19,427 pounds.

Table 1: Truck - Pre-Crash Completed Measurements

Pre-Crash Truck Measurements[8]		
Overall Height	155.12	in.
Overall Width	102.0	in.
Overall Length	442.53	in.
Wheelbase[9]	270	in.
Curb Weight (Front)	7,792	lbs.
Curb Weight (Rear)	10,500	lbs.
Curb Weight (Total)	18,292	lbs.

Figure 3 shows the damaged measurements of the subject truck post-collision utilizing the 3D terrestrial laser scans taken during the on-scene inspection.

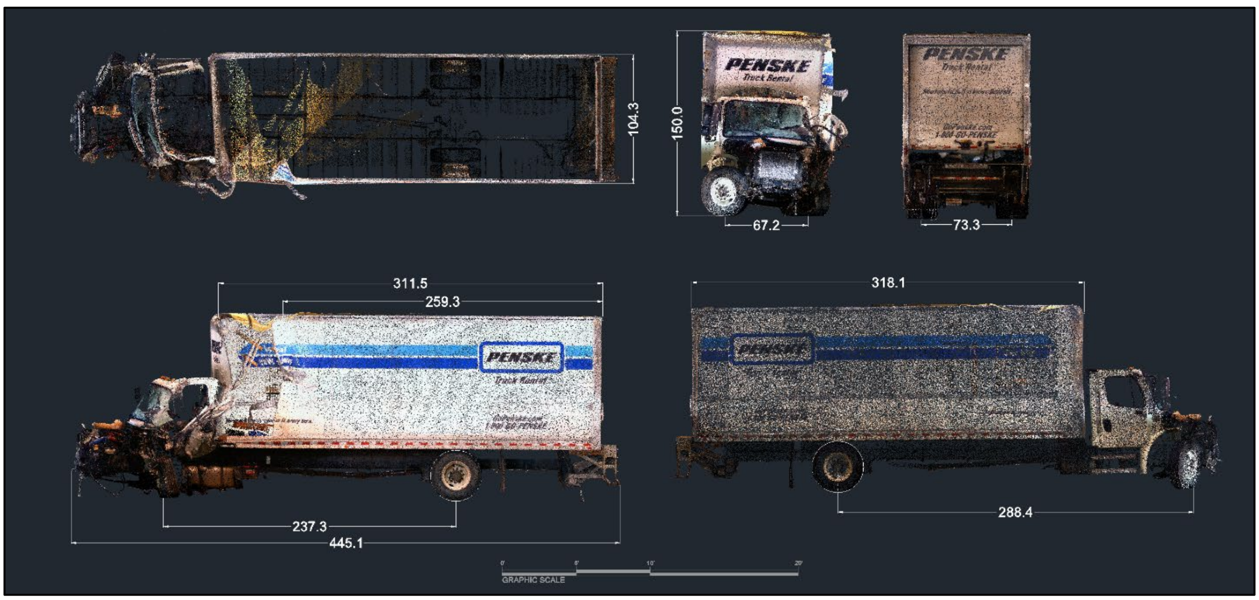

Figure 3: Truck - Damaged Measurements[10]

1.6 Driver Controls

The truck was equipped with a tilt and telescoping steering column. The truck was not equipped with any supplemental inflatable airbags. The truck was stuck in the drive position. Present on the dashboard of the truck was a WABCO OnGuard Gen 2 interface. Accessing the OnGuard interface on scene was impractical due to the collision related power loss the truck encountered. The driver controls, left of the

[8] See Vehicle Factors Attachment: *Weights and Measurements from Morgan Truck Body, LLC.*
[9] Per Freightliner.
[10] Measurements specified in inches.

steering wheel, were damaged by an unknown object and covered in a sheet of broken glass from the compromised windshield.

The instrument cluster in front of the driver's seat contained numerous gauges, indicator lights, and switches. The gauges included voltage, engine oil pressure, engine speed[11], vehicle speed (mph & km/h) with an integrated odometer and hour meter, outside temperature, water temperature and fuel level indicator. Several analog gauges were frozen in place due to the collision related power loss. The speedometer gauge was frozen at approximately 59 mph, as observed in Figure 4. The RPM gauge was frozen between 1,600-1,700 RPM. The gauges for the primary and secondary air tanks were tested by making brake applications and determined to still be functional.

Figure 4: Truck - Frozen Instrument Cluster

1.7 Steering

The steering components of the truck were inspected. With the front axle lifted, full rotation of the steering wheel shaft from left to right was possible without restriction or binding felt at the wheel. The steering column was connected to a two-part intermediate steering shaft by means of a universal joint within the cab of the truck. The intermediate steering shaft transcended through the firewall and connected to a second half of the intermediate steering shaft by a splined slip joint connection. The upper and lower steering shafts separated at the slip joint. The lower intermediate steering shaft, by means of another universal joint, remained connected to the input shaft of a hydraulically assisted steering gearbox. The boot covering the lower steering

[11] Measured in revolutions per mile (RPM)

shaft was lowered to inspect the slip joint splines. The splines were not fractured or stripped, as observed in Figure 5.

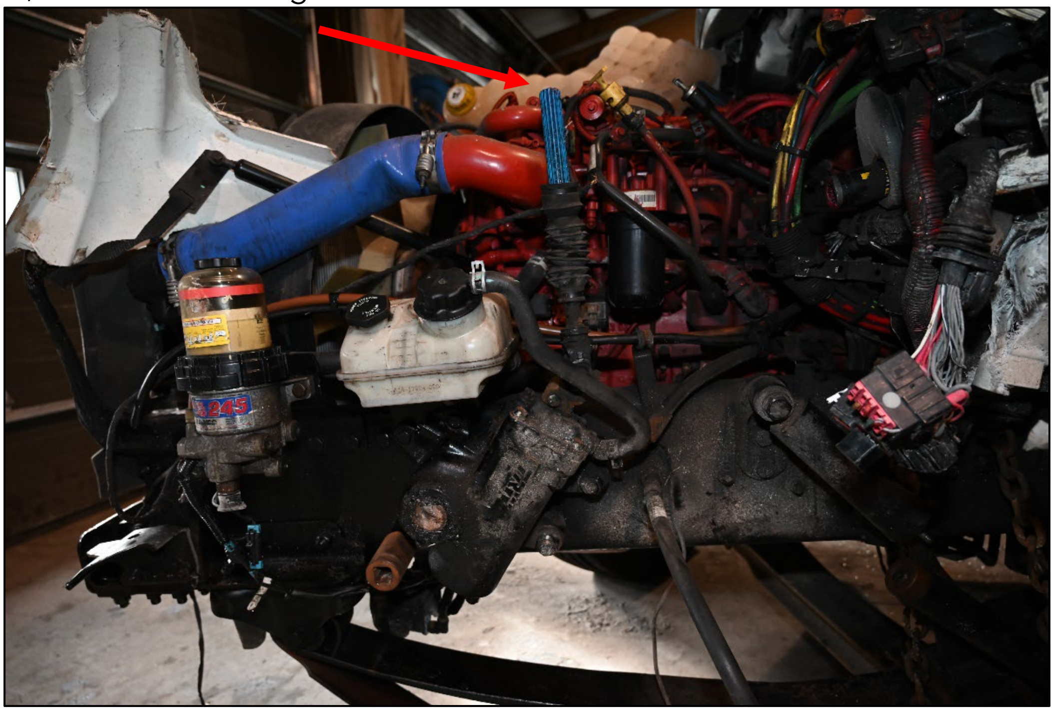

Figure 5: Truck - Lower Intermediate Steering Shaft with Splines Exposed

The truck was equipped with a TRW (now ZF) THP-60 series steering gearbox. The pitman arm separated from the gearbox at the sector shaft. The pitman arm remained connected by a ball joint to the drag link, and both were located in the cargo box of the truck along with other crash debris, as observed in Figure 6. The drag link disconnected from the left-steer knuckle during the collision, as observed in Figure 7. The tie rod was separated from the left steering knuckle. The steering gearbox, which was securely attached to the left frame, was removed from the truck by a mechanic at the direction of the NTSB. An external examination of the steering gearbox revealed separation of the pitman arm, however, no damage to the housing.

Figure 6: Truck - TRW Steering Gearbox and Pitman Arm

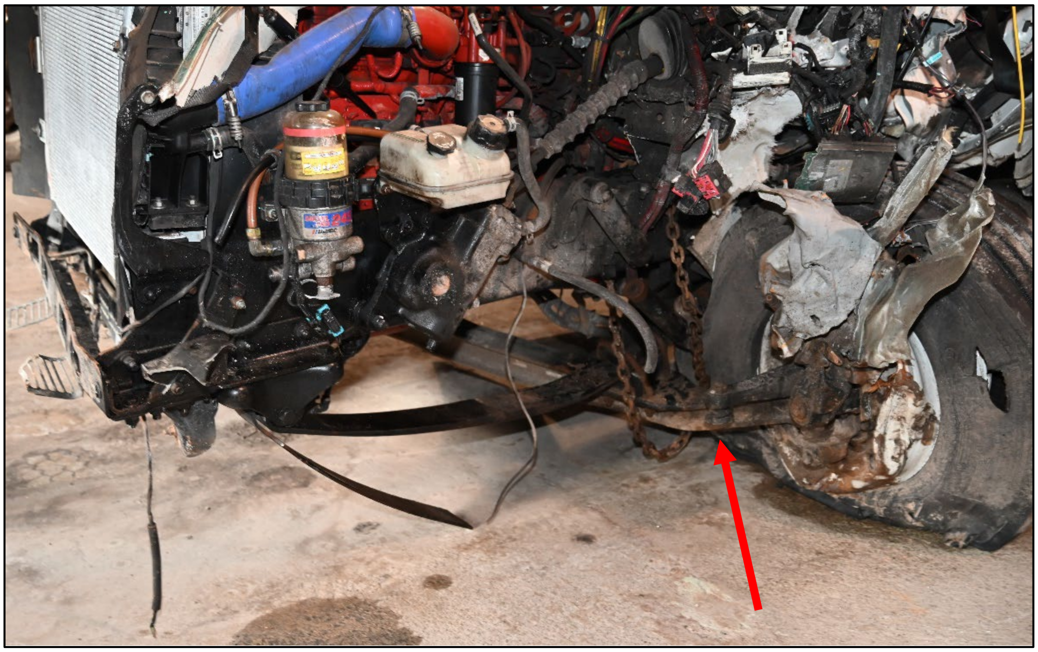

Figure 7: Truck - Steering Collision Damage

TRW-ZF was contacted regarding an examination and breakdown of the THP-60 series gearbox components, and pitman arm analysis, to evaluate the functionality, condition of the components, and the steering input at the time of impact. The steering gearbox, pitman arm, and drag link were packaged by NTSB staff, and sent to the NTSB HQ evidence control room.

On March 8, 2023, the inspection occurred at ZF's Engineering Lab, located in Lafayette, Indiana. The packages containing the gearbox, pitman arm, and drag link were sealed and subsequently opened by ZF in the presence of the NTSB investigator. During the examination, the gearbox was completely disassembled by ZF staff, and the gearbox components were inspected, documented, and photographed by ZF and the NTSB investigator. The steering gearbox model number was THP60010B, the unit possessed a date code of 21720, which represents the 217th day of the year 2020 (August 4, 2020), and the component had a serial number of U1U793.

The examination revealed that the steering gearbox received an impact load significant enough to cause Brinell impact marks[12] from recirculating ball bearings onto the internal helical worm gear and to sever the center tooth of the sector shaft, as observed in Figure 8. Brinell marks were also discovered on the sector shaft and were caused by the roller bearing, which indicated a high impact load from the pitman arm pushing against the roller bearing.[13] The brinelled helix position was closer to the

[12] Brinelling is named after the Brinell scale of hardness, in which a small ball is pushed against a hard surface at a preset level of force.
[13] ZF Group. For more information, see ZFGroup.com.

upper cylinder which indicated that there was slight right steering input at impact. An overview of the disassembled steering gearbox can be observed in Figure 9.

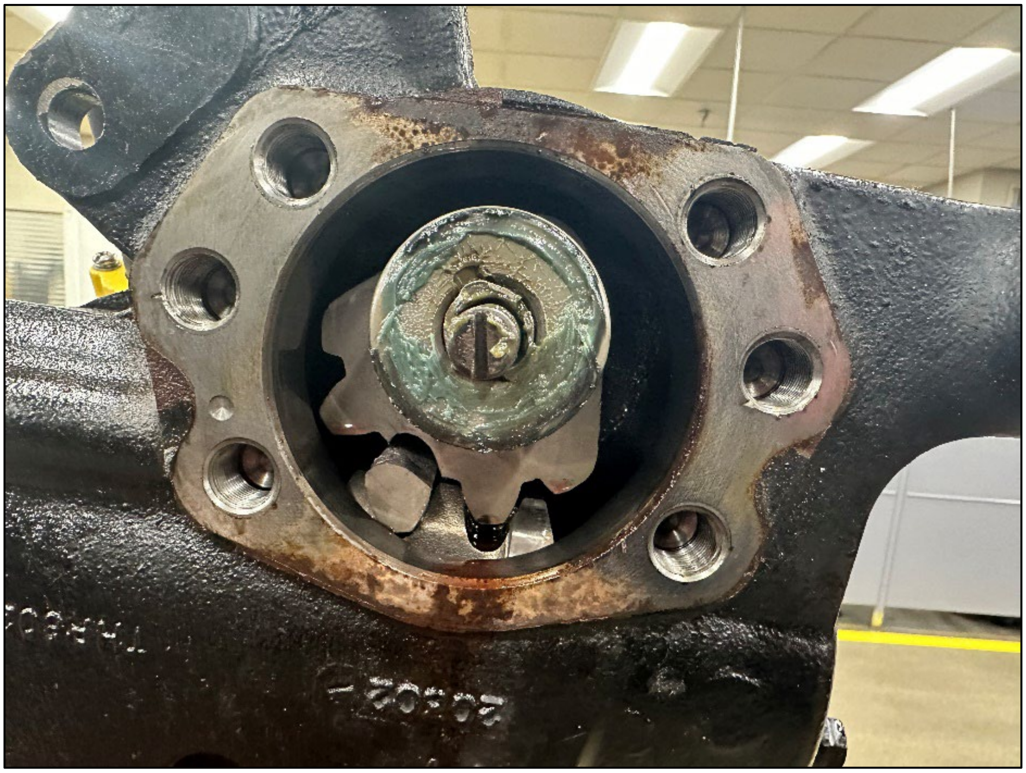

Figure 8: Truck – Center Tooth Fracture of the Sector Shaft

There was significant deformation to the steering wheel at the 1:00 o'clock position (Figure 10). The driver's seat was pushed forward due to intrusion from the rear of the cab. Please see the docket for more information regarding the occupant intrusion, seatbelt inspection, and steering wheel deformation.

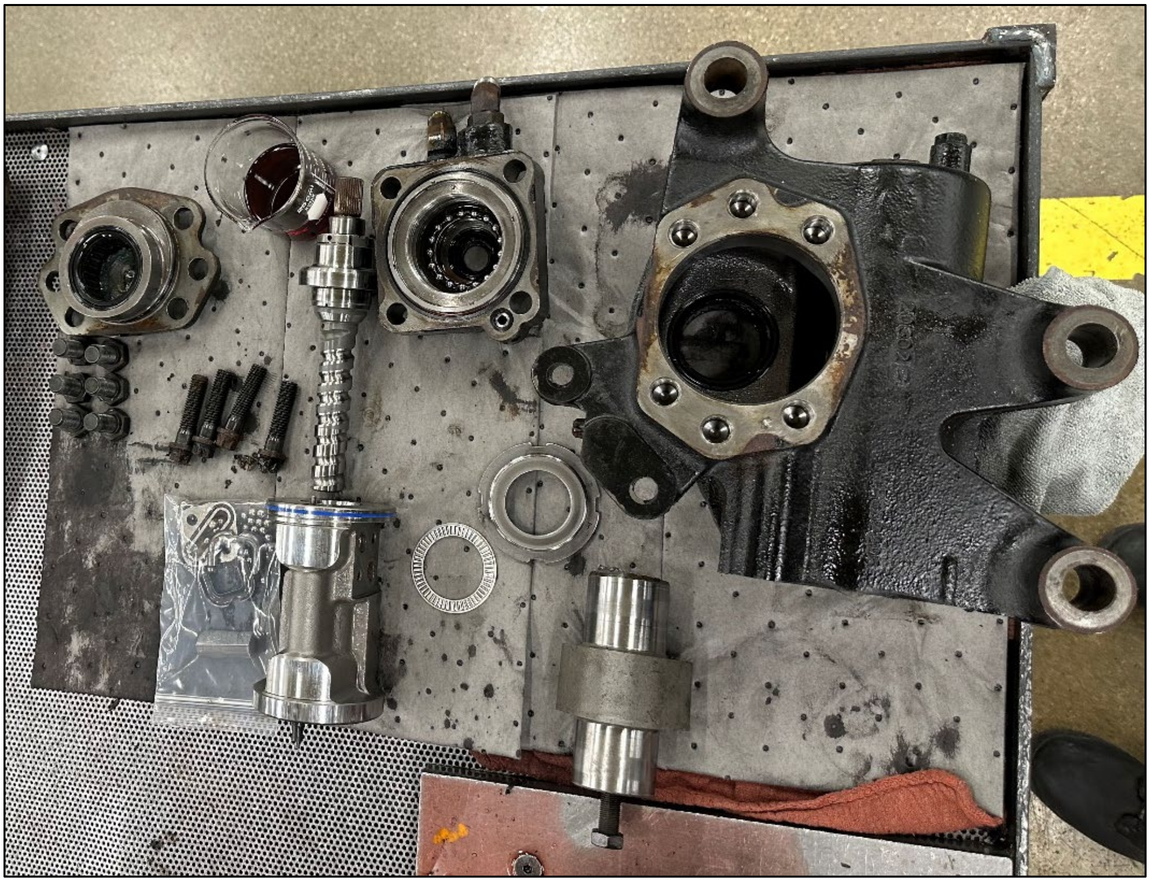

Figure 9: Truck - Disassembled Steering Gearbox Internal Components

Figure 10: Truck - Steering Wheel and Driver Controls

1.8 Suspension

The front-left wheel assembly was pushed rearward, causing the right-side of the front axle to rotate forward, resulting in one of the two front-right leaf-spring to axle U-bolts to break from the U-bolt cradle cap. The other front-right U-bolt remained attached and secured the leaf spring suspension to the front axle. All body mounts were inspected and were secured to the vehicle frame. The driveshaft was disconnected during vehicle extraction and towing.

The truck contained a solid axle with a taper leaf-spring front suspension and shock absorbers mounted to each axle end. The front-left shock absorber was disconnected due to contact damage with the front-left wheel assembly. The front-left U-bolts were damaged in the crash.

The suspension of axle-2 consisted of a solid axle with air spring suspension (Freightliner Airliner). The leaf springs were intact, in place, and securely mounted on both sides of the axles. No signs of cracks or bending in the springs were noted. The U-bolts were in place and securely fastened. The air springs and shock absorbers for the rear suspension were mounted securely. At the time of inspection, the air springs were deflated and appeared undamaged.

1.9 Tires and Wheels

General information about each of the truck's tires as they were at the time of inspection is included in Table 2. Tire tread depth measurements were taken in the major tread grooves of each tire. All the wheels were inspected for cracks, welds, and elongated lug nut holes. All wheels and tires were free from non-collision related defects. The manufacturer recommended tire pressure for this vehicle was 105 psi.[14] The truck was specified to be equipped with 11R22.5 front and rear tires.[15]

The front-left tire was flat, unseated and impaled by vehicle trim belonging to either the truck or bus. The front-left wheel was deformed in multiple locations due to contact damage. The front-left wheel assembly was pushed rearward, and the front-right wheel assembly shifted forward.

[14] Per Morgan Truck Body, LLC placard.

[15] See Vehicle Factors Attachment: *Freightliner Build Sheet Document*.

Table 2: Truck - Tire Information

Steer Axle	Left		Right	
Make	Firestone		Firestone	
Model	FS561		FS561	
Size	11R22.5 146/143L		11R22.5 146/143L	
Pressure	0 psi		102 psi	
Tread Depth	21, 22, 21, 21 (32nd)[16]		20, 21, 20, 19 (32nd)	
DOT #	1D2 3T4P66 3622		1D2 3T4P66 3622	
Axle #2	Left		Right	
	Outside	Inside	Inside	Outside
Make	Continental	Continental	Continental	Continental
Model	Conti Hybrid HD3	Conti Hybrid HD3	Conti Hybrid HD3	HDL2
Size	11R22.5 144/142L	11R22.5 144/142L	11R22.5 144/142L	11R22.5 144/142L
Pressure	102 psi	104 psi	102 psi	102 psi
Tread Depth	13, 10, 10, 12 (32nd)	8, 7, 7, 4 (32nd)	13, 11, 9, 9 (32nd)	17, 13, 13, 17 (32nd)
DOT #	A33T 2CY 0820	A33T 2GY 0920	A33T 2CY 0920	A33T L90P 0321

1.10 Brakes

Axle 1-left's Type-20 brake chamber was nonfunctional due to collision related damage. The air hose for 1-left was torn during the collision sequence. Both axle-2-left and 2-right's brake chambers were caged. Other than the air leak caused by 1-left's torn air hose, the remaining air system of the Freightliner was to be intact. The brake air pressure gauge was located in the instrument cluster of the truck and was functional. Axle 1-left's air hose was clamped to prevent air leakage and the air tanks were pressurized to 90-100 psi to facilitate an inspection of the pushrod travel during a service brake application. The resulting pushrod travel measurements were found to be within federal regulations[17] for the given type of brake chamber and can be observed in Table 4. Brake lining thickness for the undamaged brakes were measured. All measured brakes had adequate brake lining, which can be seen in Table 3.

Table 3: Truck - Measured Lining Thickness

	Brake Type	Position	Measured Lining Thickness Left (1/32)	Measured Lining Thickness Right (1/32)
Axle 1	Drum	Upper	NM[18]	17
Axle 1	Drum	Lower	NM	NM
Axle 2	Drum	Upper	17	17
Axle 2	Drum	Lower	16	17

[16] Tread measured from inboard to outboard.
[17] Federal Motor Carrier Safety Regulations (FMCSRs), Title 49 Code of Federal Regulations, Part 393.47(e).
[18] Not measurable, damaged due to collision related damage.

Table 4: Truck – Brake Information

Position	Side	Brake Chamber Type	Slack Adjuster Length (inches)	Push Rod Travel (inches)	Adjustment Limit [19] (inches)
Axle 1	Left	LS-20[20]	5 1/2	NM[21]	2
Axle 1	Right	LS-20	5 1/2	1 1/16	2
Axle 2	Left	LS-30/30	5 1/2	1 5/16	2 1/2
Axle 2	Right	LS-30/30	5 1/2	1 3/8	2 1/2

The truck was equipped with a four sensor and four modulator ABS system (4S/4M). Axle 1-left's ABS sensor was disconnected due to contact damage with the wheel assembly. All other ABS sensors and modulators were intact.

1.11 Electrical

The fuse boxes, located in the upper-left side of the engine compartment, were damaged during the collision sequence. As a result, the truck suffered a power loss at impact. This was further supported by the frozen instrument cluster that was observed inside of the cab of the truck (described further in Section 1.6). Due to the collision related power loss, the remaining electrical system and onboard lighting were unable to be inspected, and a download of the vehicle's ECM was unable to be conducted in-cab through the vehicle's Deutsch connector.

1.12 Lighting

Due to the compromised electrical system, the lighting present on the truck was unable to be powered and illuminated for a visual check during the inspection. A surveillance video was obtained from NYSP. Figure 11 shows a still image taken from the video of a home security camera located near the crash site. The video and still image show the truck traveling eastbound on SR 37 indicated the lights were on moments before the crash. The video was timestamped 5:47 am, which was approximately 15 minutes prior to the subject collision.

The left-headlight assembly was destroyed during the subject collision and not recovered by the NYSP or the NTSB. The right-headlight assembly was located in the rear of the truck with other crash debris, as observed in Figure 12. The lightbulbs from the right-headlight assembly were inspected, packaged as fragile evidence, and submitted to the NTSB Materials Laboratory for further imaging.

[19] According to the Federal Motor Carrier Safety Regulations (FMCSRs), Title 49 Code of Federal Regulations, Part 393.47(e).
[20] Long Stroke clamp type brake chamber.
[21] Not measurable, damaged due to collision related damage.

Figure 11: Truck - Pre-Crash Lighting Condition
(Source: NYSP)

Figure 12: Truck - Right Headlight Assembly

The NTSB Materials Laboratory performed radiography imaging on the submitted bulbs. Radiography is an imaging process that uses high-energy radiation to view the internals of an object. Imaging of the headlight upper and lower bulb from the right-headlight can be observed in Figure 13 and Figure 14. The upper headlight bulb contained one filament. Upon inspection, the filament was broken into two pieces, with only half of the filament still connected in its housing. The lower headlight bulb contained only one filament that was free from fractures and was contained in its housing.

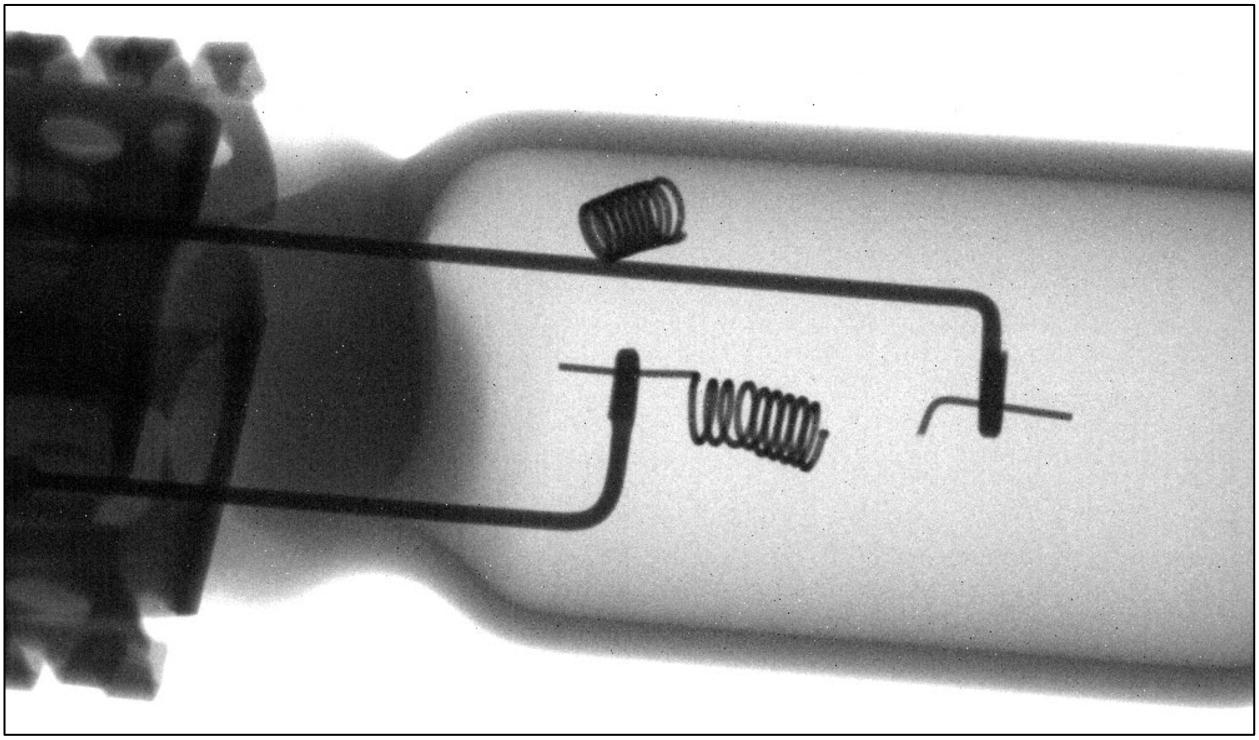

Figure 13: Truck - Upper Headlight Bulb Imaging

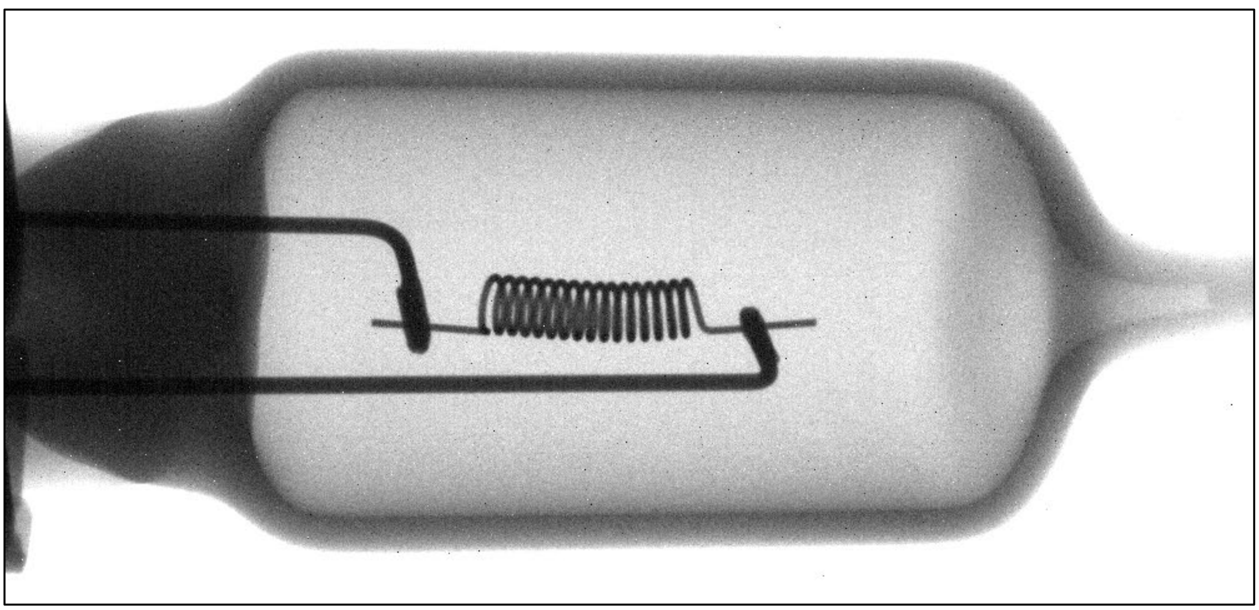

Figure 14: Truck - Lower Headlight Bulb Imaging

1.13 Maintenance and Inspection History

Maintenance records were obtained by the Motor Carrier Group Chairman from the carrier, Aero Global Logistics.[22] According to the maintenance records for the truck, the carrier performed regularly scheduled preventative maintenance. The carrier had a systematic method of inspections, repairs and services that met or exceeded the requirements prescribed under 49 CFR §396.3.[23]

According to the Federal Motor Carrier Safety Regulations (FMCSRs), commercial vehicles must be inspected at a minimum of every 12 months to ensure compliance with the requirements set forth in the regulations.[24] The latest Massachusetts annual vehicle inspection was conducted on October 24, 2022.[25] The report indicated that all testing performed resulted in a satisfactory outcome, as observed in Figure 15. An annual vehicle inspection report for 2020, which was conducted on November 3, 2020, was also obtained. The 2020 annual inspection also resulted in satisfactory outcomes for all tested criteria.[26]

Safety Inspection Results					
License Plate	PASS	Chock Blocks	PASS	Splash Guards	PASS
Horn	PASS	Warning Devices	PASS	Bumpers	PASS
Fenders	PASS	Fenders - Trailer	PASS	Seat Belts	PASS
Air Bags	PASS	Mirrors	PASS	Air Brake Sys - Leakage Test	PASS
Air Brake Sys - Low Pres Warning Dev	PASS	Air Brake Sys - Cond of Components	PASS	Brake System - Service Brakes	PASS
Brake System - Parking Brake System	PASS	Brake System - Drums/Rotors	PASS	Brake System - Hoses	PASS
Brake System - Tubing	PASS	Brake System - Low Pres Warning Dev	PASS	Brake System - Tractor Protect Valve	N/A
Brake System - Air Compressor	PASS	Brake System - Hydraulic Brakes	N/A	Brake System - Vacuum Brakes	PASS
Coupling Devices - Fifth Wheel	N/A	Coupling Devices - Pintle Hooks	N/A	Coupling Devices - Drawbar/Towbar	N/A
Coupling Device - Drawbar/Towbar Ton	N/A	Coupling Devices - Safety Devices	N/A	Coupling Devices - Saddle Mounts	N/A
Coupling Devices	N/A	Exhaust System - Leak	PASS	Exhaust System - Leak Forward/Below	PASS
Exhaust System - Bus Exhaust Leak	N/A	Exhaust System - Location	PASS	Exhaust System - Visible Smoke	PASS
Fuel System - Leak	PASS	Fuel System - Filler Cap	PASS	Fuel System - Tank	PASS
Lighting Devices	PASS	Reflectors and Reflective Tape	PASS	Safe Loading	PASS
Steering - Steering Wheel Free Play	PASS	Steering - Steering Column	PASS	Steering - Front Axle Beam & Oth Com	PASS
Steering - Gear Box	PASS	Steering - Pitman Arm	PASS	Steering - Power Steering	PASS
Steering - Ball/Socket Joints	PASS	Steering - Tie Rods and Drag Links	PASS	Steering - Fasteners	PASS
Steering - Steering System	PASS	Steering - Kingpin	PASS	Suspension - Axle Positioning Parts	PASS
Suspension - Spring Assembly	PASS	Suspension - Torque/Rad/Tracking Co	N/A	Suspension - Shocks	PASS
Frame - Frame Members	PASS	Frame - Tire and Wheel Clearance	PASS	Frame - Adjustable Axle Assembly	N/A
Driveshaft Protection - Bus Only	N/A	Tires - Steering Axle Tires	PASS	Tires - Non-Steering Axle Tires	PASS
Wheels and Rims - Locking or Side Rin	PASS	Tires	PASS	Wheels and Rims	PASS
Wheels and Rims - Fasteners	PASS	Wheels and Rims - Welds	PASS	Windshield - Critical Viewing Area	PASS
Windshield - Defects	PASS	Window Tint	PASS	Windshield Wipers - Condition	PASS
Windshield Wipers - Operation	PASS	Windshield Wipers - Cleaner Equipmen	PASS	Other	PASS

Figure 15: Truck - 2022 Annual Inspection

[22] See Vehicle Factors Attachment: *Freightliner Maintenance Records*.
[23] FMCSRs 49 § 396.3 Inspection, repair, and maintenance. - Accessed 05/31/2023.
[24] Federal Motor Carrier Safety Regulations (FMCSRs), Title 49 Code of Federal Regulations, Part 396.17(c).
[25] Annual vehicle inspection reports obtained from https://www.mavehiclecheck.com/
[26] See Vehicle Factors Attachment: *Freightliner Annual Inspection Reports*.

1.14 Documented Recalls and Warranty Claims

A search of the safety recall database maintained by the National Highway Traffic Safety Administration (NHTSA) and manufacture warranty claim records found no open recalls or current warranty claims for the truck.[27]

1.15 Collision Avoidance

The truck was equipped with a WABCO (now ZF) OnGuard Gen 2 collision warning, adaptive cruise control, and collision mitigation system. The OnGuard collision mitigation system provides driver assistance for potential rear-end collision situations. The collision mitigation system provides up to 0.6g deceleration in response to slower moving vehicle threats, and up to 0.3g deceleration in response to stationary object threats. The OnGuard collision mitigation system is not designed to mitigate head-on collisions.

The subject OnGuard's forward-looking Gen 2 radar unit was found amongst the collision related debris in the rear of the truck. The radar unit was enclosed in a fascia and mounted to a bracket. The bracket was removed from the front bumper where it was attached pre-collision. The radar unit was removed by the NTSB and the NYSP from the fascia and bracket, packaged, and sent to the NTSB Headquarters evidence control room.

On February 17, 2023, the NTSB arranged with WABCO-ZF to image the data that was recorded by the radar unit (serial number: 220831000477 and part number: 4008715740).[28]

WABCO-ZF provided stored diagnostic trouble codes (DTCs) and event information. There were two stored and one active DTCs on the radar unit. The first stored DTC was "CAN Out of Range for signal…", which last occurred at an odometer reading of 168,359.8 miles. The second stored DTC was "Blockage Detection detected system damping", which last occurred at an odometer reading of 168,362.1 miles. The only active DTC present was for "No J1939 messages are being received on this CAN port", which last occurred at an odometer reading of 0.0 miles.

The unit's Event Counter recorded 59 forward collision warnings, 10 haptic collision warnings, 0 collision mitigation braking, and nine automatic emergency braking events (AEB) throughout the life of the radar unit. According to maintenance records obtained for the subject truck, the OnGuard radar unit was replaced on October 24, 2022. Other than the most current haptic warning and collision mitigation, the unit was not capable of storing when the remaining events occurred, or the

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[27] https://www.nhtsa.gov/recalls - Accessed 05/31/2023.

[28] See Vehicle Factors Attachment: *Freightliner ECM/ EDR Download Report.*

odometer readings, though the various warnings recorded by the radar unit occurred between October 24, 2022, and the date of the subject collision, January 28, 2023.

The unit's Event Records also provided information regarding the last haptic warning and collision mitigation activation, which contained odometer information. While the exact odometer reading for the truck is unknown due to the collision related electrical failure, the odometer readings present in the Event Records were between 4,000-6,000 miles lower than odometer readings present in the DTC portion of the report and were unrelated to the subject collision.

The truck was not equipped with an active or passive lane departure warning or mitigation technologies.[29] The truck could have been ordered and built with a variety of technologies that included active or passive lane departure warning or mitigation systems.

1.16 Event Data

1.16.1 Engine/Electronic Control Module (ECM)

The truck contained a Cummins B6.7 engine, which was equipped with a Continental CM2350 ECM, as observed in Figure 16. Typically, a download of the ECM could be conducted through the Deutsch connector of the truck utilizing a vehicle connection interface using Cummins Insite and PowerSpec software. Due to the collision related damage present to the subject truck, this method for retrieving any potential data recorded by the ECM was impractical. As a result, the ECM was removed from the engine and was shipped to the NTSB Headquarters evidence control room until coordination with Cummins Inc. could be facilitated.

Cummins Inc. was contacted regarding assisting with the imaging of the ECM. On March 7, 2023, NTSB Investigators escorted the ECM to the Cummins Inc. facility, located in Columbus, Indiana. The ECM was installed into a sensor simulator type device that mimicked the configuration of the subject truck's components and sensors. This process drastically reduced the potential of activating diagnostic trouble codes[30] (DTCs), which could potentially overwrite previous data, when compared to typical direct-to-module imaging with a wiring harness. Several files were extracted from the ECM without issue.[31]

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[29] See Vehicle Factors Attachment: *Freightliner Build Sheet Document*.
[30] Diagnostic trouble codes (DTCs) are commonly also referred to as fault codes.
[31] See Vehicle Factors Attachment: *Freightliner ECM/ EDR Download Report*.

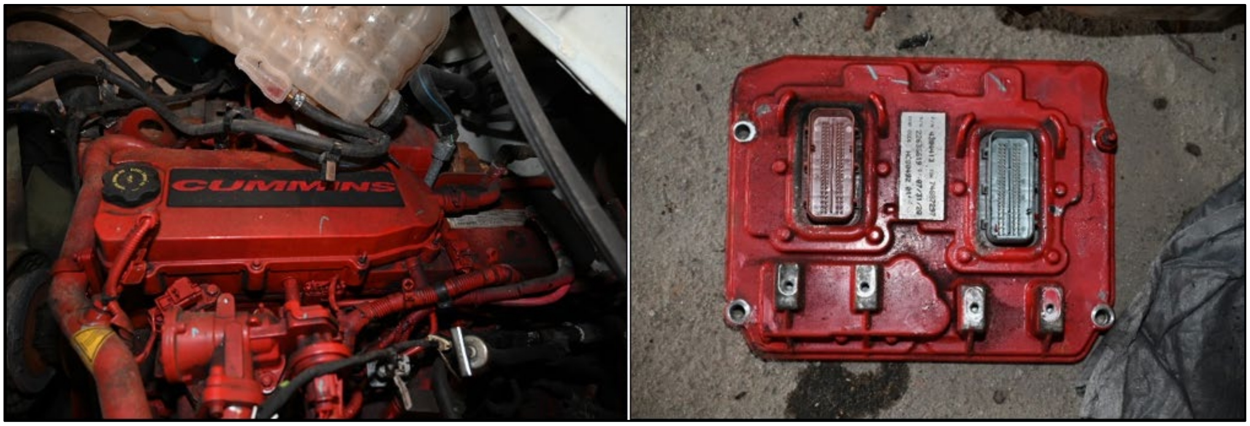

Figure 16: Truck - Cummins B6.7 Engine & ECM

The following data and information were imaged from the subject ECM:

1. After Treatment
2. Data Plate
3. Duty Cycle
4. Engine Operating Mode
5. Fault
6. Feature Parameter
7. Sudden Vehicle Speed Deceleration Report
8. Trip Detail
9. Initial Workorder
10. Final Workorder
11. Initial (Raw/Excel)
12. Final (Raw/Excel)

The ECM was connected to a sensor simulator at Cummins Inc. A series of active and inactive DTCs were recorded by the ECM. Several DTCs were expected to be triggered during the imaging of the subject ECM. The following DTCs were expected to be activated in the simulated vehicle prior to connecting our ECM and expected to be present in the imaged ECM data, but were unrelated to the subject vehicle or collision:

1. **3567** - Aftertreatment 1 Diesel Exhaust Fluid Dosing Valve 1 Circuit - Current Below Normal or Open Circuit
2. **4517** - Vehicle Identification Number - Out of Calibration
3. **5867** - Aftertreatment Diesel Exhaust Fluid Dosing Unit Relay Feedback - Voltage Below Normal or Shorted to Low Source

4. **755** - Injector Metering Rail #1 Pressure Malfunction – Mechanical system not responding or out of adjustment
5. **3541** - Engine Intake Throttle Actuator Position Sensor Circuit – Voltage Below Normal or Shorted to Low Source
6. **415** - Oil Pressure Low - Data valid but below normal operational range - Most Severe Level
7. **6255** - Engine Protection Torque Derate - Data Valid but Above Normal Operating Range - Least Severe Level

Several other DTCs were recorded by the ECM, in addition to a portion of the prior seven DTCs listed above. When a DTC is triggered with this engine, a diagnostic snapshot of information of the current conditions and settings are recorded to the ECM. Three inactive DTC snapshots recorded that the instantaneous vehicle speed was 59 mph, and the ECM runtime was approximately one minute prior to the download ECM runtime. This ECM does not record a last stop record. The following active and inactive fault codes were downloaded by the subject ECM during the sensor simulator assisted imaging.

1. **5867**- Aftertreatment Diesel Exhaust Fluid Dosing Unit Relay Feedback - Voltage Below Normal or Shorted to Low Source
2. **241** - Vehicle Speed Sensor Circuit - Data erratic, intermittent or incorrect
3. **755** - Injector Metering Rail #1 Pressure Malfunction – Mechanical system not responding or out of adjustment
4. **3567** - Aftertreatment 1 Diesel Exhaust Fluid Dosing Valve 1 Circuit - Current Below Normal or Open Circuit
5. **3541** Engine Intake Throttle Actuator Position Sensor Circuit - Voltage Below Normal or Shorted to Low Source
6. **285** - SAE J1939 Multiplexing PGN Timeout Error - Abnormal update Rate
7. **3328** - Transmission Output Shaft Speed - Abnormal Update Rate
8. **3526** - Wheel-Based Vehicle Speed - Abnormal Update Rate
9. **6339** - Fuel Level 1 - Abnormal Update Rate
10. **3497** - Aftertreatment 1 Diesel Exhaust Fluid Tank Level - Data Valid But Below Normal Operating Range - Least Severe Level
11. **4691** - Engine Injector Metering Rail 1 Cranking Pressure - Data Valid But Below Normal Operating Range - Moderately Severe Level
12. **3239** - Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 Circuit - Voltage Above Normal or Shorted to High Source
13. **249** - Ambient Air Temperature Sensor Circuit - Voltage above normal, or shorted to high source

14. **197** - Coolant Level Low - Data Valid But Below Normal Operating

Sudden vehicle speed deceleration report records (SVSDRRs) are written to non-volatile memory (EEPROM) during a key-off. If power is interrupted during a collision for this particular engine, the sudden deceleration data and odometer readings will not be saved to non-volatile memory and will be lost. DTCs are written to non-volatile memory upon occurrence and do not require a key-off.[32] Therefore, it is possible for the ECM to record DTCs just prior to a power interruption, while simultaneously losing any potential sudden deceleration data.

The ECM contained the three most recent SVSDRRs. The sudden deceleration threshold was set to 9.0 mph/s in the configuration file and was listed as 9.01 mph/s in the sudden deceleration reports, which is approximately a deceleration of 0.41g. SVSDRR 1 was recorded approximately 154 hours of ECM runtime earlier than the current runtime and was unrelated to the subject crash. SVSDRR 2 was approximately 2.5 hours of ECM runtime earlier than the current runtime and was unrelated to the subject crash. SVSDRR 3 was approximately 1.5 hours of ECM runtime earlier than the current runtime and was unrelated to the subject crash. The driver of the subject truck took possession of the vehicle approximately five hours prior to the subject collision.

[32] SAE C1022 - Module 4.2 – Cummins Engines.

2.0 Vehicle #2: 2013 Chevrolet Express 4500 Cutaway Chassis with Micro Bird School Bus Body

Figure 17: Bus - Subject Chevrolet Chassis with Micro Bird School Bus Body

2.1 General Information

Chevrolet Express 4500 Cutaway Chassis:

VIN:	1GB6G5BG2D1156753
Registration:	5-93787B (MT)
Make:	Chevrolet
Model:	Express 4500 (cutaway)
Model Year:	2013
Date of Manufacture[33]:	March 2013
Mileage:	165,010 miles
Wheelbase:	159 inches
Curb Weight:	5,023 lbs. (chassis only)
GVWR:	14,200 lbs.
GAWR – Axle #1:	4,600 lbs.
GAWR – Axle #2:	9,600 lbs.
Engine:	V8, 6.0L, 324 HP @ 4600 RPM (L96)
Transmission:	Hydra-Matic 6L90 - 6-Speed Automatic

[33] See Vehicle Factors Attachment: *Chevrolet Express RPO Decode and Chevrolet Maintenance Records.*

Rear Axle Ratio:	4.10
Steering Gear:	Integral power steering; Ratio 17.2:1
Brake Type:	Four-wheel hydraulic disc brakes with antilock braking system (ABS)
Collision Avoidance:	Not equipped
Airbag Control Module[34]:	GMT610; P/N 20778831

Micro Bird by Girardin School Bus Body:

Body Number:	13-28601
Make:	Micro Bird
Model:	278-NY-24-00WC-MBI
Model Year:	2013
Date of Manufacture:	April 2013
Type Classification:	School Bus
Curb Weight (w/ chassis):	9,600 lbs.
Retroreflective tape	DOT-C2 conspicuity tape - White

2.2 Vehicle Summary

The bus was a two-stage manufactured school bus. The first stage consisted of a rear-wheel drive Chevrolet Express 4500 cutaway incomplete chassis, manufactured in March of 2013. The second stage of the bus was a Micro Bird school bus body, manufactured in April of 2013. The Chevrolet Express with the Micro Bird school bus body will be referred to as "bus". Regarding the bus orientation, "left" refers to the driver's side of the vehicle, while "right" refers to the passenger side of the vehicle. The bus was a former New York State school bus and was later sold to LBFNY LLC. The seating arrangement of the bus was originally designed with eight seating rows (five left-side rows and three right-side rows) and a handicap accessible area and lift that was located behind the seating rows on the right-side of the vehicle.[35] After the vehicle was sold, two additional seating rows were added to the location where the handicap accessible area was previously located.

2.3 Terrestrial Laser Scans

The NYSP captured terrestrial 3D laser scans of the damaged bus. The laser scans were processed by the NYSP, and the NTSB was provided an e57[36] version of the resulting point cloud. The point cloud was comprised of millions of colorized measurement points that could be used to preserve a scaled version of the damaged vehicle and could provide a basis with regards to deformation, impact configuration,

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[34] Also referred to as a Sensing Diagnostic Module (SDM) by Chevrolet.
[35] Micro Bird CAD.
[36] e57 is a point cloud file format that can be imported into many point cloud capable software packages.

speed analysis, and many other analytical computations. A sampling of images of the resulting point cloud for the damaged bus is shown below in Figure 18.

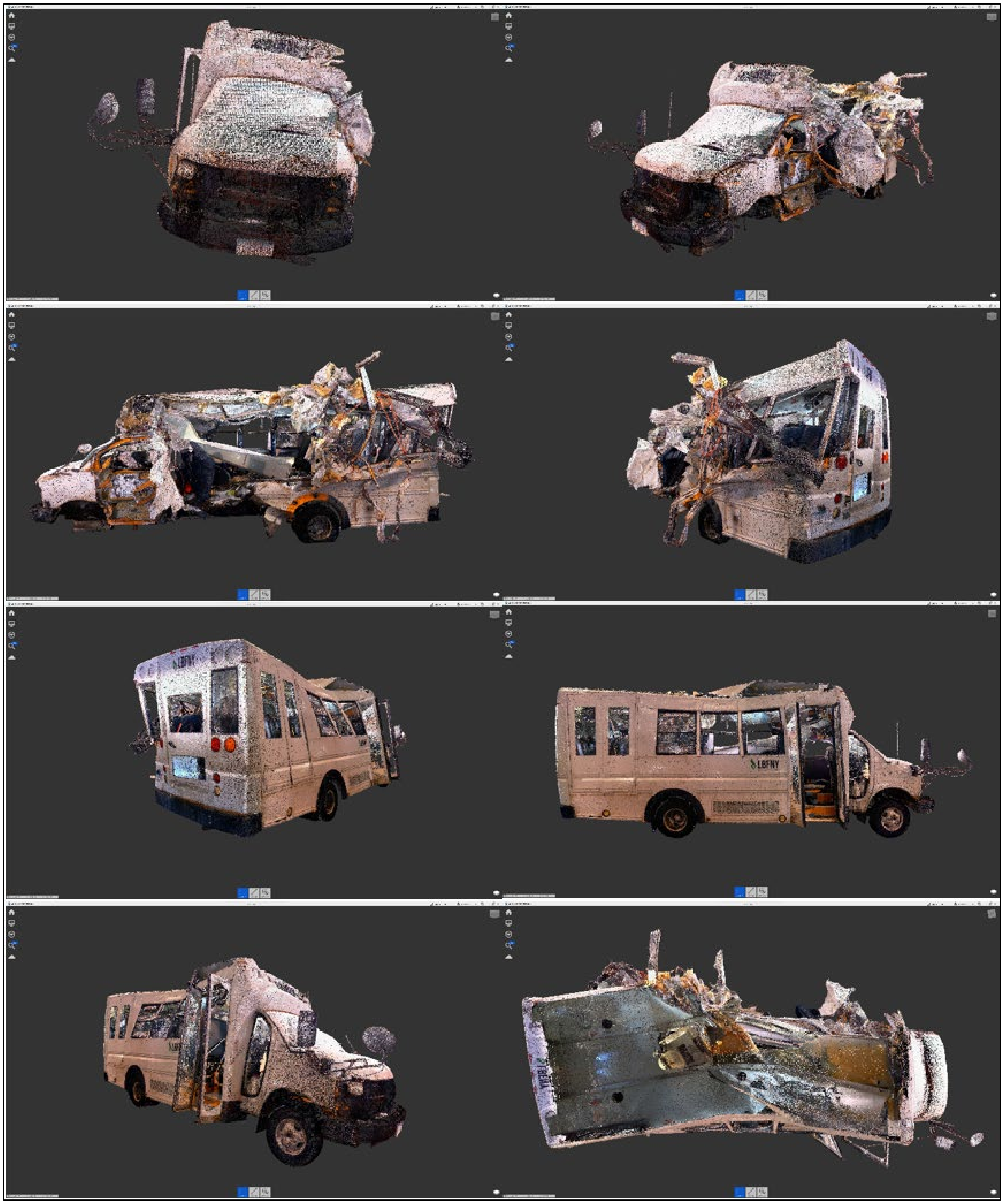

Figure 18: Bus - Scan Images of The Resulting Subject Bus Point Cloud

2.4 Exemplar Terrestrial Laser Scans

The NYSP captured terrestrial 3D laser scans of an exemplar bus. The laser scans were processed by the NYSP, and the NTSB was provided an e57 version of the resulting point cloud. The point cloud was comprised of millions of colorized measurement points that could be used to preserve a scaled version of the undamaged exemplar bus and could provide a basis with regards to many analytical computations. A sampling of images of the resulting point cloud for the undamaged exemplar bus is shown below in Figure 19.

Figure 19: Bus – Scan Images of The Resulting Exemplar Bus Point Cloud

2.5 Damage Description

The bus sustained contact damage to the front-left and left side of the vehicle. The left corner of the front bumper received the initial contact from the front of the truck. The bus's front grille, left sealed beam headlight, trim, and turn signal outer covering were all missing from the vehicle. The leading edge of the hood was dented rearward in two distinct locations. The windshield was cracked and significantly damaged on the left side. Both left-side mirrors separated from the vehicle. The left fender was dented inward. The front-left wheel assembly separated from the vehicle and the rear-left tires were flat. The outer skin to driver's door peeled away from the vehicle exposing the door mechanisms and the inboard side of the interior skin.

The bus received contact and induced damaged throughout the school bus body. The upper-front portion of the bus body sustained contact damage on the left side which compromised several vertical pillars and horizontal rails. On the right side of the upper-front portion of the bus, induced damaged in the form of tearing was observed. The left side of the bus received contact damage that compromised the waist rail, seat rail, cant rail, window rail, and other horizontal rails. All left side vertical pillars aft to the B-pillar were destroyed during the collision or significantly compromised, as observed in Figure 20. The combination of the destroyed and compromised horizontal rails and vertical pillars resulted in a large ejection port on the left side of the vehicle.

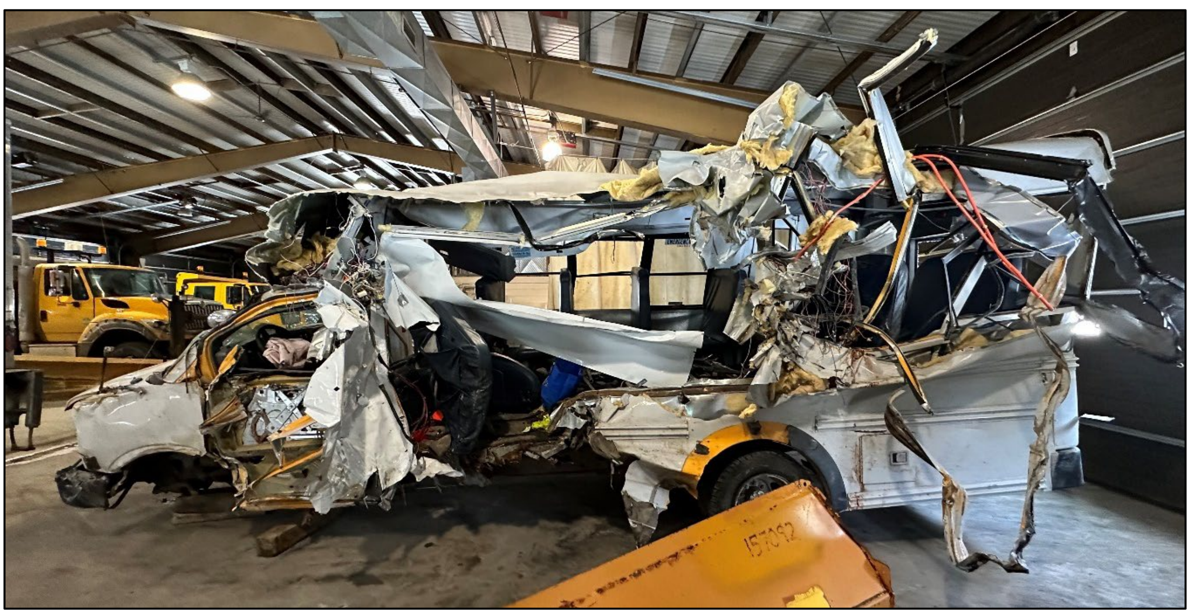

Figure 20: Bus - Left Side Damage

Many portions of the interior and exterior skin of the left side of the bus were crushed rearward. The roof's cant rail and roof bows were deformed, and the entire roof sustained a combination of contact (left side) and induced damage. The rear-left of the bus body was pushed rearward. All left side windows were broken. On the rear, the left amber light and left window were broken off. The rear emergency door was functional and there was a small hole and crack in the fiberglass rear.

The right side of the bus sustained significant induced damage that resulted to balance the forces generated by the vehicle deformation from the left-side. The induced damage to the right side of the bus was most notable along the window rail to the cant rail, as the windows on the right side of the bus were pulled inward towards the left side of the bus, which compromised several vertical pillars. The outward sliding double panel service doors received slight induced damage but remained mostly undamaged.

The driver's seat was removed by NYSP during imaging of the ACM. The airbag located in the steering wheel deployed during the crash sequence. The vehicle was not equipped with any other airbags. Regarding interior damage to the seating configuration, see the docket for further information.

Sidewall and roof construction and measurements:

- Aluminum sidewall outer layer skin measured between 0.03-0.04" thick.
- Rear measured fiberglass 0.085" thick.
- Roof exterior skin was aluminum ANSI H35.15052-H44 1.02mm.
- Sidewall aluminum skin (H35.1, 5052-H32 1.02mm) was connected side plate with H8600 glue and 3/16" rivets and was connected to vertical pillars with rivets.

Utilizing the 3D laser scans of the subject and exemplar bus, an intensity map of the deformation sustained by the bus was created. By comparing the cloud-to-cloud distance between the respective points between the two point clouds, the damaged subject bus deformation, with respect to undamaged exemplar bus can be measured and visualized. Figure 21 shows the resulting visual product of the deformation comparison between the damaged and undamaged bus.

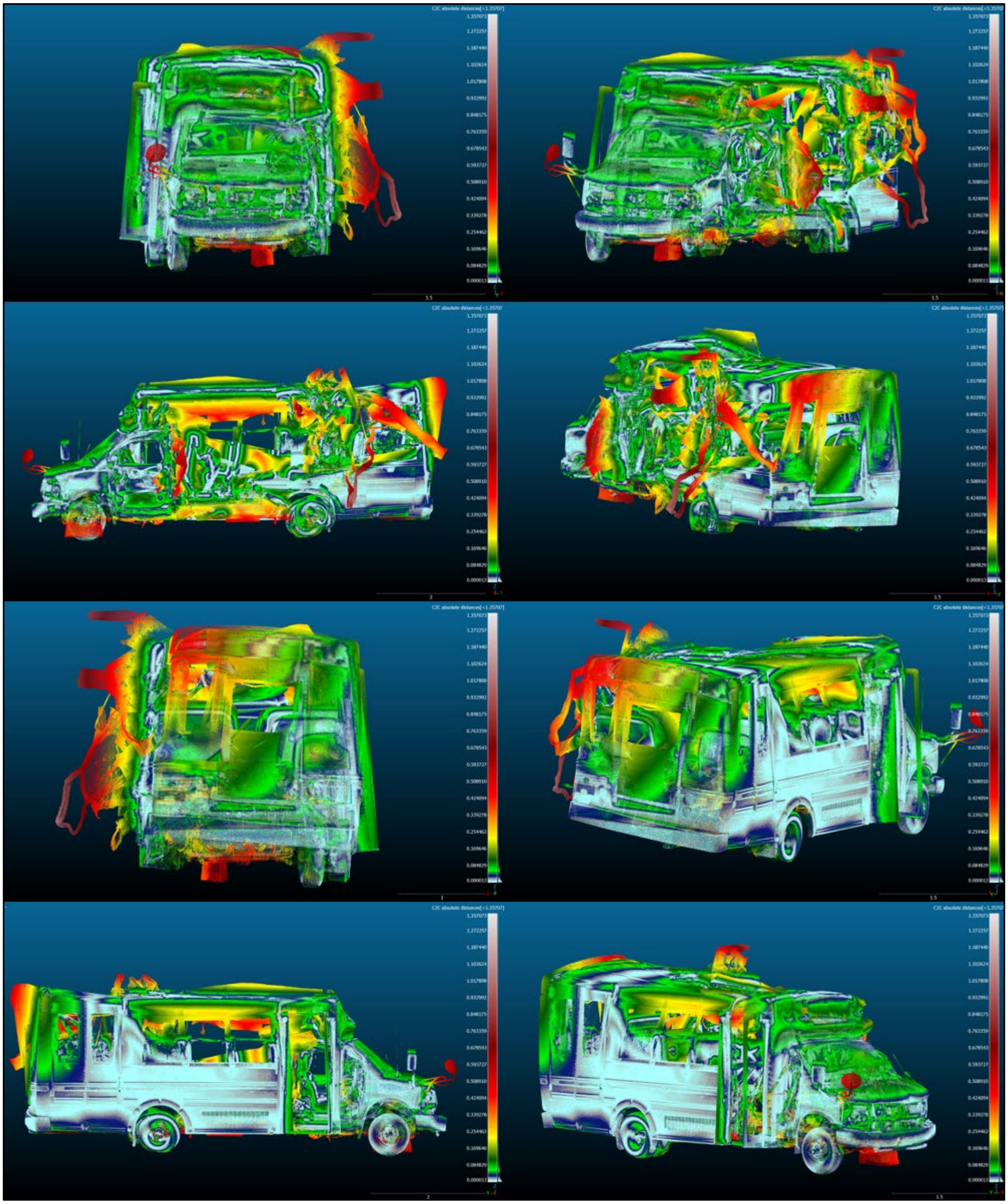

Figure 21: Bus - Intensity Map of Bus Deformation

A top-down view of the damage deformation can be observed in Figure 22. Most of the vehicle's roof was removed in the graphic to show the interior of the bus and its corresponding seating arrangement and deformation.

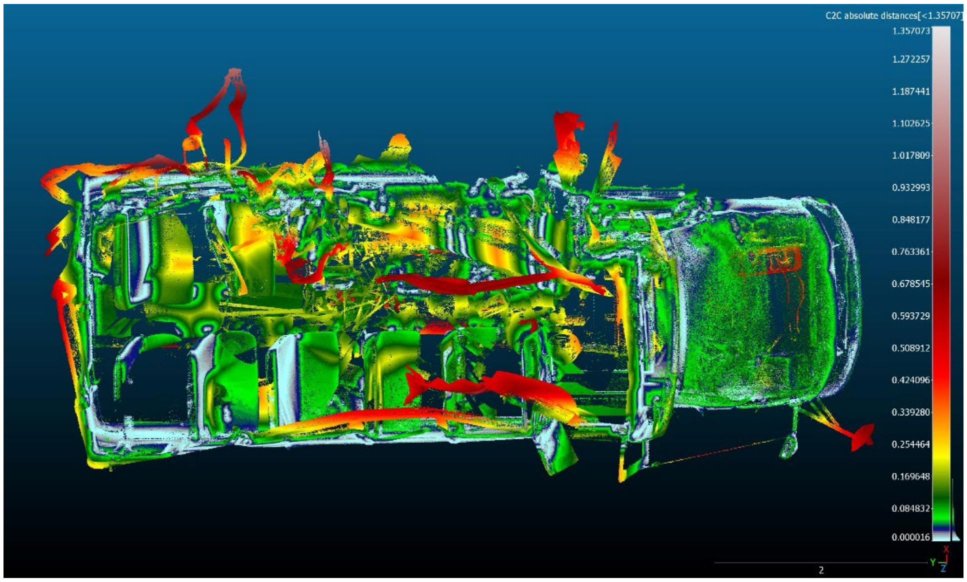

Figure 22: Bus - Top-Down Intensity Map of Bus Deformation

2.6 Weights and Measurements

Pre-Crash measurements were obtained from terrestrial 3D laser scans of an exemplar bus (Figure 23) and can be observed in Table 5.

Table 5: Bus - Pre-Crash Measurements[37]

Pre-Crash Bus Measurements		
Overall Height	108.7	in
Overall Width	98.0	in
Overall Length	288.4	in
Wheelbase	159.3	in
Front Overhang	39.3	in
Rear Overhang	89.8	in
Front Track Width	68.3	in

[37] Measurements were taken from an exemplar bus, observed in Figure 14.

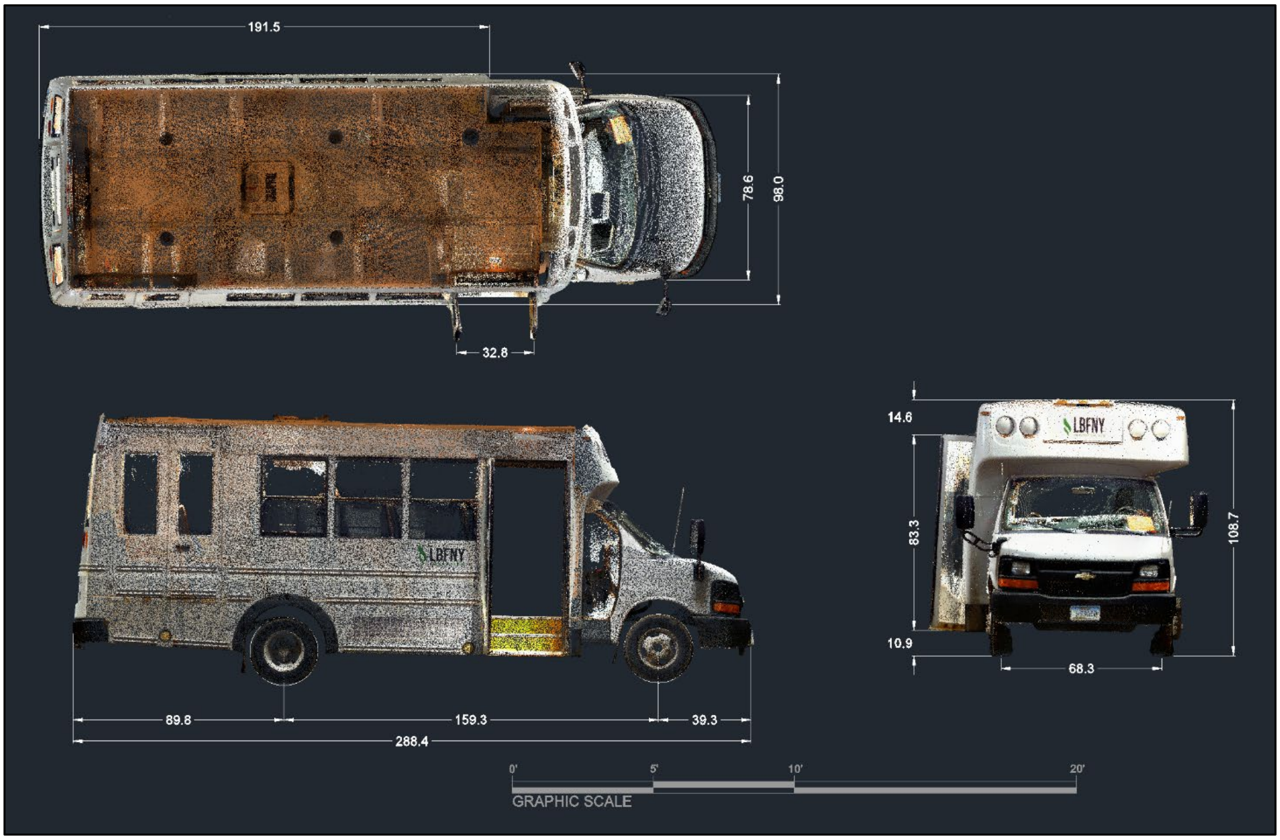

Figure 23: Bus - Approximate Measurements from Exemplar Point Cloud[38]

A summary of the curb weight can be found below in Table 6. The curb weight of the Chevrolet Express chassis was obtained from Chevrolet. The total curb weight of the chassis and the Micro Bird school bus body was obtained from Micro Bird. The Micro Bird body curb weight was calculated by subtracting the curb weight of the chassis from the total curb weight from Micro Bird.

Table 6: Bus - Curb Weight of Chassis and Body

Curb Weight of Chevrolet and Micro Bird		
Chassis Only	5023	lbs.
Body Only	4577	lbs.
Chassis & Body	9600	lbs.

2.7 Driver Controls

The bus was equipped with a tilt and telescoping steering column. The airbag contained in the steering wheel was deployed. The windshield wipers were set to off.

[38] Measurements specified in inches.

The headlight switch was set to automatic. To momentarily activate the vehicle's high beam lights, the indicator stalk would need to be pulled towards the direction of the driver. To activate the vehicle's high beam lights beyond a momentary condition, the indicator stalk can be locked out by pushing it away from the driver. The indictor stalk was found to be in a neutral position and not locked out. The heat and airflow intensity were set to the maximum setting and the front defroster was on. The bus was not equipped with a cruise control option.[39] There were additional school bus lighting controls located near the center console that operated previously used school bus lighting features. The instrument cluster in front of the driver's seat contained numerous gauges, indicator lights, and switches. The gauges included voltage, engine oil pressure, engine speed[40], vehicle speed (mph & km/h), water temperature and fuel level indicator.

Figure 24: Bus - Driver Controls and Instrument Cluster

The bus was equipped with a GPS transmitter and video equipment. Further inspection revealed that the GPS unit had been removed from the vehicle. The video

[39] See Vehicle Factors Attachment: *Chevrolet Express RPO Decode and Chevrolet Maintenance Records.*
[40] *Measured in revolutions per mile (RPM)*

equipment was also non-functional as components belonging to the system had been removed from the vehicle.

2.8 Steering

The bus was equipped with integral power steering. The steering ratio for the vehicle was 17.2:1.[41] The steering system was manually rotated from the left stop to the right stop, via the steering wheel, with no binding issues observed.

2.9 Suspension

The front suspension consisted of independent short/long arm (SLA) coil springs with stabilizer bar. The rear suspension consisted of a two-stage, semi-elliptic multi-leaf springs and semi-floating rear axle.[41] The front sway bar was still secured to the bus, as observed in Figure 25. The left and right axle-2 sway bar links were broken but still attached to the sway bar. The left-front wheel-assembly that included lower-control arm, hub, steel rim, and brake assembly separated from vehicle at the upper control arm, as observed Figure 26.

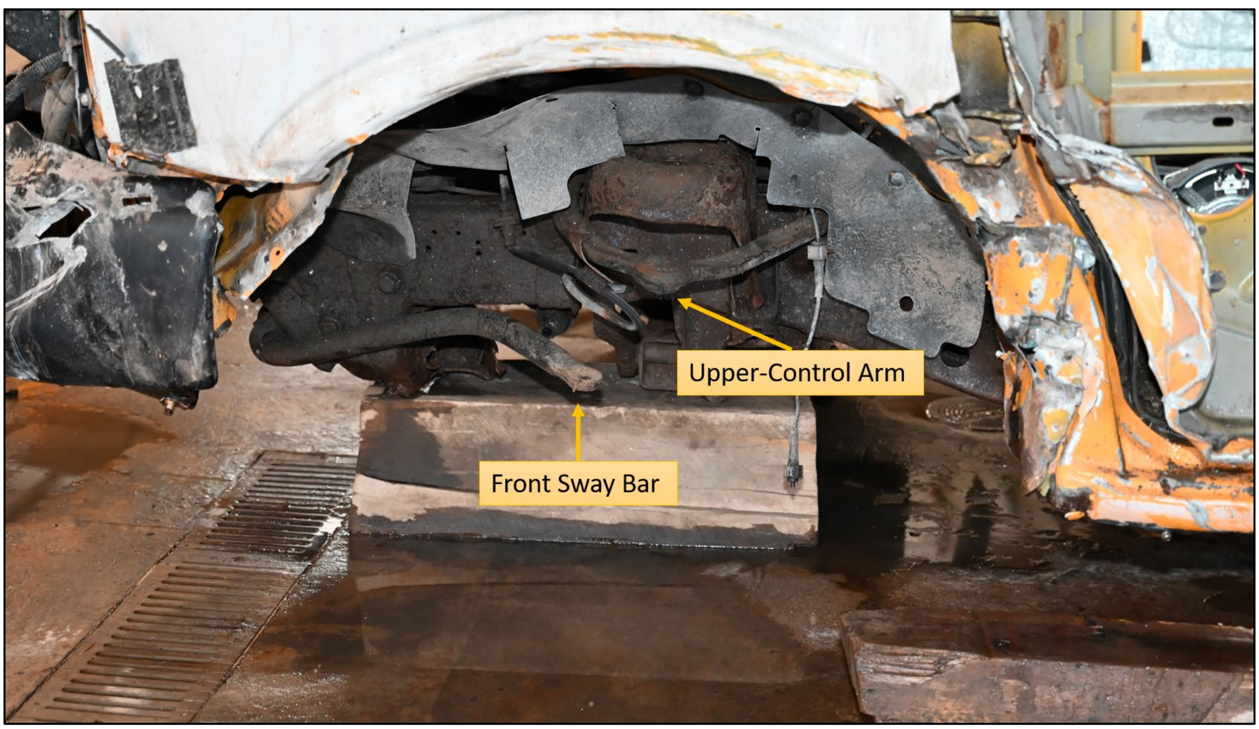

Figure 25: Bus - Left-Front Upper-Control Arm and Sway Bar

[41] See Vehicle Factors Attachment: *Chevrolet Express RPO decode and Chevrolet Maintenance Records.*

Figure 26: Bus - Left-Front Wheel Assembly

2.10 Tires and Wheels

General information about each of the bus's tires as they were at the time of inspection is included in Table 7. Tire tread depth measurements were taken in the major tread grooves of each tire. All the rims were inspected for cracks, welds, and elongated lug nut holes. All wheels and tires were free from non-collision related defects. The manufacturer's recommended tire pressure for this vehicle was 65 psi for the front tires and 80 psi for the rear tires. The bus was specified to be equipped with LT225/75R16 tires for both the front and rear.[42]

[42] Micro Bird placard.

Table 7: Bus - Tire Information

Steer Axle	Left		Right	
Make	Firestone		Firestone	
Model	TransForce HT2		TransForce HT2	
Size	LT225/75R16		LT225/75R16	
Pressure	0 psi		0 psi	
Tread Depth	7, 9, 9, 7 (32nd)		10, 11, 10, 9 (32nd)	
DOT #	17X 1LHT61[43]		1WB 1LHT01 1322	
Axle #2	Left		Right	
	Outside	Inside	Inside	Outside
Make	Cooper Tire	Cooper Tire	Vee Rubber	Cooper Tire
Model	Discoverer AT3 LT	Discoverer AT3 LT	Taiga H/T	Discoverer AT3 LT
Size	LT225/75R16	LT225/75R16	LT225/75R16	LT225/75R16
Pressure	0 psi	0 psi	58 psi	60 psi
Tread Depth	10, 12, 11, 10 (32nd)	12, 12, 11, 12 (32nd)	4, 3, 3, 3 (32nd)	12, 12, 13, 12 (32nd)
DOT #	UP1L 1M2 2022	UP1L 1AN[43]	6MSC CG 1821	UP1L 1M2[43]

2.11 Brakes

The bus contained four-wheel hydraulic disc brakes with ABS. The front-left wheel assembly separated from the bus during the collision sequence. With the exception of axle 1-left of the bus, all other ABS wires and sensors were intact.

Table 8: Bus - Measured Liner and Rotor Thickness

Axle	Side	Brake Type	Measured Lining Thickness		Rotor (in)
			Inner (mm)	Outer (mm)	
Axle 1	Left	Disc	NM[44]	NM[44]	NM[44]
Axle 1	Right	Disc	6	8	1.508
Axle 2	Left	Disc	7	8	1.599
Axle 2	Right	Disc	5	5	1.616

2.12 Electrical

The Chevrolet's electrical system was intact and functional upon supplying an external power source to the vehicle.

[43] No manufactured date code observed.
[44] Not measurable, damaged due to collision related damage.

2.13 Lighting

The bus contained sealed beam headlights. The left sealed beam headlight was damaged during the collision and not recovered by the NYSP or the NTSB, as observed in Figure 27. The right sealed beam headlight was recovered and submitted to the NTSB Materials Laboratory for advanced imaging.

Figure 27: Bus – Headlights

Without opening the sealed right headlight, the NTSB Materials Laboratory performed radiography imaging on the headlight. The radiography imaging shows that the right headlight was comprised of two filaments. Using the orientation observed in Figure 28, the lower filament was thicker and larger than the upper filament. The upper filament was thinner than the lower filament and was slightly curved.

"The high beam filament is always located centrally, along the axis of the beam. The low beam filament is positioned above the high beam and, therefore, somewhat off axis. The off-axis placement of the low beam filament results in a decrease in the illumination range compared to the high beam." [45]

The lower filament was consistent with being the high beam filament and the upper filament was consistent with being the low beam filament.

[45] Society of Automotive Engineers (SAE) – High Beam and Low Beam Filament Identification in Dual Filament Headlamp Sealed Beams and Replaceable Bulbs technical paper 941038.

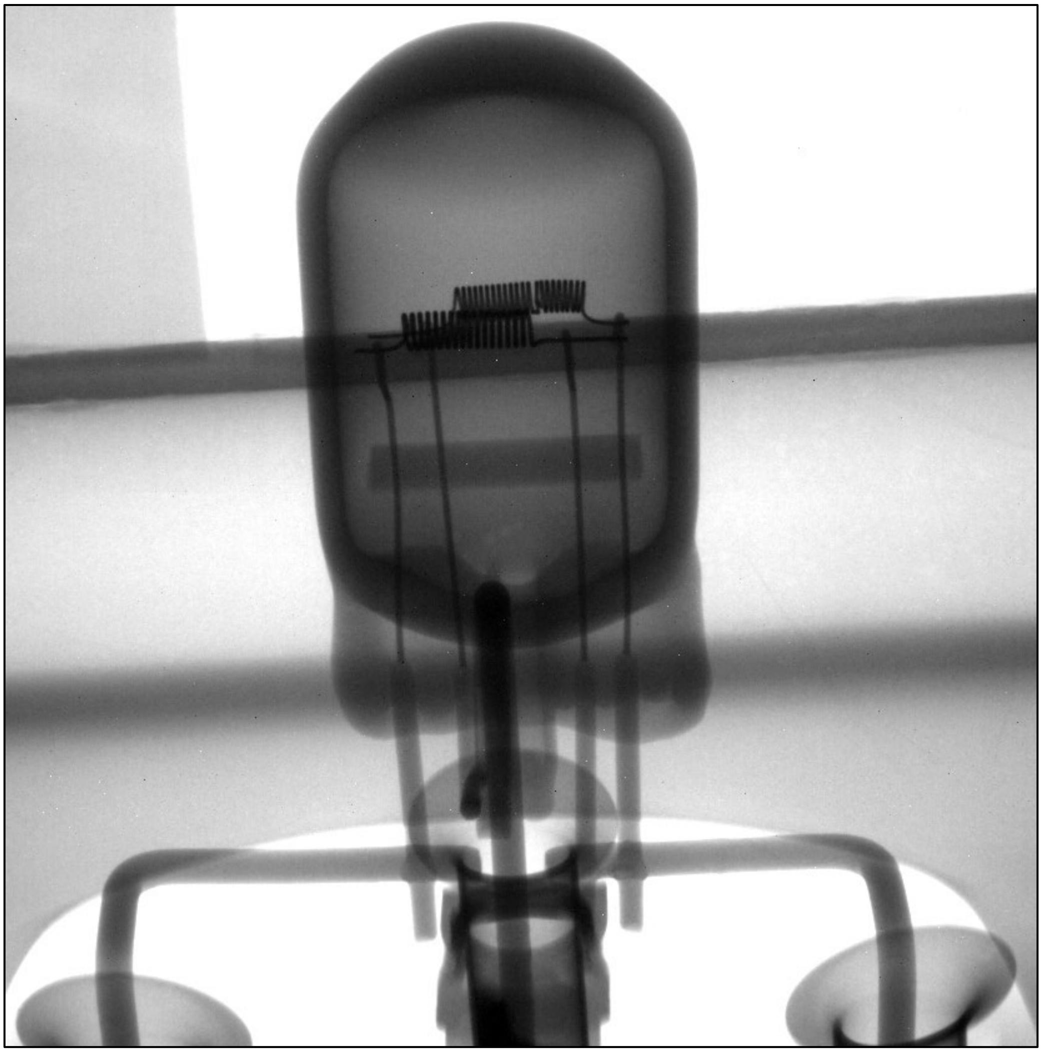
Figure 28: Bus - Right Sealed Headlight Radiography Imaging

Though the left sealed headlight was not recovered from the bus, other lights were recovered from what remained of the left assembly, as observed in Figure 29.

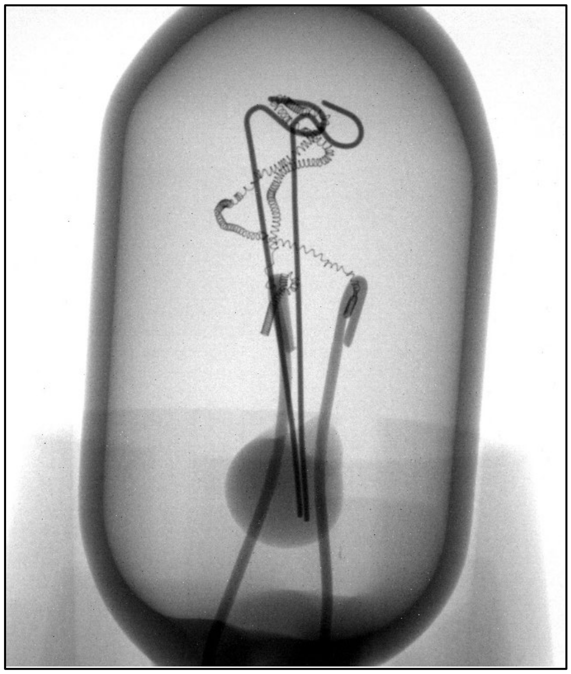

Figure 29: Bus - Left Assembly Bulb

Video surveillance footage was obtained of the subject bus leaving the hotel the morning of the collision and was date and timestamped 1/28/2023 5:51 am. The still-frame from the video, observed in Figure 30, was from approximately 11 minutes prior to the collision and shows the bus with fully functional taillights, rear marker lights, reverse lights, and two distinct headlight beams (circled in red).

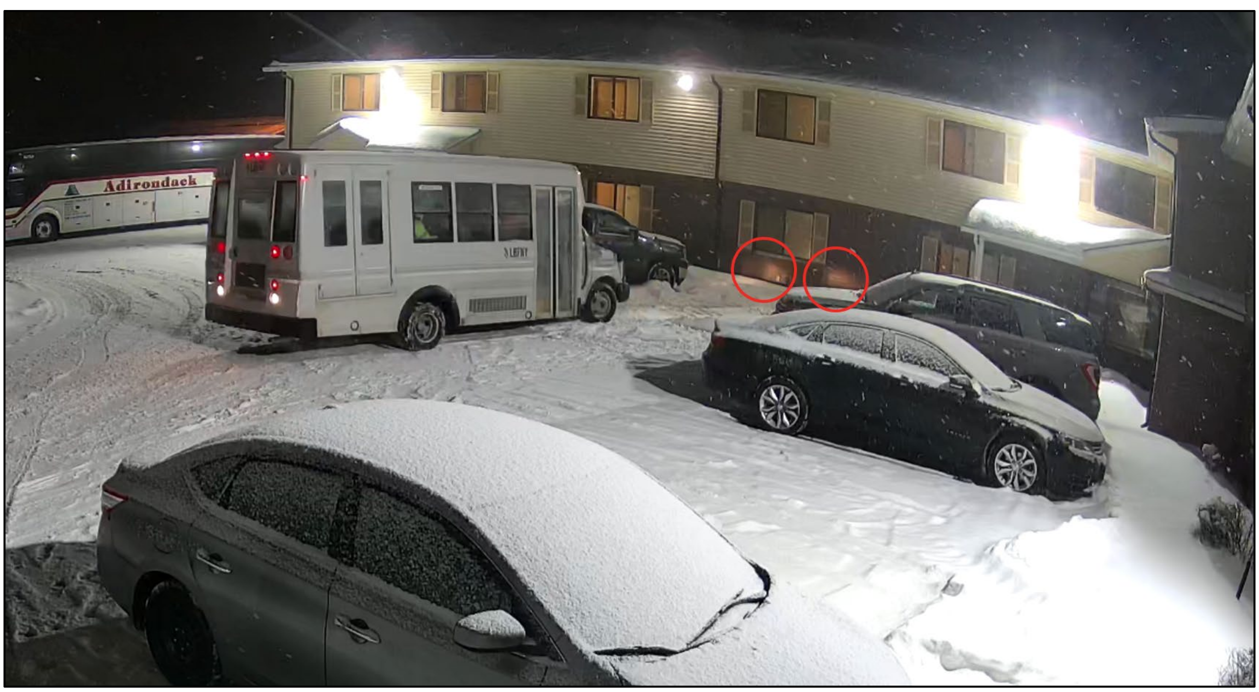

Figure 30: Bus - Surveillance Video from Hotel

2.14 Maintenance and Inspection History

According to the Motor Carrier Group Chairman, the motor vehicle carrier for the bus did not maintain any maintenance records for the subject bus. According to a New York State Department of Transportation Commercial Motor Vehicle Inspections post-collision inspection report, the carrier and subject bus were cited for violation code 396.17C for operating a CMV without proof of a periodic inspection.[46] There are no known annual inspections for the subject bus.

2.15 Documented Recalls and Warranty Claims

According to Chevrolet, the subject bus underwent the following services and corrective maintenance for previous recalls, as observed in Table 9. The pre-delivery inspection was completed at Girardin Inc., located in Quebec, Canada. The three other services were completed at various Chevrolet dealerships throughout the state of New York.

Table 9: Bus - Service and Completed Recalls

Date	Type	Operation	Odometer
07/10/19	ZFAT - Field Action Recall	9103995 - 18345 - Engine Control Module Reprogramming with SPS	128,067 miles
01/04/17	ZREG - Regular Vehicle	4030460 - Engine Oil Cooler Pipe Replacement	93,913 miles
03/31/15	ZFAT - Field Action Recall	9101077 - N140730 - Transmission Control Module Reprogramming with SPS	45,948 miles
04/03/13	ZPDI - Pre-Delivery Inspection	Z7000 - Pre-Delivery Inspection - Base Time	10 miles

According to NHTSA's Safety Issues and Recalls, there was one outstanding unrepaired recall associated with the subject VIN for the bus. The recall effected Chevrolet Express cutaway incomplete vehicles, model years 2003-2023. For the subject recall, the manufacturer recall number is N222386050, and the NHTSA recall number is 23V247.

According to the safety risk associated with the recall:

If the final-stage manufacturer leaves the circuit's connectors or cut wires unsealed, exposure to moisture or contamination may, over time, cause corrosion. In rare cases, this could result in high current draw through the circuit at the vehicles' lower left side B-pillar. Unintended release of excessive heat from the circuit may pose a risk of a vehicle fire and increase the risk of injury.[47]

[46] Driver/Vehicle Examination Report - NYMC74000503 – Dated 01/31/2023.
[47] https://www.nhtsa.gov/recalls - Accessed 05/31/2023.

The recommended remedy for the recall is to properly seal the rear HVAC blow motor circuit at the left-side B-pillar to prevent moisture exposure. The recall was issued on April 6, 2023, which was approximately 68 days after the subject collision.

2.16 Collision Avoidance

The bus was not equipped with any collision mitigation or avoidance technologies.

2.17 Event Data

2.17.1 Airbag Control Module

The bus was equipped with a sensing diagnostic module (SDM). Chevrolet refers to the module as an SDM, however, this type of module is generally referred to as an airbag control module (ACM). For this report, the terms SDM and ACM are used interchangeably, as they refer to the same type of module. The subject ACM contained an onboard accelerometer and was capable of communicating with various vehicle components and sensors throughout the bus.

The ACM had the capability of recording electronic collision data as well as diagnostic system status information leading up to an event trigger. The bus's ACM was jointly imaged by NYSP and NTSB using a Bosch Crash Data Retrieval (CDR) downloading kit. A Bosch CANPlus interface and a direct-to-module (DTM) downloading methodology was utilized by connecting to the subject ACM directly, using the 02003320 Bosch DTM cable listed in the Bosch CDR software, as observed in Figure 31. The ACM was still secured to the vehicle during the imaging process and was not free to move. The imaging resulted in three successful passes, and the data recorded by the ACM was saved locally.[48]

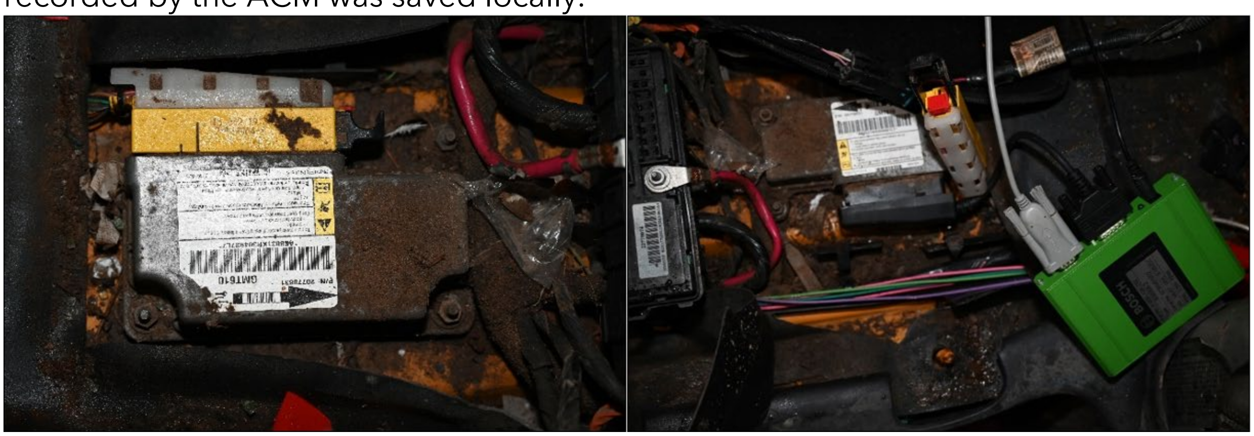

Figure 31: Bus - Airbag Control Module and Imaging

[48] See Vehicle Factors Attachment: *Chevrolet ACM/SDM CDR Report*.

The ACM recorded one deployment event, which was related to the subject collision. The event consisted of five data points, which was approximately 2.5 seconds of asynchronously captured pre-crash information, cumulative lateral and longitudinal Delta-V, and system status information at the time of collision. The accelerator pedal position percentage, vehicle speed, engine speed, percent throttle, and brake switch circuit state were recorded by the ACM with a sampling rate of 2 hertz.

The ACM recorded that the bus was traveling between approximately 53 and 54 mph, during the 2.5 seconds leading up to the event trigger. During all 2.5 seconds of pre-crash recorded data, the ACM recorded that the bus's brakes were not applied. The accelerator pedal position percentage recorded by the ACM was between 27-31% during the 2.5 to 1.0 seconds prior to the event trigger. The ACM recorded that the accelerator pedal position percentage reduced to 0% during the last asynchronously recorded data point, which occurred approximately 0.5 seconds prior to the event trigger. The bus's ACM did not record steering wheel input or angle. The ACM recorded that cruise control was not active but further stated "if (the vehicle was) equipped (with cruise control)". The ACM recorded that the driver's seatbelt was buckled at the event trigger, but further analysis would be required to conclude if the seatbelt was worn properly (see the Docket for further information).

Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	29	30	31	27	0
Vehicle Speed (MPH)	54	53	53	53	53
Engine Speed (RPM)	1728	1728	1728	1728	1664
Percent Throttle	40	40	41	41	29
Brake Switch Circuit State	OFF	OFF	OFF	OFF	OFF

Figure 32: Bus: ACM Recorded Pre-Crash Data (Raw Data - Unanalyzed)

The maximum cumulative longitudinal change in velocity (Delta-V) that was recorded by the ACM was approximately -26.02 mph, which occurred approximately 220ms after the event trigger, as observed in Figure 33. The negative Delta-V indicates that the bus experienced a forward speed loss during the collision sequence. Due to limitations with the subject ACM, the ACM was only capable of recording a maximum of 220 msec of post-event trigger data and the ACM stopped recording the cumulative Delta-V when the 220 msec elapsed.

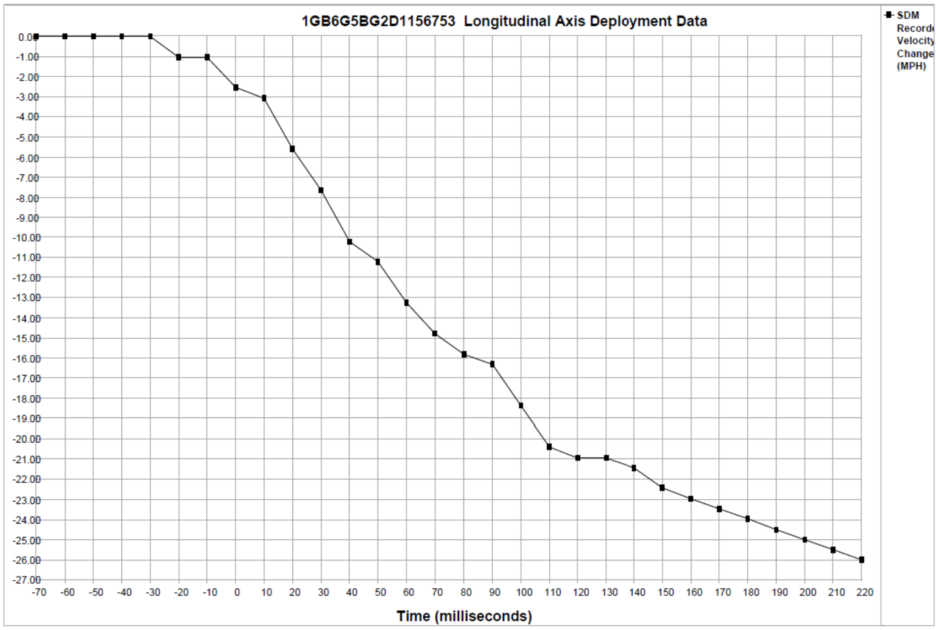

Figure 33: Bus - Longitudinal Delta-V Graph

F. DOCKET MATERIAL

<u>Vehicle Factors Attachments:</u>

1. Vehicle Factors Attachment: Freightliner Build Sheet Document.
2. Vehicle Factors Attachment: Weights and Measurements from Morgan Truck Body, LLC.
3. Vehicle Factors Attachment: Freightliner Maintenance Records.
4. Vehicle Factors Attachment: Freightliner Annual Inspection Reports.
5. Vehicle Factors Attachment: Freightliner ECM/ EDR Download Report.
6. Vehicle Factors Attachment: Chevrolet Express RPO Decode and Chevrolet Maintenance Records.
7. Vehicle Factors Attachment: Chevrolet ACM/SDM CDR Report.

Submitted by:

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