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

HWY24MH013

VEHICLE FACTORS

Group Chair's Factual Report

TABLE OF CONTENTS

A. Crash 4
B. Vehicle Factors Group 4
C. Crash Summary 4
D. Details of the Investigation 4
1.0 Vehicle Examinations: 4
1.1 2019 Mack Truck-Tractor 4
1.2 Damage Description: 5
1.3 Combination Vehicle Weights 6
1.4 Powertrain 6
1.5 Driver Controls 7
1.6 Electrical System 8
1.7 Steering System 8
1.8 Suspension 8
1.9 Brake System 9
1.10 Tires and Wheels 9
1.11 Anti-Lock Braking System 11
1.12 Electronic Stability Control 12
1.13 Engine Control Module Data Download 12
1.14 Collision Avoidance System Technologies 13
1.15 Maintenance Records / Recalls 14
2.0 2009 Great Dane Semitrailer: 14
2.1 Damage Description 14
2.2 Electrical System 14
2.3 Suspension 15
2.4 Brake System 15
2.5 Tires and Wheels 15
2.6 Anti-Lock Braking System 17
2.7 Maintenance Records 17
3.0 2015 Toyota Highlander 18
3.1 General Information 18
3.2 Damage Description 18
4.0 Subsequent Crash Information 19
4.1 5:54 a.m. Crash Vehicle Description 19
4.2 6:24 a.m. Crash Vehicle Description 20
E. Docket Material 21

LIST OF FIGURES

Figure 1. 2019 Mack Truck-Tractor Cab and Rear Drive Axle 5
Figure 2. Mack Truck-Tractor - Rear Drive Axles Missing 7
Figure 3. Left-Front of the 2015 Toyota 18
Figure 4. Left-Rear view of the 2015 Toyota 19

LIST OF TABLES

Table 1. 2019 Mack Brake Information 9
Table 2. 2019 Mack Tire Information 10
Table 3. Great Dane Semitrailer Brake Information 15
Table 4. Great Dane Semitrailer Tire Information 16
Table 5. 5:54 a.m. Crash Vehicle Description 20
Table 6. 6:24 a.m. Crash Vehicle Description 20

`

A. CRASH

Location: Swanton, Lucas County, Ohio
Date: August 15, 2024
Time: 5:29 a.m. EDT

B. VEHICLE FACTORS GROUP

Group Chair — Jerome Cantrell
National Transportation Safety Board
Washington, DC

Group Member — Robert Catron
National Transportation Safety Board
Washington, DC

C. CRASH 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.

D. DETAILS OF THE INVESTIGATION

The Vehicle Factors Group Chair's Factual Report provides detailed factual information related to the vehicles involved in the subject crash and an overview of the vehicles involved in two subsequent crashes. For the initial crash detailed inspections were conducted on a 2019 Mack Anthem truck-tractor in combination with a 2009 Great Dane dry van semitrailer. Photographs and damage descriptions were obtained for the 2015 Toyota Highlander. All crash vehicles were examined at Bubba's Heavy Duty Towing and Truck Repair in Monclova, OH, between August 16 and 19, 2024. For the two subsequent crashes, a list of the involved vehicles was obtained from the Ohio State Highway Patrol.

1.0 Vehicle Examinations:

1.1 2019 Mack Truck-Tractor[1]

Make:	Mack
Model:	AN64T
VIN:[2]	1M1AN3GY6KM007078
Model Year:	2019
Date of Manufacture:	December 6, 2018

[1] See Vehicle Attachment – 2019 Mack Build Specifications.
[2] Vehicle Identification Number.

Placed into Service:	December 6, 2018
Mileage:[3]	479,628
GVWR:[4]	52,500 lbs.
GAWR[5] (Axle 1):	12,000 lbs.
GAWR (Axle 2):	20,000 lbs.
GAWR (Axle 3):	20,000 lbs.
Engine:	Mack MP8 445 HP, 13L, Diesel
Fuel Tanks:	(2) 75-gallon fuel tanks
DEF Tank[6]:	23-gallons
Transmission:	12-speed, Automated Manual
Rear Axle Ratio:	2.41
Steering Gear:	TRW/ZF THP-60
Brake Type:	Air-operated drum brakes with Bendix 6s/6m 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 vehicle. The 2019 Mack truck-tractor (truck-tractor) had major crash damage, such as the cab was completely separated from the vehicle's frame rails. – See figure 1.

Figure 1. 2019 Mack Truck-Tractor Cab and Rear Drive Axle

[3] Per ECM data.
[4] 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.
[5] Gross Axle Weight Rating (GAWR) is the maximum distributed weight that a given axle is designed to support.
[6] Diesel Exhaust Fluid.

The top of the cab, on the left side, was crushed rearward. The left a-pillar was buckled. The hood was detached and located with the crash debris pile. The driver's entry door was detached. All electrical wiring and air lines to the cab were severed. There were holes punched through the rear of the cab. The roof above the rear window was creased and crushed downward. The windscreens and rear window were missing.

Damage to specific areas and operational components will be discussed later in this report.

1.3 Combination Vehicle Weights

The unladen weights of the truck-tractor were listed between 18,000 and 21,000 pounds. The semitrailer was listed between 13,000 and 15,000 pounds. The bill of lading itemized the load along with the weight which was reported as 41,687 pounds. The combinations weight at the time of the collision could have been between 72,687 and 77,687 pounds.

1.4 Powertrain

The engine, batteries, and electrical cables and wires sustained crash damage. The fluid cooling radiators for the engine, transmission, and air conditioning were displaced rearward and all sustained crash damage. The valve cover, on top of the engine, was broken in multiple locations exposing the interior of the engine. During the crash sequence, both drive axles were torn from the vehicle mounts and separated from the vehicle –See figure 2. Both diesel fuel tanks remained attached to the vehicle. The left-side tank had sustained crush damaged at the lower leading edge, was displaced rearward, and was punctured.

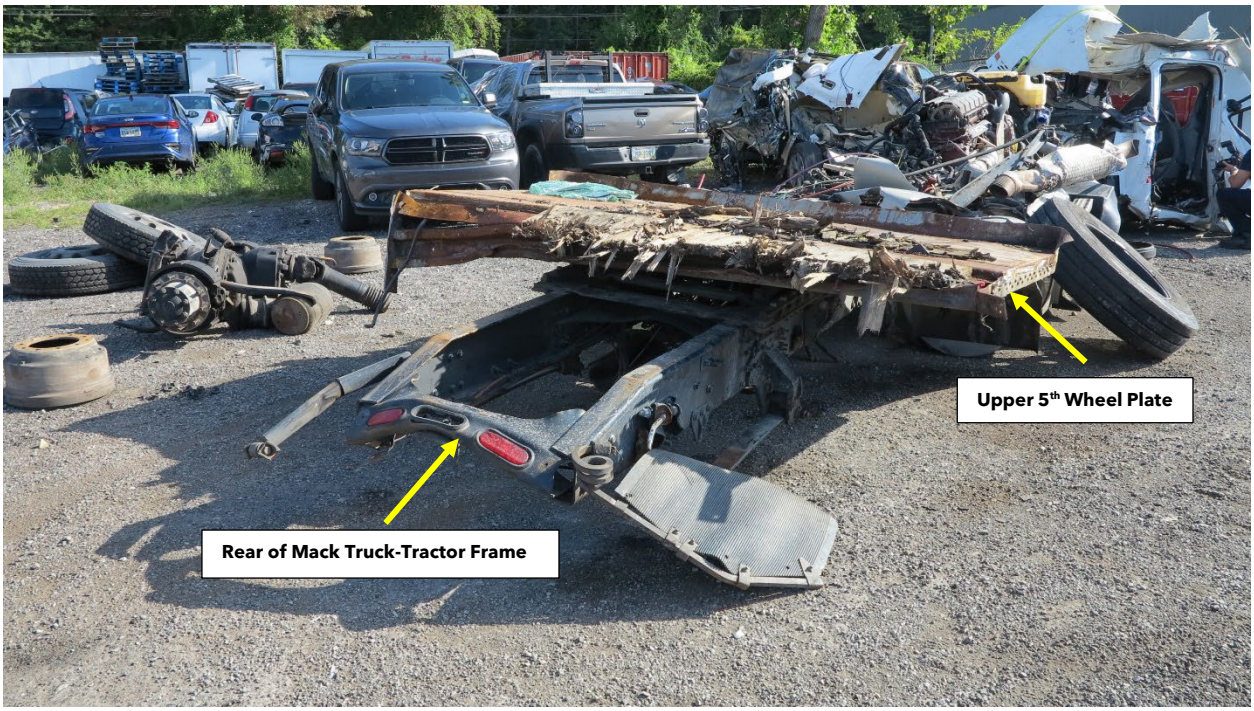

Figure 2. Mack Truck-Tractor - Rear Drive Axles Missing

The transmission remained connected to the rear of the engine. The propeller shaft, which transferred torque from the engine and transmission combination to the drive axles, consisted of three pieces. The first section, the forward shaft, was connected to the rear of the transmission and the intermediate shaft at the carrier bearing. The second section, the intermediate shaft, was connected from the forward shaft connection to the pinion gear shaft at the front drive axle. The third section, the short rear propeller shaft, was connected to the rear of the front drive axle and the pinion gear shaft on the rear drive axle. Although the forward propeller shaft remained connected to the transmission, the intermediate shaft was separated from the forward shaft at the splined or slip joint connection. The short rear propeller shaft was separated from axle 2 but remained connected to axle 3. The axle 3 drive axle housing exhibited crash damage in the form of a hole being punched through the top.

1.5 Driver Controls

All the driver controls, gauges, and switches were damaged by the crash. The dash, instrument cluster, and center stack were all displaced rearward into the cab area.

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 would have been 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 stem mounted to the left-side of the 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.

1.6 Electrical System

The truck-tractor wiring was broken and frayed and lighting components for the cab were broken. The battery housings were broken. No electrical functional testing could be conducted. The truck-tractor was equipped with multiple control modules for engine management and vehicle operations. The modules were located and removed for further analysis - refer to the Technical Reconstructionist factual report for additional imaging information.

1.7 Steering System

The steering gear box and lower steering arm remained connected at the steering gear input shaft, via a universal joint. The lower steering arm and intermediate steering arms were separated at the compensating joint. The upper steering arm remained connected to the steering column and steering wheel via a universal joint. The intermediate steering shaft was bowed but was able to rotate with the steering wheel. The steering wheel was cut in half during recovery operations. The lower steering arm was utilized to check the steering gearbox for roughness and broken gears. The gear box operated roughly, and the sector shaft did not operate in corresponding movements. The steering axle was displaced toward the left-side and right-side front spring hangers. The tie rod, which was connected to the left and right steering arms was bowed toward the front.

1.8 Suspension

The suspension on the steering axle (axle 1) consisted of single-leaf springs, shock absorbers, and a solid axle. Both axle centering pins were broken, and the axle-to-spring securement U-bolts were loose on both sides allowing the front axle to slide forward. Both shock absorbers were broken, and the left-front spring hanger was broken.

The suspension on the drive axles (axle 2 and axle 3 respectively) consisted of single-leaf springs, air springs, shock absorbers, and solid axles. During the crash sequence both drive axles were separated from the vehicle. All four shocks were broken, all four air springs sustained damage, and the transverse torque arm mount on axle 2 was bent forward. All axle-to-spring securement U-bolts were loose.

1.9 Brake System

Brake adjustments were checked by utilizing brake application air pressure from a tow truck (120 psi). Due to the brake air hoses and thermoplastic airlines having been severed, the air was plumbed directly to each individual brake chamber. See Table 1 for brake information.

Table 1. 2019 Mack Brake Information

Brake Location	Axle 1 Left	Axle 1 Right	Axle 2 Left	Axle 2 Right	Axle 3 Left	Axle 3 Right
Brake Type	Bendix Drum 24 L/S[7]	Bendix Drum 24 L/S	Bendix Drum 30/30	Bendix Drum 30/30	Bendix Drum 30/30	Bendix Drum 30/30
Pushrod Stroke	1 ½ inches	1 ½ inches	NA	1 ½ inches	NA	NA
Measured Lining Thickness (inches)	Upper: 23/32nds	Upper: 23/32nds	Upper: 21/32nds	Upper: 21/32nds	Upper: 16/32nds	Upper: 23/32nds
	Lower: 23/32nds	Lower: 23/32nds	Lower: 21/32nds	Lower: 21/32nds	Lower: 16/32nds	Lower: 23/32nds
Drum Measurement	16.07 inches	16.03 inches	15.99 inches	16.08 inches	16.08 inches	16.07 inches
Manufacturer's Specification – Maximum Drum Measurement	16.620 inches	16.620 inches	16.620 inches	16.620 inches	16.620 inches	16.620 inches

The brake chamber mounted to the left side of axle 2 was broken. The push rod for the brake chamber mounted to the left side of axle 3 was bent and would not allow the brake to release from the applied position. The brake chamber mounted to the right side of axle 3 was broken.

1.10 Tires and Wheels

The manufacturer's specification label was located inside the left-side door frame. Per the manufacturer's specification label, 295/75R22.5 sized tires inflated to 110 psi were specified for all axles on this vehicle. The tires were to be mounted on 8.25"x22.5" wheels.

General information about each of the tires on the Mack at the time of the inspection is documented in Table 2. All the wheels were inspected for cracks, welds, and elongated lug nut holes. No non-crash related defects were discovered on any of the wheels.

[7] The maximum push rod stroke is 3-inches.

Table 2. 2019 Mack Tire Information

Axle 1	**Left**		**Right**	
Make/Model	Missing		General RA	
Tire Size	NA		295/75R22.5	
Pressure	NA		96 psi	
Tread Depth (inches)	NA		16/32nds, 16/32nds, 16/32nds	
DOT #	NA		1A3051RMY4723	
Maximum Load Rating	NA		6,940 LBS	
Tire Plies	NA		Tread: 5 steel Sidewall: 1 steel	
Wheels	Cast: 22.5x8.25		Cast: 22.5x8.25	
Axle 2	**Left Outside**	**Left Inside**	**Right Inside**	**Right Outside**
Make/Model	Bridgestone M710	Hankook Max AL21	Bridgestone R123	Bridgestone M710
Tire Size	295/75R22.5	295/75R22.5	295/75R22.5	295/75R22.5
Pressure	102 psi	100 psi	Deflated	Deflated
Tread Depth (inches)	19, 20, 20, 20/32nds	20,19,19, 21/32nds	15,15,15,15/32nds	17,16,16,17/32nds
DOT #	32BT3JN3519 RC# RAAA4123	15M0255H14020 RC# RAAA4123	EKBT2JN4120 RC# Not Located	Y7BT3X42318 RC# YYJC10623
Maximum Load Rating	5,675 LBS (Dual)	6,610 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	Cast: 22.5x8.25	Cast: 22.5x8.25	Cast: 22.5x8.25	Cast: 22.5x8.25
Axle 3	**Left Outside**	**Left Inside**	**Right Inside**	**Right Outside**
Make/Model	Missing	Goodyear Endurance LHD	Bridgestone R268	Michelin X-Line
Tire Size	NA	295/75R22.5	295/75R22.5	295/75R22.5
Pressure	NA	Deflated	Deflated	Deflated
Tread Depth (inches)	NA	17,16,16, 17/32nds	18,17,17,18/32nds	24,23,23,23/32nds
DOT #	NA	MC37F1BW2518 RC# RAAA2323	2GBT3B25122 RC# Not Located	HAJF010X4521 RC# RAFRCA3723

Axle 3	Left Outside	Left Inside	Right Inside	Right Outside
Maximum Load Rating[8]	NA	5,675 LBS (Dual)	7,160 LBS (Dual)	5,675 LBS (Dual)
Tire Plies	NA	Tread: 5 Steel Sidewall: 1 Steel	Tread: 5 Steel Sidewall: 1 Steel	Tread: 4 Steel Sidewall: 1 Steel
Wheels	Cast: 22.5x8.25	Cast: 22.5x8.25	Cast: 22.5x8.25	Cast: 22.5x8.25

The tire mounted to the outside position on the left side of axle 2 was sliced on the inboard tire shoulder and tread area, and there was a 3-inch by 3-inch piece of tread area missing. The tire mounted to the inside position on the left side of axle 2 was missing about 9 inches of tread. The tire mounted to the inside position on right side of axle 2 sustained a sidewall split of about 50% of the tire radius, the sidewall was ruptured in 2 locations, and the inboard wheel flange was abraded about 1/3 of the wheel radius.

The tire mounted to the outside position on the right side of axle 3 sustained outboard sidewall punctures in two locations, and there was an axial collapse on the wheel which was about 9 inches in chord length. The outboard wheel flange sustained three radial collapses in three locations, and the wheel flange was abraded about 10 ½ inches in chord length. The tire mounted to the inside position on the right side of axle 3 sustained a 6 ½-inch radial collapse and a 2-inch axial collapse on the inboard wheel flange.

1.11 Anti-Lock Braking System

All air braked truck-tractors manufactured after March 1997, and all other commercial vehicles (such as single-unit trucks, trailers, and buses) manufactured after March 1998, are required to be equipped with anti-lock braking systems (ABS).[9] ABSs are designed to assist with keeping a vehicle steerable and stable during heavy braking moments by preventing wheel lock, maintaining the maximum friction possible between the tire and roadway, and making the vehicle stop in the shortest distance possible. In addition to the vehicle's physical brakes, ABSs are comprised of wheel speed sensors, electronic control units (ECU), and modulator units.

The Mack was originally equipped with a Bendix 6S/6M ABS.[10] The ABS sensors, modulators, and wiring were all in place, but the wiring had been severed during the crash sequence.

[8] This is the maximum weight each tire can carry when mounted in a dual tire configuration.
[9] FMVSS 121 (49 CFR 571.121. S5.1.6.1 (a)(b)
[10] 6S/6M means there were 6 sensors and 6 modulators.

1.12 Electronic Stability Control

Federal Motor Vehicle Safety Standard (FMVSS) 136 requires all truck tractors, with limited exceptions, with a gross vehicle weight rating (GVWR) greater than 26,000 pounds are required to be equipped with an electronic stability control (ESC) system.[11] ESC is a stability control system designed to mitigate un-tripped rollovers and loss-of-control crashes caused by yaw instability. ESC systems enhance vehicle directional stability by countering lateral acceleration by applying brake torque at individual wheel positions.

According to the build sheet, the 2019 Mack was equipped with Mack Road Stability Advantage by Bendix, which includes the Bendix Electronic Stability Program (ESP) and Roll Stability Program. These systems were designed to comply with electronic stability requirements of FMVSS 136.

1.13 Engine Control Module Data Download

The primary function of the Engine Control Module (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 diagnostics associated with engine and/or sensor faults, which may then activate warnings on the dash, as well as record vehicle speed, engine speed, and other parameters during triggered events. Some ECMs contain an internal clock and calendar, with an internal battery, which tracks time and stamps event-based occurrences such as sudden deceleration data, hard braking incidents and last stop records.

The ECM, Vehicle Electronic Control Unit (VECU), and ABS ECU were removed from the vehicle and were imaged on October 7, 2024. There was a triggered event that closely matches the date and time of this crash. The recorded data indicated that at 60-seconds prior to impact, the Mack was traveling at a speed of about 70 miles-per-hour (mph). Leading up to the impact with the Toyota, the speed of the Mack was recorded to be about 69 mph. the service brake switch was off until 0.75 seconds before impact. Although the build sheet for the Mack shows that the vehicle speed was governed at 65 mph, data from the ECM indicate that the governed speed at design was no longer in effect. The maximum speed allowable for cruise control was 70 mph. Because the Mack had been leased by multiple carriers, there was no information available which indicates when the truck's performance was modified. For more information regarding the imaged data from the Mack, refer to the Technical Reconstruction Factual Report for this investigation.

[11] Truck tractors not able to attain a speed of not more than 33 mph in 2 miles or not able to attain a speed of not more than 45 mph in 2 miles with an unloaded vehicle weight that is not less than 95 percent of its gross vehicle weight rating are exempted from ESC requirements.

1.14 Collision Avoidance System Technologies

This section highlights Collision Avoidance Systems (CAS) that are designed to prevent or reduce the severity of crashes. Although some of these technologies were available, currently there are no federal regulations requiring the installation of these systems. According to the carrier that owned the Mack in this crash, the truck-tractor was a lease vehicle and was not owned by this carrier.

A collision avoidance system is a suite of technologies designed to prevent or reduce the severity of a crash. These technologies are also referred to as Advanced Driver Assistance Systems (ADAS). ADAS employs various technologies, including RADAR (radio detection and ranging), 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 2019, Mack Anthems were built with a suite of ADAS that were offered as standard equipment. Although ADAS technologies are listed as standard equipment, truck specifications are often customizable to meet varying vocational needs. As a result, purchasers may choose to exclude these technologies during the build specification process. Mack utilizes the second generation of the Bendix Wingman Fusion ADAS.[12] The Bendix Wingman Fusion integrates radar, camera, and brake system data to help drivers detect and avoid potential hazards on the road. The following collision mitigation hardware and software is included: a) active emergency braking, b) adaptive cruise control, c) lane departure warning, d) multiple-lane AEB, and e) driver awareness support. Active emergency braking utilizes multiple short- and long-range radars and a windshield mounted camera and can reduce speeds from up to 50 mph. Adaptive cruise control automatically adjusts vehicle speed to maintain a safe following distance from a forward vehicle. Adaptive cruise control can bring the vehicle to a complete stop, if necessary, in stop-and-go traffic. Lane departure warning alerts the driver if the vehicle begins to travel out of its intended travel lane. Multiple-lane AEB applies the brakes if another vehicle is detected while changing lanes.

According to the Bendix diagnostic report from the 2019 Mack, the truck was equipped with Bendix ESP. The truck was not equipped with Bendix Wigman Fusion, a suite of ADAS technologies. [13]

---

[12] Bendix: Safer Trucks

[13] For more information on the carrier's acquisition of the 2019 Mack, the *Motor Carrier Factual Report* for this investigation.

Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) technologies are generally referred to as connected vehicle technology. This technology is being designed to allow vehicles to communicate with each other regarding traffic flow, braking actions, and turning movements at a minimum. This technology will also allow vehicles to interpret road signs and receive messages from changing message boards. This technology was not available for large-scale distribution at the time of this report.

1.15 Maintenance Records / Recalls

A review of available maintenance records from August 24, 2023, through July 24, 2024, indicated that the carrier had completed preventative maintenance servicing, tire and brake replacements, and general repairs. The most recent annual/DOT inspection was conducted on June 25, 2024, with no issues being detected. On October 23, 2023, the maximum road and cruise control speed was set to 70 mph.

There were no recalls issued to the VIN issued to this Mack. There were minor repairs completed under warranty, but there were no repairs on major operating systems. The last warranty-related work was completed on July 30, 2021.

2.0 2009 Great Dane Semitrailer:

Make:	Great Dane
Model:	N/A
VIN:	1GRAA06239T549798
Model Year:	2009
Placed into Service:	Unknown
GVWR:	68,000 lbs.
GAWR (Axle 1):	20,000 lbs.
GAWR (Axle 2):	20,000 lbs.
Brake Type:	Air-operated drum brakes with Antilock Braking System (ABS) 2S/1M

2.1 Damage Description

The front 13-feet of the semitrailer was missing along with the king pin and upper fifth wheel plate. The upper fifth wheel plate and king pin remained attached to the lower fifth wheel assembly mounted to the truck-tractor. There were multiple locations along both sides of the trailer that showed signs of corrosion. The corrosion intruded through the outside sheet metal toward the interior cargo area of the trailer. The stainless-steel frame around the cargo doors was cracked at both lower corners.

2.2 Electrical System

The electrical system was compromised by the crash and was unable to be inspected. The semitrailer was equipped with light emitting diode (LED) tail lamps.

2.3 Suspension

The semitrailer suspension consisted of pivot control beams, air springs, shock absorbers, and solid axles. No damage to the suspension was noted.

2.4 Brake System

The brake linings and brake drums were examined and measured. The examination results are listed in Table 3.

Table 3. Great Dane Semitrailer Brake Information

Brake Location	Axle 1 Left	Axle 1 Right	Axle 2 Left	Axle 2 Right
Brake Type[14]	Haldex 30/30 Drum	Haldex 30/30 Drum	Haldex 30/30 Drum	Haldex 30/30 Drum
Pushrod Stroke (Inches)	1 ¾ inches	NA	1 ¾ inches	2 inches
Measured Lining Thickness (inches)	Upper: 9/32nds	Upper: 18/32nds	Upper: 17/32nds	Upper: 11/32nds
	Lower: 9/32nds	Lower: 18/32nds	Lower: 17/32nds	Lower: 11/32nds
Drum Measurement	16.06 inches	16.10 inches	16.06 inches	16.12 inches
Manufacturer's Specification – Maximum Inside Drum Measurement	16.620 inches	16.620 inches	16.620 inches	16.620 inches

The brake chamber mounted to the right side of axle 1 was broken. The clevis jam nut on the left side of axle 1 was backed off into the face of the brake chamber. The brake chamber mounted to the right side of axle 2 was cracked around both mounting bolts and the brake chamber was loose.

2.5 Tires and Wheels

The manufacturer's specification plate that was mounted to the front portion of the semitrailer was missing. Per the manufacturer's build sheet for this vehicle, the vehicle was equipped with Bridgestone R123 Ecopia, 295/75R22.5 tires mounted on 8.25"x22.5" wheels and inflated to 110 psi.

[14] These were long stroke brakes.

General information about the tires and wheels mounted on the semitrailer at the time of the examination is documented in Table 4. The wheels were inspected for cracks, welds, and elongated lug nut holes. No non-crash-related defects were discovered on any of the wheels.

Table 4. Great Dane Semitrailer Tire Information

Axle 1	**Left Outside**	**Left Inside**	**Right Inside**	**Right Outside**
Make/Model	Yokohama Blue Earth 109L	Yokohama Blue Earth 109L	Goodyear Marathon LHS	Muscle Power MP991
Tire Size	295/75R22.5	295/75R22.5	295/75R22.5	295/75R22.5
Pressure	58 psi	100 psi	90 psi	Deflated
Tread Depth (inches)	11,10,10, 11/32nds	11,11,12, 12/32nds	9,9,9,8/32nds	16,16,17,16/32nds
DOT #	FABTJAW2422 Not a recap	FABTJAW1621 Not a recap	MC37B7BW4219 RC#RAMD3223	04MKJARMP2423 Not a recap
Maximum Load Rating	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: 4 Steel, 1 Polyamide Sidewall: 1 Steel	Tread: 5 Steel Sidewall: 1 Steel

Axle 2	Left Outside	Left Inside	Right Inside	Right Outside
Make/Model	Toyo M920	Firestone FD691	BF Goodrich Highway Control	BF Goodrich Highway Control
Tire Size	295/75R22.5	295/75R22.5	295/80R22.5	295/80R22.5
Pressure	96 psi	90 psi	96 psi	96 psi
Tread Depth (inches)	9,8,8,9/32nds	10,9,8,8/32nds	9,9,9,9/32nds	9,9,8,9/32nds
DOT #	3BTDA90419 RC# HDP0322	4DBT3J74319 RC#RYYJC11324	M5DFCT111720 RC#RJFJ2623	M5DFCT110620 RC# RDRJ2323
Maximum Load Rating	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

The tire mounted at the outside position on right side of axle 2 sustained a radial collapse of about 9 inches, and the tire tread was split from shoulder to shoulder – exposing steel reinforcement plies. The sidewall for the tire mounted at the inboard position on axle 2 left side was split about 50% around the tire bead.

2.6 Anti-Lock Braking System

The semitrailer was equipped with a 2S/1M ABS. All Anti-Lock Braking System (ABS) sensors and wires remained in place.

2.7 Maintenance Records

Maintenance records were requested, but no records were received from the rental company. The most recent annual/DOT inspection was conducted on July 11, 2024, with no issues or defects being noted.

3.0 2015 Toyota Highlander

Figure 3. Left-Front of the 2015 Toyota

3.1 General Information

VIN:	5TDJKRFH2FS******
Manufacturer:	Toyota 4WD
Model:	Highlander Sport Utility Vehicle (SUV)
GVWR:	2,268 lb.
Engine:	2GR-FE, 6 cylinders (gasoline)
Transmission:	Automatic
Brake System:	Hydraulic Antilock-Braking System

3.2 Damage Description

The right side of the hood was crumpled. The right-front tire was deflated, and the outboard wheel flange was broken in one location. The front bumper fascia was dragging on the ground. There were multiple scratches across the hood, fenders, roof, and driver's door. The hood was crushed downward, and the windscreen was shattered – See Figure 3. The left rear of the Toyota was crushed forward past the left-rear passenger seat. The left-rear passenger door was crushed, and the exterior sheet metal skin was missing. The left B pillar was displaced to the left. The rear cargo hatch and roof were displaced forward, and the sheet metal for the roof was peeled along the top up to the sunroof and then folded forward over the driver's door – See figure 4. The left rear tire was deflated, the sidewall was split, and the outboard wheel flange

was broken in three locations. The rear bumper was crushed forward past the rear frame horns.

Figure 4. Left-Rear view of the 2015 Toyota

The event data recorder of the Toyota was imaged by the Ohio State Highway Patrol on August 19, 2024. At the time of impact with the Mack, the Toyota was traveling at a speed of about 15 mph. Refer to the Technical Reconstructionist factual report for additional imaging information.

4.0 Subsequent Crash Information

Following the initial crash, two additional crashes occurred in close proximity on I-80; one at 5:54 a.m. and another at 6:24 a.m. This section provides a basic description of the vehicles involved in those crashes.

4.1 5:54 a.m. Crash Vehicle Description

The 5:54 a.m. crash occurred in the eastbound lanes of I-80 near milepost 48, west of the initial crash. The crash involved six commercial combination vehicles and one passenger vehicle. A list of the involved vehicles and damage classification is below in Table 5.

Table 5. 5:54 a.m. Crash Vehicle Description

Vehicle	Damage Classification
2022 Volvo Truck Tractor in combination with a van-style semitrailer	Disabling Damage
2016 Volvo Truck Tractor in combination with a cargo tank semitrailer	Disabling Damage
2024 Peterbilt Truck Tractor in combination with a van-style semitrailer	Disabling Damage
2018 Freightliner Truck Tractor in combination with a van-style semitrailer	Disabling Damage
2024 Freightliner Truck Tractor in combination with a van-style semitrailer	Minor Damage
2016 Nissan Rogue Sport Utility Vehicle	Disabling Damage

4.2 6: 24 a.m. Crash Vehicle Description

The 6:24 a.m. crash occurred in the westbound lanes of I-80 near mile post 51, east of the initial crash. The crash involved a commercial combination vehicle, a pickup truck in combination with a utility trailer and two passenger cars. A list of the involved vehicles and damage classification is below in Table 6.

Table 6. 6:24 a.m. Crash Vehicle Description

Vehicle	Damage Classification
2024 Volvo Truck Tractor in combination with a van-style semitrailer	Disabling Damage
2021 Ram pickup truck in combination with a flatbed utility trailer	Disabling Damage
2023 Honda Passport Sport Utility Vehicle	Disabling Damage
2015 GMC Acadia Sport Utility Vehicle	Disabling Damage
2017 Volvo Truck-Tractor in combination with double van-style trailers	Disabling Damage
a2024 Volvo Truck Tractor in combination with a van-style semitrailer	Disabling Damage

E. DOCKET MATERIAL

The following attachment is included in the docket for this investigation:

Vehicle Attachment - 2019 Mack Build Specifications

Submitted by:

Jerome Cantrell
Senior Vehicle Factors Specialist