National Transportation Safety Board
Office of Highway Safety
Washington, DC 20594

HWY23MH004

VEHICLE FACTORS GROUP

Group Chair's Factual Report

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A. CRASH INFORMATION AND SUMMARY

For a summary of the crash, refer to the *Crash Information and Summary Report, which can be found* in the NTSB docket for this investigation.

B. VEHICLE FACTORS GROUP

Group Chair	Jerome Cantrell National Transportation Safety Board Washington, DC

C. DETAILS OF THE VEHICLE FACTORS INVESTIGATION

The Vehicle Factors Group Chairman's Factual is a collection of factual information obtained during the detailed inspections of the 2000 Eldorado bus, the 2022 Freightliner truck-tractor in combination with a 2020 Great Dane semitrailer. The bus and semitrailer were examined at Scotty's Auto & Fleet Repair facility, located in Toano, VA, between December 17 and 21, 2022. An examination of the 2022 Freightliner was conducted at Scotty's Auto & Fleet Repair facility between January 11 and 12, 2023.

1.0 Vehicle Examinations[1]

1.1 2000 Eldorado Bus

Chassis Make:	Navistar International Transportation Corp.
Model:	3400 2-Axle bus
Bus Body Make:	ElDorado National CO.
Model:	320 Aero Elite
Serial Number:	ENRMN3213Y0970706
VIN:[2]	1HVBEABM1YH274962
Model Year:	2000
Date of Manufacture:	May 4, 2000 (Chassis)
Date of Manufacture:	November 2000
Placed into Service:	Unknown
Mileage:	305,664
GVWR:[3]:	21,440 lbs.
GAWR[4] (Axle 1):	6,000 lbs.

[1] See Vehicle Attachment – Eldorado Bus Specifications.

[2] Vehicle Identification Number.

[3] Gross Vehicle Weight Rating (GVWR) is the total maximum weight that a vehicle is designed to carry when loaded, including the weight of the vehicle itself, plus fuel, passengers, and cargo.

[4] Gross Axle Weight Rating (GAWR) is the maximum distributed weight that a given axle is designed to support.

GAWR (Axle 2):	15,440 lbs.
Engine:	B190, 190 hp. International Elect T444E diesel, SN: YNVXH0444ANB
Transmission:	Allison Automatic AT545 4-speed, SN: 30-98911
Rear Axle Ratio:	3.07
Steering Gear:	TRW / Ross TAS40
Brake Type:	Air Over Hydraulic disc brakes with Antilock Braking System (ABS)

1.2 Damage Description

For uniform description, "left" will refer to the driver's side, and "right" will refer to the passenger/curbside of the bus.

The 2000 Eldorado bus body was mounted to an International incomplete chassis (bus) and sustained crash damage to the front bumper. The left side of the front bumper was displaced rearward and was positioned to the inside of the steer tire mounted to the left-side of the front axle. The right side of the front bumper was displaced rearward, creased, and twisted downward. The hood of the bus was not attached at the time of examination and was later found with the crash debris. The radiator was displaced rearward into the engine cooling fan. The windshield was shattered and had separated from the upper part of the window frame.

The frame rails, at the rear of the bus, were bent to the right. The rear of the right-side frame rail was crushed in a forward direction folding the end of the frame rail. The rearmost frame crossmember was displaced forward and broken.

The bus body, which started from the rear of the driver's seat, was no longer mounted to the vehicle chassis. The remnants of the bus body and vehicle contents were either strapped to the back of the chassis or found in the crash debris pile – **See Figure 1**.

Figure 1: Looking at the rear of the bus.

1.3 Weights and Measurements

In the build sheets, the wheelbase was listed as being 218.0-inches. The bus was weighed at the tow yard using portable scales supplied by the Virginia State Police. The crash debris pile was sorted through, and all bus-related components were placed onto the vehicle before weighing. The bus was weighed with and without the roof to find if the weight of the roof was causal to the body of the bus separating from the vehicle. **Table 1- lists** the weights observed first with the roof laying on top of the bus, and second with the roof off the bus.

Table 1: Post-Crash Bus Weights

Bus Post-Crash Axle-end Weight		
Wheel Position	Weight (lbs)	
Left Front	2,850	
Right Front	3,175	
Left Rear	5,150	
Right Rear	5,125	
	16,300	Total
* Axle end weights do not replicate pre-crash vehicle weight distribution or passengers.		

Bus Post-Crash Axle-end Weight - No Roof		
Wheel Position	Weight (lb.)	
Left Front	2,750	
Right Front	3,050	
Left Rear	4,900	
Right Rear	4,350	
	15,050	Total

Subtracting the total weight of the bus without the roof from the weight of the bus with the roof gives us a roof weight of about 1,250 lbs.

1.4 Powertrain

The powertrain of the bus consisted of an eight-cylinder diesel engine, a four-speed automatic transmission, a propeller shaft,[5] and a rear drive axle assembly (axle 2) with a 3.07 gear ratio.

The engine was mounted at the front of the bus. An examination of the engine compartment, which included the accessory drive belt, operating fluids, and fuel system was conducted. The air conditioner condenser and engine radiator were displaced rearward into the engine cooling fan blades. The air conditioner condenser cooling fins were crushed. The serpentine accessory drive belt was broken. All operating fluids were full and there were no leaks seen around the engine area. The right-rear engine mount was broken allowing the engine and transmission to sag downward below the frame rails. The two carrier bearings for the three-piece propeller shaft were damaged.

Although the fuel system did not show any damage or leakage, NTSB investigators disassembled the fuel system looking for a cause of the lack of power

[5] Commonly referred to as a drive shaft.

experienced by the bus. The mechanical fuel pump, which is mounted in the valley of the engine, was operated by the rotation of the cam shaft lobe. The fuel pump was removed to see if there was a mechanical issue, such as a worn or broken tappet, leaking seals, or a broken plunger. Also, the fuel line between the fuel filter and fuel pump assembly was checked for blockage. No issues were identified with the fuel pump assembly or fuel line.

The engine was equipped with a paper element fuel filter assembly and a wire screen mesh pre-screen element assembly. The pre-screen element, between the fuel tank and the fuel pump was designed to filter out larger debris down to 25 microns coming from the fuel tank. The fuel filter assembly filtered the fuel coming directly from the pre-screen element and was mounted inside the fuel bowl and filtered the fuel for debris down to 14 microns before the fuel traveled to the fuel pump. The fuel filter assembly and fuel bowl were examined. The fuel filter, fuel bowl, and remaining fuel appeared clean and free of debris. The pre-screen element was examined, and it was found to be about 50% clogged with debris – **See Figure 2.**

Figure 2: Pre-Screen Element and Debris

A clogged fuel filter reduces the amount of fuel delivered to the fuel pump and can cause several issues such as difficulty starting, engine misfires, stalling, and reduced power. As a result, the engine may stall or shut off completely while driving, and it can be difficult for the engine to generate the power needed to operate properly, resulting in slower speeds and loss of towing and hill climbing power.

The Engine Operation and Maintenance Manual, which is provided to customers for the T444E diesel engine, provided the following maintenance schedule for fuel filter cleaning and replacement:

- Clean pre-strainer (pre-screen) filter every 10,000 miles, 350 hours, 1,000 gallons of fuel or 6 months; whichever occurs first.
- Change the fuel filter and pre-strainer (pre-screen) elements every 20,000 miles, 700 hours, 2,000 gallons of fuel or 12 months; whichever occurs first.[6]

1.5 Driver Controls

All driver controls remained intact and functionable. Listed below are the location and reading of the switches and gauges at the time of examination.

- Cruise control switch was in the on position.
- The windshield wiper switch was on the intermittent – 4th dash setting.
- The headlamp switch was in the on position and the panel lights were set to maximum illumination.
- The instrument cluster was intact with the following readings frozen on the analog gauges -**See Figure 3**
    - Tachometer: 1,200 rpms
    - Speedometer: 10 mph
    - Air Pressure: approximately 5 psi
    - Battery Voltage: between 12 and 14 volts
    - Vehicle Hours: 26, 556 hrs.
    - Oil Pressure: approximately 45 psi
    - Water Temperature: 210-degrees

[6] See Vehicle Attachment – Bus engine operation and maintenance manual excerpts.

Figure 3: Instrument Cluster of the Bus

1.6 Electrical System

The positive and ground electrical cables had been disconnected from the batteries, which were located beneath the driver's door. The electrical system was compromised due to the crash. All the wiring from the rear of the driver's compartment was severed. A video of the crash event confirmed that all the rear-facing lights were functional at the time of impact – **See Figure 4.**

Figure 4: This is where the wiring for the rear of the bus was either severed or cut.

1.7 Steering System

The steering system was intact and functional. The bus was equipped with tilt steering. The steering was checked for looseness at the sector shaft as well as the ball joints. The steering system was manually rotated from the left stop to the right stop, via the steering wheel, with no binding detected.

1.8 Suspension

Axle 1 suspension consisted of a solid axle with leaf-spring packs and shock absorbers mounted to each axle end and no defects were observed. Axle 2 suspension consisted of a solid axle with a tapered leaf spring, air springs, and a shock absorber mounted to each axle end. The shock absorber mounted to the right side was bent in a forward direction. No other damage was noted.

1.9 Brake System

Due to the bus having disc brakes, there were no push rod strokes to be measured as with typical air-drum brakes. There were no defects noted during the examination of the brake system – see **Table 2**.

Table 2: Bus Brake Information:[7]

Brake Location	Axle 1		Axle 2	
	Left	Right	Left	Right
Brake Type	Disc	Disc	Disc	Disc
Measured Lining Thickness	Inside 15/32	Inside 15/32	Inside 15/32	Inside 15/32
	Outside 15/32	Outside 15/32	Outside 8/32	Outside 13/32
Pushrod Stroke	NA	NA	NA	NA
Rotors[8] (inches)	1.43	1.43	1.43	1.34

1.10 Tires and Wheels

The manufacturer's specification plate was attached to the left-side door frame.

[7] All measurements recorded are in inches.

[8] All 4 rotors had the same minimum thickness specification of 1.32-inches.

Per the specification plate, the bus was to be equipped with 245/70R19.5F tires, mounted on 19.5 x 7.5 rims. The tires were specified to be inflated to 85 psi for both axles.

General information about each of the tires on the bus at the time of the inspection is documented in **Table 3**. All the wheels were inspected for cracks, welds, and elongated lug nut holes. There was no non-crash related defect discovered on any of the wheels. Tire pressure measurements were taken using a commercial grade tire pressure gauge.

Table 3: Bus Tire Information:

Axle 1	**Left**		**Right**	
Make/Model	AMERICUS / AP2000		SUMTOMO / ST719	
Tire Size	245/70R19.5		245/70R19.5	
Pressure	60 psi		80 psi	
Tread Depth[9,10]	16,16,16,16		15,15,15,16	
DOT #	00808A01R0319		DARX5X3W4219	
Maximum Load Rating[11]	4,805 lbs.		4,805 lbs.	
Tire Plies	Tread – 5 steel Sidewall – 1 steel		Tread – 5 steel Sidewall – 1 steel	
Axle 2	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Make/Model	AMERICUS / AP2000	AMERICUS / AP2000	AMERICUS / AP2000	AMERICUS / AP2000
Tire Size	245/70R19.5	245/70R19.5	245/70R19.5	245/70R19.5
Pressure	64 psi	70 psi	64 psi	64 psi
Tread Depth[12]	15,15,15,15	15,15,15,15	16,16,16,16	16,16,16,16
DOT #	00808A01R3019	00808A01R1919	00808A01R3019	00808A01R3019
Maximum Load Rating[13]	4,805 lbs.	4,805 lbs.	4,805 lbs.	4,805 lbs.

[9] Measurements were taken from the outboard to inboard. Measurements are in 32nds.

[10] 49CFR 393.75 (b) Any tire on the front wheels of a bus, truck, or truck-tractor shall have a tread groove pattern depth of at least $^{4}/_{32}$-inch.

[11] This is the maximum weight this size tire can carry in a single tire configuration.

[12] 49CFR 393.75 (c) – Other tires shall have a tread groove pattern depth of $^{2}/_{32}$-inch.

[13] This is the maximum weight each tire can carry when mounted in a dual tire configuration.

Tire Plies	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel

The tire and wheel damage observed during the tire and wheel examination:

- The outside tire mounted to the right-side of axle 2 sustained an approximate 4 ½ - inch cut along the outboard shoulder.

1.10.1 Anti-Lock Braking System (ABS)

All ABS sensors, wiring, and modulators remained intact and in place.

1.11 Engine Control Module (ECM) Data Download

The Engine Control Module (ECM), which had been mounted on the right-side of the engine, had been removed by NTSB investigators for further evaluation. The data retrieved from the ECM provided data limited to engine configuration information.[14]

1.12 Maintenance Records / Recalls

Futrell's Party Adventures, the carrier that owned and operated the Eldorado bus, was not able to provide any records as to preventive or corrective maintenance. Staff was able to obtain maintenance records from Virginia state inspections, and a prior owner of the bus. Additional maintenance record requirements can be found in the docket for this investigation. Maintenance records obtained to date include the following:

Maintenance records from the previous vehicle owner indicate that between August and November of 2019, there were multiple issues with the engine.

- 8/26/2019: Loss of engine power - due to low coolant level.
- 10/14/2019: Engine stalled – replaced IPR and fuel solenoid.
- 10/23/2019: Engine stalling – replaced ICP and cam positioning sensor.
- 11/11/2019: Engine intermittently shutting off – replaced ECM power relay.

Maintenance records produced since current owner took possession of the bus.

[14] See Vehicle Attachment – 2000 Eldorado ECM Download.

- On 10/8/2020, the bus failed a Virginia State Police inspection due to brakes, headlights, signal lights, steering, and suspension defects.[15]
- On 10/21/2020, the bus passed a follow-up inspection.[16]
- Repair order dated 10/22/2020, shows the steering, brakes, suspension, headlights, and signal light defects were fixed. An oil change was completed, and new oil filters were installed. [17]
- On 12/23/2021, the bus passed the Virginia State Inspection.[18]
- There was no warranty work information on file with the manufacturer.
- There were no active recalls located either through the manufacturer or through National Highway Traffic Safety Administration's database.

2.0 2022 Freightliner Truck-tractor

Make:	Freightliner
Model:	Cascadia
VIN:	3AKJHHDRXNSMZ7498
Model Year:	2022
Date of Manufacture:	May 2021
Placed into Service:	Unknown
Mileage:	222,442
GVWR:[19]:	52,500 lbs.
GAWR[20] (Axle 1):	12,500 lbs.
GAWR (Axle 2):	20,000 lbs
GAWR (Axle 3):	20,000 lbs.
Engine:	DD15 Gen 5, 14.8L, 455 HP diesel
Transmission:	DT12-1650, 12-speed automatic
Rear Axle Ratio:	2.85
Wheelbase:	229 inches
Steering Gear:	TRW hydraulic power assisted
Brake Type:	Air-operated drum brakes with Antilock Braking System (ABS)

[15] See Vehicle Attachment – Virginia State Bus Inspections.
[16] See Vehicle Attachment – Virginia State Bus Inspections.
[17] See Vehicle Attachment – 2000 Eldorado Maintenance Records.
[18] See Vehicle Attachment – Virginia State Bus Inspections.
[19] Gross Vehicle Weight Rating (GVWR) is the total maximum weight that a vehicle is designed to carry when loaded, including the weight of the vehicle itself, plus fuel, passengers, and cargo.
[20] Gross Axle Weight Rating (GAWR) is the maximum distributed weight that a given axle is designed to support.

2.1 Damage Description:

For uniform description, “left” will refer to the driver’s side, and “right” will refer to the passenger/curbside of the truck-tractor.

The hood and front bumper were missing. The bumper guard was bent and creased in multiple locations. The right-side bumper guard mounting bracket was displaced toward the left, and the left-side mounting bracket was displaced to the left and was in contact with the power steering gearbox. The full width of the windscreen was shattered. There was a large hole through the right side of the windscreen. Three of the five vehicle identification lights above the windscreen were broken. On the upper left side of the cab and on the left wind deflector there were black transfer marks. The left-side rear-view mirror was broken, and the driver’s door had scratches and gouges forward of the door handle – **See Figure 5**. The exterior skin on the left side of the sleeper berth had been torn open, and there was a gouge that went from the bottom of the side storage compartment up into the storage compartment door bending the bottom of the door upward. The left fairing that attaches to the rear of the sleeper berth was missing. The right-side air suspension and shock absorber for the cab were broken away from their respective upper mounts.

Figure 5: The front of the truck-tractor

The fifth wheel assembly remained securely mounted to the truck-tractor. The upper fifth wheel plate assembly, from the semitrailer, remained attached to the fifth wheel assembly via the king pin.

The exterior door skin on the right-side passenger door contained creases and the bottom of the door was bent upward. The right-side entrance steps were deformed and displaced rearward. The lower leading edge of the sleeper berth was gouged.

2.2 Powertrain:

The transmission oil cooler, air conditioning condenser, and the engine coolant radiator were displaced rearward into the engine cooling fan, breaking the fins on the fan. One of two auxiliary drive belts was broken. The expansion tank for the engine coolant radiator was displaced and broken.

On the left side of the engine compartment, the fuel filter housing was broken and displaced from its mounting location. The remotely mounted, steering gear hydraulic fluid reservoir was broken. A small amount of hydraulic fluid remained in the broken reservoir. The front 1/3rd of the engine oil pan was missing. On top of the engine, the valve cover and engine air-intake filter assembly were broken, and the main power cable to the vehicle control electronics had been severed.

Although both 100-gallon saddle fuel tanks sustained dents and minor gouges, they remained securely mounted and neither tank had been compromised.

2.3 Driver Controls:

The truck was equipped with a tilt/telescoping steering column. The plastic center cover of the steering wheel, which could activate the electric horn, was missing. On the left-side steering wheel pod, there were push buttons to navigate through the digital instrument cluster. On the right-side steering wheel pod, there were push buttons to operate the cruise control, hands-free calling, and the ability to flash the headlamps and marker lights.

There was a multifunction turn signal switch mounted to the left-side of steering column. In addition to the turn signals, the driver could operate the windshield wipers and the high beam and low beam setting for the headlamps.

Mounted on the right side of the steering wheel column was the transmission multifunction control lever. With this lever the driver could operate the transmission in either manual or automatic shift modes. The up and down position of the lever also controlled the level of engine braking.

Most of the dash mounted switches were the self-centering rocker type and whether they were on or off at the time of the crash could not be documented. The following analog gauges and knobs were documented:

- Brake air pressure: 60 psi
- Climate control fan speed: approximately 60% of max speed
- Temperature setting: slightly into the heating zone
- The air was being directed to the defroster vents
- The speedometer was stuck at 42 mph
- The tachometer was stuck at 1,000 rpms

2.4 Electrical System:

The electrical system remained intact except for the main power supply cable to the vehicle control electronics had been severed during the crash sequence. The severed supply cable was reconnected, and accessory power was applied to the vehicle control electronics and the onboard camera. With the onboard camera repowered, it was able to upload the relevant crash data to the motor carrier.

There were no headlamps or turn signals remaining on the front of the truck-tractor, but the rear turn signals, brake lamps, and tail lamps were inspected and found to be functional.

2.4.1 Vehicle Logged Data:[21]

The truck-tractor was equipped with multiple control modules for engine management and vehicle operations. The engine was controlled by a Detroit Diesel Electronic Control (DDEC) Engine Control Module (ECM). The primary function of the ECM is to control the engine's performance, fuel efficiency, and emissions based on various engine and sensor inputs. The ECM is also capable of recording diagnostic trouble codes associated with engine and/or sensor faults, which may then activate warnings on the dash. Also, the ECM is capable of capturing vehicle speed, engine speed, and other parameters during triggered events.

The ECM, Central Powertrain Control Module (CPC), Transmission Control Module (TCM), and Aftertreatment Control Module (ACM) were all removed and transported to Detroit Diesel Corporation for data extraction. On January 13, 2023, all the modules were transported by NTSB investigators to the Detroit Diesel headquarters in Detroit, Michigan. Under direction of NTSB investigators, the modules were connected to bench test and the data was downloaded and saved.

The data retrieved from the modules showed the truck-tractor had been traveling between 65 and 70 mph during the 2-minutes prior to impact. Cruise control was active during this same time frame.

[21] See vehicle Attachment – Truck-Tractor Vehicle logged Data for more information.

There was no braking action detected prior to impact, but there was indication of braking action following the impact. Additional download information can be found in the docket for this investigation.

2.5 Steering System:

The truck was equipped with a tilt/telescoping steering column, upper and lower steering shafts, a hydraulic assisted power steering gearbox with a remotely mounted hydraulic reservoir, a pitman arm, a drag link, steering knuckles, and a tie rod. The lower steering arm, which was connected to the input shaft on the gearbox, was bowed. With the front axle lifted off the ground, the steering wheel was rotated from the right stop to the left stop without binding. All ball joint connections were tight, and there was no looseness felt at any connection.

2.6 Suspension:

The suspension on axle 1 consisted of leaf springs, shock absorbers, and a solid axle. There was no damage noted during the examination.

The suspension on axle 2 and axle 3 consisted of leaf springs, air springs, shock absorbers, and solid axles. There was no damage noted during the examination.

2.7 Tires and Wheels:

The manufacturer's specification plate was attached to the inside of the left-side door frame.

Per the specification plate, the truck-tractor was to be equipped with 275/80R22.5 (H) tires inflated to 120 psi on axle 1, and 275/80R22.5 (G) tires inflated to 110 psi on axle axles 2 and 3. All tires were to be mounted on 22.5 x 8.25 rims.

General information about each of the tires on the truck-tractor at the time of the inspection is documented in the **Table 4.** All the wheels were inspected for cracks, welds, and elongated lug nut holes. There was no non-crash related defect discovered on any of the wheels. Tire pressure measurements were taken using a commercial grade tire pressure gauge.

Table 4: Truck-Tractor Tire Information

Axle 1	**Left**		**Right**	
Make/Model	MICHELIN X LINE ENERGY D		MICHELIN X LINE ENERGY D	
Tire Size	275/80R22.5		275/80R22.5	
Pressure	0 psi		110 psi	
Tread Depth[22]	18,18,18,18		16,16,16,16	
DOT #	M5EJ014X2121		M5EJ013X2422	
Maximum Load Rating[23]	6,175 lbs. (Single)		6,175 lbs. (Single)	
Tire Plies	Tread – 5 steel Sidewall – 1 steel		Tread – 5 steel Sidewall – 1 steel	
Wheels	Cast: 22.5x8.25		Cast: 22.5x8.25	
Axle 2	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Make/Model	MICHELIN X LINE ENERGY D	MICHELIN X LINE ENERGY D	MICHELIN X LINE ENERGY D	MICHELIN X LINE ENERGY D
Tire Size	275/80R22.5	275/80R22.5	275/80R22.5	275/80R22.5
Pressure	100 psi	94 psi	90 psi	90 psi
Tread Depth	12,12,12,12	14,14,14,14	12,12,12,12	14,14,14,14
DOT #	R#GLB0116R	R#GLB40544R	R#GLB40560R	R#GLB40563R
Maximum Load Rating[24]	5,675 lbs. (Dual)	5,675 lbs. (Dual)	5,675 lbs. (Dual)	5,675 lbs. (Dual)
Tire Plies	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel
Wheels	Steel: 22.5x8.25	Steel: 22.5x8.25	Steel: 22.5x8.25	Steel: 22.5x8.25
Axle 3	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Make/Model	MICHELIN X LINE ENERGY D	MICHELIN X LINE ENERGY D	MICHELIN X LINE ENERGY D	MICHELIN X LINE ENERGY D
Tire Size	275/80R22.5	275/80R22.5	275/80R22.5	275/80R22.5
Pressure	94 psi	82 psi	86 psi	94 psi
Tread Depth	11,11,11,11	9,9,9,9	9,9,9,9	10,10,10,10
DOT #	R#GLB40561R	B6EJ00LX1821	B6EJ00LX1821	R#GLB40548R

[22] Measurements were taken from the outboard to inboard. Measurements are in 32nds.
[23] This is the maximum weight this size tire can carry in a single tire configuration.
[24] This is the maximum weight each tire can carry when mounted in a dual tire configuration.

Maximum Load Rating[25]	5,675 lbs. (Dual)	5,675 lbs. (Dual)	5,675 lbs. (Dual)	5,675 lbs. (Dual)
Tire Plies	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel
Wheels	Steel: 22.5x8.25	Steel: 22.5x8.25	Steel: 22.5x8.25	Steel: 22.5x8.25

Tire and wheel damage observed during the tire and wheel examination:

Since the tire mounted to the left-side of axle 1 was separated from the wheel, the letter M in the word Michelin was utilized as the 12:00 o'clock position. The outboard sidewall sustained an approximate 13-inch in chord length puncture from the 12:00 to 2:00 o'clock positions. There was a second sidewall puncture located from the 7:30 to 8:00 o'clock positions which was approximately 4-inches in chord length. The entire circumference of the outboard wheel flange was abraded.

Approximately 25-inches of tread was missing from the tire mounted to the left inside position of axle 2.

Approximately 19-inches of tread was damaged with missing chunks and two diagonal cuts across the tread approximately 10-inches apart on the tire mounted to the left outside position on axle 2.

2.8 Brake System:

The truck-tractor was equipped with a dual pneumatic brake system with drum brakes on all axles. The service and emergency brake air hoses had broken away from the tractor control valve at the connection fittings at the rear of the cab. The service and emergency brake thermoplastic airlines were separated from the brake valve body attached to the firewall. The "wet" air tank, which was mounted behind the right-side fuel tank, had separated from its original mount, and was hanging by the thermoplastic airlines[26]. The air supply line from the compressor to the air dryer had been crushed and severed in multiple locations. To check brake adjustments, shop air was plumbed directly onto the air dryer. Brake information along with brake adjustments are documented in **Table 5.**

[25] This is the maximum weight each tire can carry when mounted in a dual tire configuration.
[26] The first air tank in an airbrake system is commonly referred to as a "wet" tank.

Table 5: Truck-Tractor Brake Information

Brake Location	Axle 1		Axle 2		Axle 3	
	Left	Right	Left	Right	Left	Right
Brake Type[27]	Wabco[28] 24 Drum	Wabco 24 Drum	Wabco[29] 30/36 Drum	Wabco 30/36 Drum	Wabco 30/36 Drum	Wabco 3036 Drum
Pushrod Stroke (Inches)	1 1/8	1 5/8	2 3/8	2 ½	2 1/2	2 1/2
Measured Lining Thickness	Upper: 20/32nds	Upper: 19/32nds	Upper: 21/32nds	Upper: 26/32nds	Upper: 21/32nds	Upper: 19/32nds
	Lower: 20/32nds	Lower: 18/32nds	Lower: 21/32nds	Lower: 26/32nds	Lower: 21/32nds	Lower: 18/32nds
Drum Measurement (inches)	16.58	16.50	16.50	16.50	16.50	16.50
Manufacturer's Specification – Maximum Inside Drum Measurement (inches)	16.620	16.620	16.620	16.620	16.620	16.620

2.9 Anti-Lock Braking System:

The truck-tractor was equipped with a Wabco 6S/6M Anti-Lock Braking System (ABS). During the electrical system check no ABS warning lamp illuminated inside the cab to indicate an ABS malfunction. All sensors and modulators were in place and secure.

2.10 Vehicle Recorded Event Data:

The Detroit engine was controlled by an Engine Control Module (ECM) that controlled engine timing and fuel injection, based on various engine and sensor inputs. This module is also capable of recording diagnostic and event data associated with engine, sensor faults, vehicle speed, engine speed, other various parameters, and events triggered after meeting a deceleration threshold.

[27] All brakes were long stroke.

[28] The maximum pushrod stroke allowed is 2-inches - per North American Standard Out-of-Service Criteria.

[29] The maximum pushrod stroke allowed is 2 ½ -inches – per North American Standard Out-of-Service Criteria.

Detroit Diesel Corporation completed the data extraction from the ECM, Central Power Controller (CPC, Transmission Control Module (TCM), and the Aftertreatment Control Module (ACM).[30]

2.11 Collision Avoidance Systems:

A Collision Avoidance System is a suite of technologies designed to prevent or reduce the severity of a crash before it occurs. These technologies are also referred to as Advanced Driver Assistance Systems (ADAS). ADASs employ various technologies, including radars, cameras, and lidar (light detection and ranging) systems, to monitor the environment for potential conflicts that could lead to a crash, such as a sudden lane change and slow-moving or stopped vehicles. An ADAS monitors the forward environment. When the ADAS detects a conflict, it begins to prepare the brakes and sends a warning to the driver. Warnings can be auditory, visual, or haptic. In some cases, the system can also prepare the occupant restraint system to improve protection if a crash occurs.

As of 2018, Freightliner Cascadia's were built with a suite of ADASs offered as standard equipment. The latest version of the Detroit Assurance Safety Suite being offered is 5.0, which included the following collision mitigation hardware active brake assist, adaptive cruise control, lane departure warning and software. Active brake assist utilizes a bumper-mounted radar and a windshield mounted camera. The signals from the radar and camera are fused for greater object recognition to provide enhanced braking capabilities.[31] Adaptive cruise control automatically adjusts vehicle speed to maintain a safe following distance from a forward vehicle. The following distance of between 2.4 and 3.6 seconds can be adjusted by the driver. Adaptive cruise control can bring the vehicle to a complete stop, if necessary, in stop-and-go traffic. The latest version of the Detroit Assurance Safety Suite 5.0 has the capability to incorporate additional systems which are listed as optional. The optional systems consist of active lane assist technology which includes lane departure warning, lane keep assist technology, side guard assist technology, traffic sign recognition, automatic wipers and headlights, and intelligent high beam.

Despite the equipment being labeled as standard for this model vehicle, this equipment and software were not required to be installed per any federal regulations, and it was not present during the inspection. During an interview conducted with the carrier, they stated that the ADAS equipment was deleted from the vehicle builds because the drivers didn't want the technology. Additional information regarding the interview can be found in the docket for this investigation.

[30] See Vehicle Attachment – 2022 Freightliner Logged Data

[31] Information obtained from Detroit Assurance On-Highway | Demand Detroit

2.12 Maintenance Records:

The only maintenance done to the truck-tractor, according to the maintenance records from 8/31/2021 through 11/1/2022, were oil changes and tire replacements. The last annual inspection was conducted on 4/25/2022 and listed no defects.

The manufacturer provided two recalls for this vehicle.

- Recall FL893A-G issued February 2022: This recall pertained to the replacement of aluminum battery cables with copper battery cables.
- Recall FL922A-C issued May 2022: This was an emissions recall to replace the exhaust pipe between the turbocharger outlet and the aftertreatment system inlet.
- There is no record regarding if these recalls were completed.

3.0 2020 Great Dane Semitrailer

Make:	Great Dane
Model:	Champion 53' Dry Van
VIN:	1GR1P0623LT148693
GVWR:[32]:	68,000 lbs.
GAWR[33] (Axle 1):	20,000 lbs.
GAWR (Axle 2):	20,000 lbs.
Brake Type	Air-operated drum brakes with Antilock Braking System (ABS)

3.1 Damage Description

The front portion of the semitrailer was missing along with the king pin, upper fifth wheel plate, and the landing gear. The larger pieces of the semitrailer were located inside the remaining portion of the semitrailer – **See Figure 6**.

[32] Gross Vehicle Weight Rating (GVWR) is the total maximum weight that a vehicle is designed to carry when loaded, including the weight of the vehicle itself, plus fuel, passengers, and cargo.

[33] Gross Axle Weight Rating (GAWR) is the maximum distributed weight that a given axle is designed to support.

Figure 6: The left-front of the semitrailer

3.2 Electrical System

The electrical system was compromised and unable to be checked.

3.3 Suspension

The suspension system for both axles consisted of a solid axle with air springs mounted to each axle end – no damage was noted.

3.4 Brake System

The brake system was examined, but no push rod stroke measurements were taken. During scene recovery, the brakes were backed off to allow movement of the semitrailer – **See Table 6**.

Table 6: Semitrailer Brake Information:[34]

Brake Location	Axle 1		Axle 2	
	Left	Right	Left	Right
Brake Type[35]	Drum 30/30 Clamp	Drum 30/30 Clamp	Drum 30/30 Clamp	Drum 30/30 Clamp
	Upper 25/32	Upper 25/32	Upper 18/32	Upper 20/32

[34] All measurements are in inches.
[35] All brake chambers were long stroke.

Measured Lining Thickness (inches)	Lower 25/32	Lower 25/32	Lower 18/32	Lower 20/32
Pushrod Stroke	NA	NA	NA	NA
Drums[36] (inches)	16.44	16.44	16.44	16.62

3.5 Tires and Wheels

The manufacturer's specification plate was missing along with the front of the semitrailer.

General information about each of the tires on the truck at the time of the inspection is documented in **Table 7.** All the wheels were inspected for cracks, welds, and elongated lug nut holes. There was no non-crash related defect discovered on any of the wheels. Tire pressure measurements were taken using a commercial grade tire pressure gauge.

[36] The maximum inside diameter was specified not to exceed 16.62-inches.

Table 7: Semitrailer Tire Information

Axle 1	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Make/Model	MICHELIN ENERGYD	MICHELIN ENERGYD	BFGOODRICH TR144	BFGOODRICH TR144
Tire Size	275/80R22.5	275/80R22.5	275/80R22.5	275/80R22.5
Pressure	100 psi	100 psi	102 psi	102 psi
Tread	11/32nds	12/32nds	12/32nds	12/32nds
DOT #	HAEJ087X0720 RC# YYJCL1922	HAEJ087X1020 RC# YYJCL1922	7VDFBF114917 RC# RAFRC1A2320	M5DFAF111518 RC# YYJCL3820
Maximum Load Rating	5,675lbs @ 110 psi (dual)	5,675lbs @ 110 psi (dual)	5,675lbs @ 110 psi (dual)	5,675lbs @ 110 psi (dual)
Tire Plies	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel
Axle 2	**Left**		**Right**	
	Outside	Inside	Inside	Outside
Make/Model	MICHELIN ENERGYD	GOODYEAR G316 LHT	MICHELIN ENERGYD	MICHELIN ENERGYD
Tire Size	275/80R22.5	295/75R22.5	275/80R22.5	275/80R22.5
Pressure	102 psi	110 psi	84 psi	100 psi
Tread Depth	8	9	8	9
DOT #	HAJF010X4221	Y137YLBW3120 RC# YYJCL3820	HAEJ087X2419 RC# 3621	HEJF010X0821 RC# RDRV282201A
Maximum Load Rating[37]	5,675lbs @ 110 psi (dual)	5,840lbs @ 105 psi (dual)	5,675lbs @ 110 psi (dual)	5,675lbs @ 110 psi (dual)
Tire Plies	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel	Tread 5-Steel Sidewall 1-Steel

There was no pre-existing or crash related damage noted to the tires mounted on the semitrailer.

3.5.1 Anti-Lock Braking System (ABS)

All ABS sensors, wires, and modulators were intact and in place – no defects noted.

[37] This is the maximum weight each tire can carry when mounted in a dual tire configuration.

3.6 Maintenance Records

- Repair order R-04449 dated 6-14-2021: all brakes were replaced, and one wheel seal was changed.
- Repair order R-06457 dated 2/11/2022: All brake linings and drums were replaced, 2 retread tires were mounted, and 3 wheel seals were changed.
- Repair order R-06902 dated 3/16/2022: Two brake linings were replaced, and four tires were mounted.
- Repair order R-07908 dated 7-22-2022: Indicates tires were replaced but there is no indication of how many.
- Repair order R-08766 dated 10/5/2022: Four tires were replaced.
- Repair order R-09275 dated 12/7/2022: Two brake drums were balanced, two brakes were replaced, and one tire was changed.

Annual inspection report conducted on 10-4-2022 states that no defects were present.

D. DOCKET MATERIAL

The following attachments are included in the docket for this investigation:

LIST OF ATTACHMENTS:

Vehicle Attachment -	Eldorado Bus Specifications
Vehicle Attachment -	Bus engine operation and maintenance manual excerpts
Vehicle Attachment -	2000 Eldorado ECM Download
Vehicle Attachment -	Virginia State Bus Inspections
Vehicle Attachment -	2000 Eldorado Maintenance Records
Vehicle Attachment -	2022 Freightliner Logged Data
Vehicle Attachment -	Vehicle Photographs

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