SHERMAN, TEXAS
HWY-08-MH-022
(37 Pages)

VEHICLE GROUP CHAIRMAN'S FACTUAL REPORT

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

VEHICLE FACTORS
GROUP CHAIRMAN'S FACTUAL REPORT

A. ACCIDENT INFORMATION

Accident:	Motorcoach Run-Off Roadway Bridge and Rollover
Location:	U.S. Highway 75 Northbound at Milepost 208.0236 on Post Oak Creek Bridge Sherman, Texas
Vehicle #1:	2002 MCI 56-Passenger Motorcoach
Carrier:	Iguala Busmex, Inc
Date:	August 8, 2008
Time:	12:42 a.m. CDST
NTSB #:	HWY-08-MH-022

B. VEHICLE FACTORS GROUP

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C. ACCIDENT SUMMARY

About 12:45 a.m., central daylight time, on Friday, August 8, 2008, a 2002, 56-passenger Motor Coach Industries, Inc. (MCI), motorcoach, operated by Iguala BusMex, Inc., was northbound on U.S. Highway 75 when it was involved in a single-vehicle, multiple-fatality accident in Sherman, Texas. The chartered motorcoach had departed the Vietnamese Martyrs Catholic Church in Houston, Texas, at approximately 8:30 p.m. on August 7, 2008, with a driver and 55 passengers onboard, en route to the Marian Days Festival in Carthage, Missouri[i]. When the accident occurred, the motorcoach had completed about 309 miles of the approximately 600-mile-long trip.

Before the crash, the motorcoach was traveling in the right lane of the four-lane divided highway. As the motorcoach approached the Post Oak Creek bridge at a speed of about 68 mph, its right steer axle tire failed. The motorcoach departed the roadway on an angle of about 4 degrees to the right, overrode a 7-inch-high, 18-inch-wide concrete curb, and struck the metal bridge railing. After riding against the bridge railing for about 120 feet and displacing approximately 136 feet of railing, the motorcoach went through the bridge railing and off the bridge. It fell about 8 feet and slid approximately 24 feet on its right side before coming to rest on the inclined earthen bridge abutment adjacent to Post Oak Creek. As a result of the accident, 17 motorcoach passengers died; 12 passengers were found to be fatally injured at the crash site, and 5 others died at area hospitals. In addition, the 52-year-old driver received serious injuries, and 38 passengers received minor-to-serious injuries.

D. DETAILS OF THE INVESTIGATION

Post collision mechanical inspections of the motorcoach were performed on August 14, 2008 through August 18, 2008, at the Sherman Public Works facility located at 800 S. East Street, in Sherman, Texas.

Inspections included power train, brake, steering and suspension systems as well as tire and wheel assemblies. A review of the coach's maintenance and inspection history, state and federal inspection regulations and tire pressure monitoring systems were also reviewed.

1. MCI MOTORCOACH

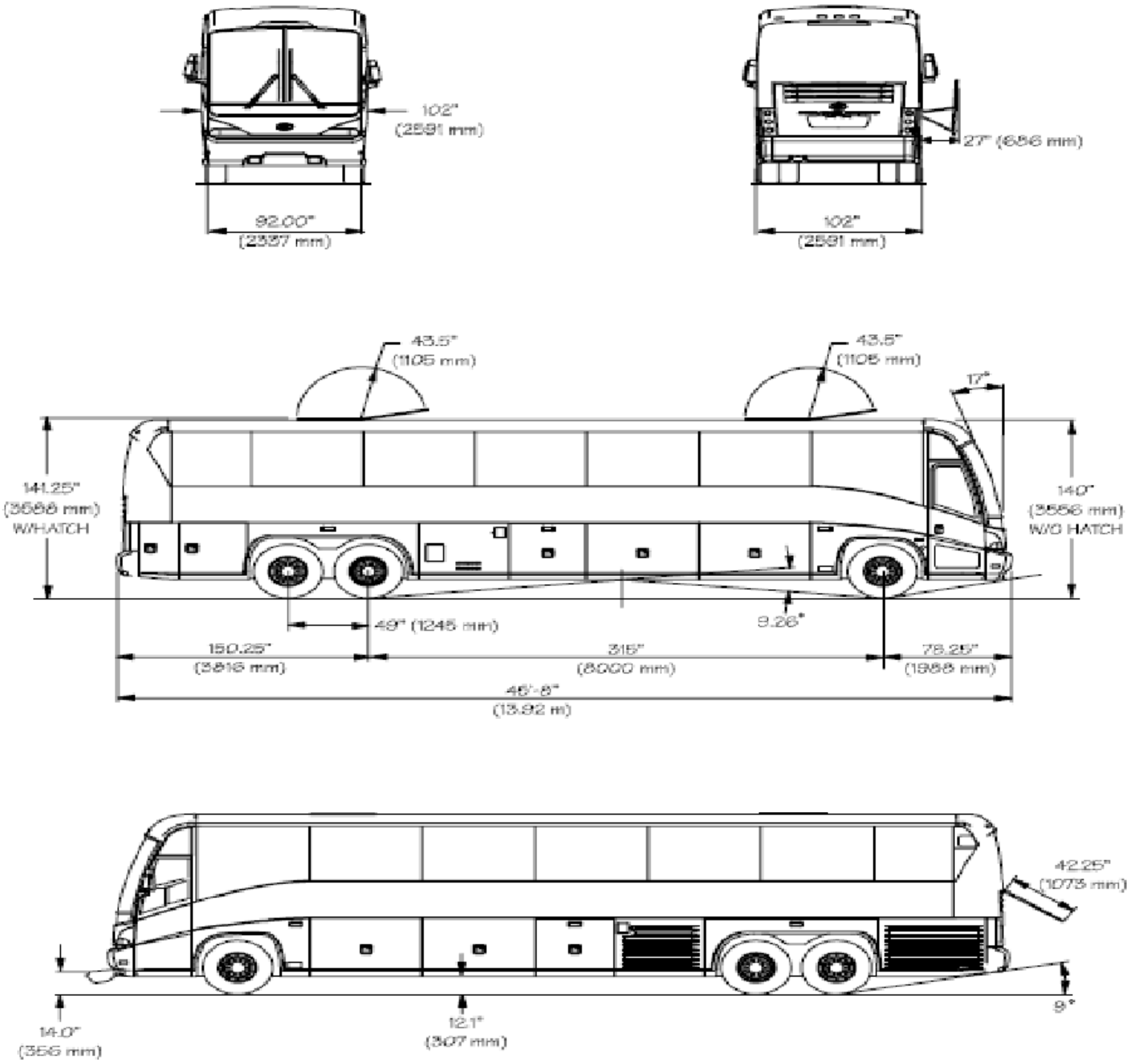
1.1 GENERAL INFORMATION

The coach was designed to seat 56 passengers and a driver. The digital odometer data was not recorded during post accident inspections due to electrical fire considerations. However, a pre-trip inspection card completed by the driver the morning of the accident indicated an odometer reading of 435,394 miles. At the time of the accident, the bus displayed operator placard as:

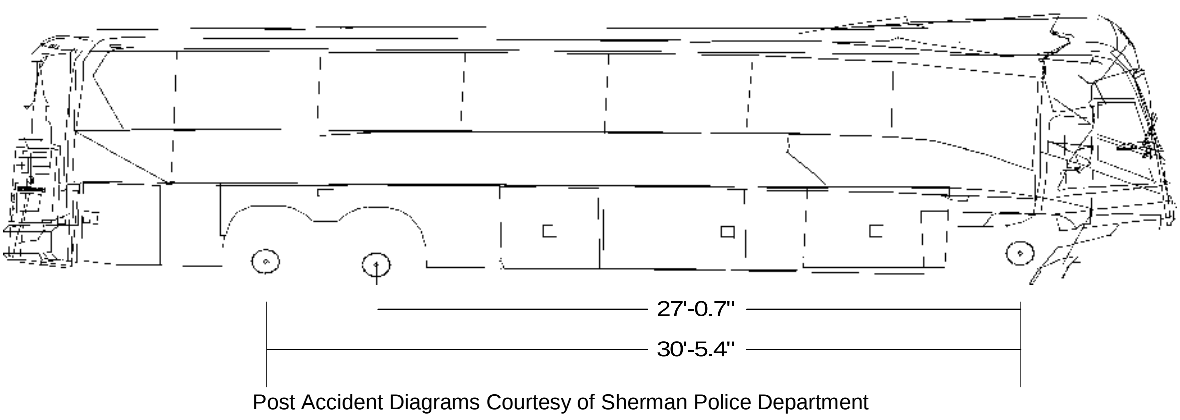
Iguala BusMex USDOT
1786461 MC 651972
Houston, Texas

General Vehicle Data:[ii]

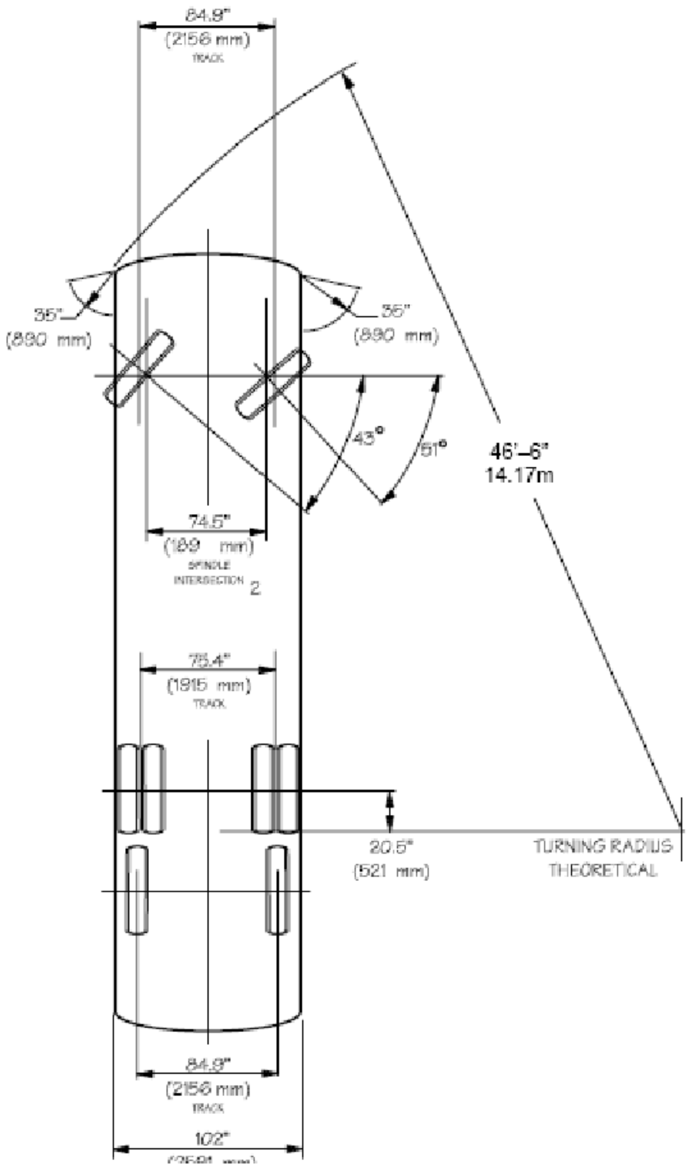
Year:	2002
Make:	MCI
Model:	J4500
VIN:	1M83JMRA62P061796
Registration:	P13705 (Texas Temporary Registration; expired 08-09-2008)
Seating Capacity:	56 Passengers
Registered Owner:	Iguala BusMex
Wheel Base:	339.5 inches
Engine Model:	Detroit Diesel Series 60, DDEC IV
Axle Ratio:	4.56:1
Transmission:	Allison Automatic, Model B500
Odometer:	435,731.5 (According to Engine ECM)
GVWR:	54,000 lbs.
GAWR Front:	16,500 lbs.
GAWR Drive:	23,000 lbs.
GAWR Trailing:	16,500 lbs.
Post Crash Weight:	40,000 lbs
Overall length:	45.58 feet
Overall Width:	102 inches
Height:	141.25 inches



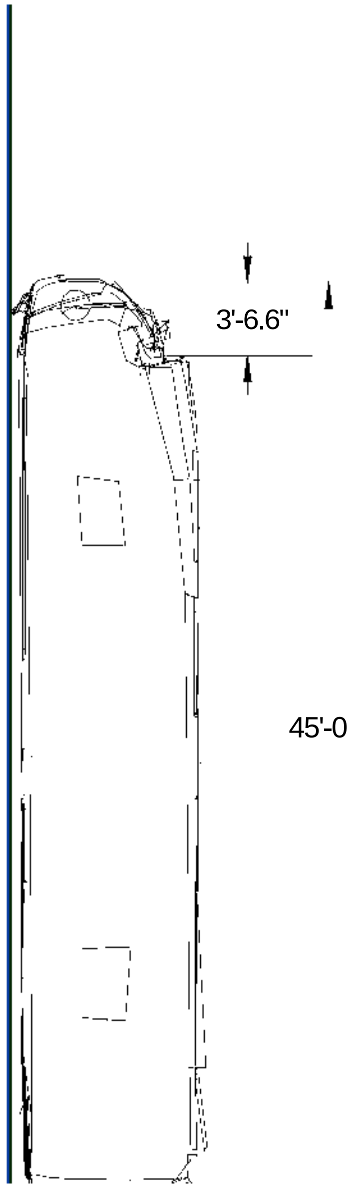
As Built Diagrams Courtesy of Motor Coach Industries



Post Accident Diagrams Courtesy of Sherman Police Department



As Built Diagram Courtesy of Motor Coach Industries



Above Diagram Courtesy of Sherman Police Department

The accident coach was purchased by Angel Tours, Inc., on July 19, 2008, from MCI Sales and Service of Dallas, Texas as a refurbished, pre-owned coach. The coach was previously owned and operated by Schoolman Transportation System Inc., of Bohemia, New York.

According to available documents, Schoolman Transportation traded the coach to MCI Sales and Service located in Blackwood, New Jersey on November 30, 2007.

On January 9-10, 2008, the coach was transferred from the Blackwood, New Jersey location to MCI's Loudonville, Ohio facility for refurbishing.

On June, 23-25, 2008, the coach was transferred from the Loudonville, Ohio facility to the Dallas, Texas facility for resale where the coach was sold on July 19, 2008.

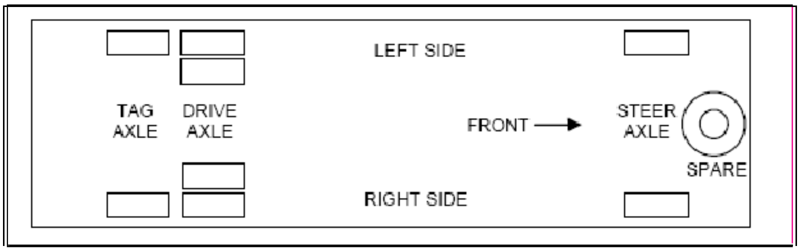
1.2 POWER TRAIN

The bus was equipped with a Detroit Diesel, Series 60, 12.7-liter, 6-cylinder, and engine brake equipped, and electronically controlled diesel engine. The engine brake and cruise control switches consisted of membrane type switches located on the steering wheel. The engine's electronic control module (ECM) was capable of capturing limited vehicle operating data, which when properly interpreted has proven useful in accident investigation and reconstruction[iii].

The coach was equipped with an Allison B500 automatic transmission and a Rockwell 4.56:1 ratio drive axle with a gross axle weight rating of 23,000 lbs.

1.3 TIRE AND WHEEL ASSEMBLIES

1.3.1 TIRE DATA & SPECIFICATIONS



According to MCI, the accident coach possessed axle load ratings and tire application specifications as shown in the table below, followed by industry standards for tire load, inflation, and rim contour

<u>Motorcoach Axle Ratings and Tire Specifications</u>

Vehicle Position*	GAWR	Tire Size	Wheel	Cold Inflation
Steer Axle	7,484 kg 16,500 lbs	315/80R22.5 Load Range J	22.5 X 9.00	830 kPa 120 psi
Drive Axle	10,432 kg 23,000 lbs	315/80R22.5 Load Range J	22.5 X 9.00	620 kPa 90 psi
Tag Axle	7,484 kg 16,500 lbs	315/80R22.5 Load Range J	22.5 X 9.00	830 kPa 120 psi

Industry Standards for 315/80R22.5 Load Range J Tires (Tire & Rim Association, Inc.)

Tire Size	Approved Rim Contours	Single Usage		Dual Usage	
		Max Load	@ Inflation	Max Load	@ Inflation
315/80R22.5 Load Range J (154/151)	8.25* 9.00 9.75	3030 kg 6670 lbs	620 kPa 90 psi	2750 kg 6070 lbs	620 kPa 90 psi
		3750 kg 8270 lbs*	830 kPa 120 psi	3450 kg 7610 lbs	830 kPa 120 psi

*Use of an 8.25 rim contour with a 315/80R22.5 tire is limited to 8,000 lbs. per tire in single usage, 7,610 lbs. per tire in dual usage, and inflation pressure of 120 psi.

Post Accident Tire Inspection Data

FRONT AXLE	LEFT FRONT	RIGHT FRONT
Make	Firestone FS-400 (Regroovable)	Goodyear G409 MBA(Recapped)
Size	315/80 R 22.5	315/80 R 22.5
Pressure	118 psi @ 79°F	Deflated – Failed
Tread Groove Depths[iv]	14/32"-14.5/32"-13/32"-13/32"	14/32"-14/32"-14/32"-14/32"
DOT Number	4D4D 35C 2407	MJ72 9MAW 4404
Recap Number	N/A	ANC-B23507
Lease ID Number	M7U	ZP573
Max Tire Weight Rating	Single 8,270lbs @ 120 psi cold Dual 7,610lbs @ 120 cold	Single 3750kg / 8,270lbs @ 120 psi cold Dual 3450kg / 7,610lbs @ 120 cold
Load Range	J	J
Speed Rating	75mph	75mph
Tread Ply	5-Steel	5-Steel
Sidewall Ply	1-Steel	1-Steel
Wheel Type	22.5" X 9.0" Steel 03-28-06	22.5" X 9.0" Steel 05-04-01
DRIVE AXLE	**LEFT INNER**	**RIGHT INNER**
Make	Firestone FS-400 (Regroovable)	Ling Long LLF02 (Regroovable)
Size	315/80 R 22.5	315/80 R 22.5
Pressure	96 psi @ 79°F	94 psi @ 79°F
Tread Groove Depths	8/32"-8/32"-8/32"-8.5/32"	17/32"-17/32"-17/32"-17/32"
DOT Number	4D4D 35C 0107	OURT CF 2308
Recap Number	None	None
Lease ID Number	M7F	None
Max Tire Weight Rating	Single 8,270lbs @ 120 psi cold Dual 7,610lbs @ 120 psi cold	Single 8,265lbs @ 120 psi cold Dual 7,385lbs @ 120 psi cold (154/150 M 120 psi)
Load Range	J	J
Speed Rating	75mph	81mph
Tread Ply	5-Steel	4-Steel
Sidewall Ply	1-Steel	1-Steel
Wheel Type	22.5" X 9.0" Steel 01-17-03	22.5" X 9.00" Steel 03-09-06
DRIVE AXLE	**LEFT OUTTER**	**RIGHT OUTTER**
Make	Firestone FS-400 (Regroovable)	Ling Long LLF02 (Regroovable)
Size	315/80 R 22.5	315/80 R 22.5
Pressure	93 psi @ 79°F	0 psi @ 79°F (debeaded)[v]
Tread Groove Depths	14/32"-11/32"-11/32"-12/32"	17/32"-16.5/32"-16.5/32"-17/32"
DOT Number	4D4D 35C 1307	OURT CF 2308
Recap Number	None	None
Lease ID Number	M7Y	None
Max Tire Weight Rating	Single 8,270lbs @ 120 psi cold Dual 7,610lbs @ 120 psi cold	Single 8,265lbs @ 120 psi cold Dual 7,385lbs @ 120 psi cold (154/150 M 120 psi)
Load Range	J	J
Speed Rating	75mph	81mph
Tread Ply	5-Steel	4-Steel
Sidewall Ply	1-Steel	1-Steel
Wheel Type	22.5" X 9.0" Steel 01-07-05	22.5" X 9.00" Steel 03-28-06

Post Accident Tire Inspection Data CONT.

TAG AXLE	LEFT	RIGHT
Make	Goodyear G409 MBA (Regroovable)	Ling Long LLF02 (Regroovable)
Size	315/80 R 22.5	315/80 R 22.5
Pressure	88psi @ 79°F	89psi @ 79°F
Tread Groove Depths	13.5/32"-12/32"-12/32"-12/32"	16/32"-16/32"-16/32"-16/32"
DOT Number	MJ72 9MAW 3604	OURT CF 2208
Recap Number	None	None
Lease ID Number	KC1932	None
Max Tire Weight Rating	Single 8,270lbs @ 120 psi cold Dual 7,610lbs @ 120 psi cold (154-151L)	Single 8,265lbs @ 120 psi cold Dual 7,385lbs @ 120 psi cold (154/150 M 120 psi)
Load Range	J	J
Speed Rating	75mph	81mph
Tread Ply	5-Steel	4-Steel
Sidewall Ply	1-Steel	1-Steel
Wheel Type	22.5"X8.25"Stee(10-16-00	22.5"X8.25"Steel 04-15-98
Make	Goodyear G409 MBA (Regroovable)	Ling Long LLF02 (Regroovable)
Size	315/80 R 22.5	315/80 R 22.5
Pressure	88psi @ 79°F	89psi @ 79°F

SPARE	
Make	Ling Long LLF02 (Regroovable)
Size	315/80 R 22.5
Pressure	0psi @ 79°F (Debeaded)
Tread Groove Depths	18/32"-18/32"-18/32"-18/32"
DOT Number	OURT CF 2308
Recap Number	None
Lease ID Number	None
Max Tire Weight Rating	Single 8,265lbs @ 120 psi cold Dual 7,385lbs @ 120 psi cold (154/150 M 120 psi)
Load Range	J
Speed Rating	81 mph
Tread Ply	4-Steel
Sidewall Ply	1-Steel
Wheel Type	22.5"X9.00"Steel 05-24-05)

The three-axle coach was equipped with eight tires; two on the steering axle, four tires on the drive axle and two tires on the trailing or tag axle. All tread depths were examined and found to be in compliance with the North American Standard Inspection criteria as well as Federal Motor Carrier Safety Regulations CFR 49 Part 393.75[vi].

Inspections of tire and wheel assemblies were generally unremarkable with the exception of the following.

- The use of the retreaded tire found mounted on the right steering axle position is a prohibited condition under 49CFR§393.75(d).

- Based upon DOT numbers, the four (4) Ling Long tires on the motorcoach were produced by Shangdong Linglong Rubber Co., Ltd. in China, during the 22nd week of 2008 (June 1-7, 2008) and the 23rd week of 2008 (June 8-14, 2008).

- The Ling Long tires were not properly marked for maximum load rating in kilograms (kg) with corresponding inflation pressures in kilopascals (kPa) as required within 49CFR§571.119 S6.5(d). This labeling requirement dictates the format and content that must be included on the tire's sidewall in regard to loading and inflation information.

<u>The tire's load label content and format as observed upon the tires.</u>

Max load single 8265 lbs @ 120 psi cold
Max load dual 7385 lbs @ 120 psi cold

<u>An example of the required content and format is listed below.</u>

Max load single __kg (__lb) at __kPa (psi) cold.
Max load dual __kg (__lb) at __kPa (psi) cold.

- The manufacturer specified tire size, rim contour, and inflation pressures found on the VIN plate were in compliance with Federal Motor Vehicle Safety Standard 120 (FMVSS 120), codified at 49CFR 571.120 to carry the maximum rated axle loads of the coach.

- The tires mounted on the tag axle were not appropriate equipment for use upon the accident coach. A single 315/80R22.5 tire mounted to a 8.25 wheel and inflated to 120 psi, has a maximum load capacity of only 8,000 lbs and the combination of the two tires on the tag axle of the coach could only carry a maximum load of 16,000 lbs. Because the tag axle had a GAWR of 16,500 lbs, each tire would be overloaded by 250 lbs. at the GAWR even when properly inflated.

- In addition to the tag axle tires being mounted to under sized wheels for their application, post crash inflation pressures indicated that the tires were approximately 30 psi underinflated. (Inflation pressures of the left and right tires were 88 psi and 89 psi respectively.) In this condition each tire was potentially overloaded by 1,580 lbs., or 19% based on the vehicle's GAWR.

1.3.2 AVAILABLE GUIDENCE TO OWNERS, OPERASTORS & TECHNICIANS

As indicated in Section 1.3.1 the coach's vehicle specification plate indicated that the recommended tire equipment for the coach was that of 315/80R22.5 size tires with recommended tire inflation pressures which varied by axle position. The tire inflation chart below was a reiteration of the coach's axle ratings and tire specifications. The following are notable findings as it relates to this investigation.

Accident Motorcoach Axle Ratings and Tire Specifications

Vehicle Position*	GAWR	Tire Size	Wheel	Cold Inflation
Steer Axle	7,484 kg 16,500 lbs	315/80R22.5 Load Range J	22.5 X 9.00	830 kPa 120 psi
Drive Axle	10,432 kg 23,000 lbs	315/80R22.5 Load Range J	22.5 X 9.00	620 kPa 90 psi
Tag Axle	7,484 kg 16,500 lbs	315/80R22.5 Load Range J	22.5 X 9.00	830 kPa 120 psi

- Conflicting tire equipment and inflation pressure data was found within the MCI model J4500 maintenance manual for the subject accident coach. The following chart below is an excerpt copied directly from the MCI J4500 maintenance manual. It should be noted that the table below provides maintenance personal with inaccurate information in regard to necessary tire inflation pressures for the accident coach's drive axle as well as the tag axle tires.[vii]

Tire Inflation Chart

Make and type	Size	Front Axle	Drive Axle	Tag Axle
Goodyear G391	315/80R22.5	120 psi (827 kPa)	85 psi (586 kPa)	105 psi (723 kPa)
Goodyear G124 (Snow tires)	12R22.5	Not approved	85 psi (586 kPa)	Not approved
Michelin XM + S4 (Snow tires)	12R22.5	Not approved	95 psi (655 kPa)	Not approved
Firestone HP3000	315/80R22.5	120 psi (827 kPa)	85 psi (586 kPa)	105 psi (723 kPa)
Goodyear G291	315/80R22.5	120 psi (827 kPa)	85 psi (586 kPa)	105 psi (723 kPa)
Michelin PXZA 1	315/80R22.5	120 psi (827 kPa)	90 psi (620 kPa)	105 psi (723 kPa)

- Additional conflicting guidance or specification data was also found throughout the MCI J4500 maintenance manual and or owners/operators manuals. The below excerpt improperly identifies the Model and gross axle weight rating of the accident coach as a model E coach with a 16,000lb GAWR rather than 16,500lbs.[viii]

Maintenance Manual Section 15A Wheels
Wheels
"NOTE: Wheels conform to The Tire and Rim Association specification SAE J694.
The wheel size on the EModel is also different from previous MCI coaches. Due to the 16,000 lb. front axle rating, *only 22.5 X 9.00 wide wheels are sufficiently rated to carry this load with 315/80R22.5 tires.*
NOTE: This tire mounted on a 8.25 wide wheel is also insufficiently rated to carry this load.
Both steel and aluminum rims are 22.5 x 9.00"....."

- The below excerpt properly identifies the coach Model, however improperly identifies the gross front axle weight rating of the accident coach as 16,000lbs rather than the observed 16,500lbs.
- Notably it does reinforce the proper use of wheel sizes.

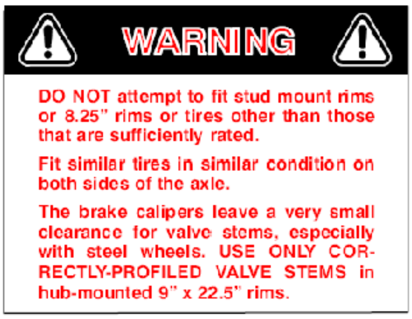
<u>Maintenance Manual Section 15C Tires</u>
General Description
*"J4500 coaches use special intercity coach tires designed for on highway service. These tires are steel belted radials, and carry a J load rating. The tire size is 315/80R22.5, and the tires mount on 22.5 x 9.00 wide rims. **<u>Due to the 16,000 lb. front axle</u>** rating, only this size tire mounted on a 9.00 wide rim carries a sufficient load rating for this application. This size tire mounted on a narrower rim is not sufficiently rated. Use only 315/80R22.5 tires mounted on 9.00 wide rims. The only exception to this requirement is for snow tires on the drive axle. In a dual tire application, 12R22.5 or 12.75R22.5 tires on a 9.00 wide rim also carry a sufficient rating. This is true only for the drive axle; the front axle must use 315/80R22.5 tires on a 9.00 wide rim."*

- The below excerpts reinforce the importance of proper tire maintenance and recommends daily tire inspections and <u>pre-trip</u> tire inflation checks, as well as the significant importance even minor tire under-inflation conditions can have upon the operating characteristics of the coach.

MAINTENANCE
"Inspect tires daily: carefully inspect for cuts or foreign matter such as nails, glass, etc. Remove any foreign matter lodged between the tires and dual wheels."

INFLATION
"Check tire inflation pressure with an accurate gauge. Check the pressure before starting a run and as recommended by the tire manufacturer. Always use the same gauge to check the pressure, to eliminate any differences resulting from gauge error (Figure 1). If the pressure loss is greater than normal, remove and inspect the tire to determine the cause. Replace any missing valve caps."
"....Al tires on the same axle should always carry the same air pressure. A 5 psi (34.5 kPa) under inflation in one front tire can not only cause hard steering, but can create steering hazards which may cause an unsafe condition. An underinflated rear tire can seriously affect braking."

- ***<u>Operator's Manual, Service & Maintenance Section</u>*** also included the following warning in regard to the utilization of 8.25"wheels.



1.3.2 RIGHT FRONT TIRE (Failed)[x]

At the time of the accident the coach had been travelling for approximately 4.5 hours and traversed just over 300 miles since departing Houston, Texas.

As indicated within Section 1.2, post accident inspection of the right front tire revealed the tire was a retread[xi]; and as a retread, was prohibited for use on the steer axle of the coach. The original tire casing was identified as a Goodyear model G409 MBA radial tire produced by the Goodyear Tire and Rubber Company in Topeka, Kansas during the 44th week of 2004. The tire casing had been retreaded with a Bandag[xii] product ID number 10.5T4100238, pre-cured tread that was produced by Bandag, LLC in Griffin, Georgia during the third quarter of 2007.

Information obtained from Bandag indicated that the applied tread package utilized during the retread process was a Bandag model "T4100(r) with MilEdges(r)". Bandag's Tread Product Guide listed the T4100(r) as an "over the road" trailer tire intended for both single or tandem wheel applications.

Also located on the subject tire's sidewall, was a "lease tire" branding. The branding of "ZP573" upon the tire indentified the tire as having been leased. Research indicated that the subject tire was originally leased by Goodyear to Land Jet of Waterbury, Connecticut in January of 2005, and in January 2007, the tire was sold to Land Jet when the bus was being traded-in.

According to Land Jet, the subject tire was mounted upon a 2000 MCI Renaissance Model E4500 motorcoach which on January 29, 2007 was transferred to MCI Sales and Service of Blackwood, New Jersey.

The U.S. Department of Transportation (DOT) required labeling / branding of "[R]ANC-B23507"[xiii] found upon the tire's sidewall clearly identified the tire as a retread. Information derived from the DOT number also indicated the tire had been retreaded by Henise Tire Service of Cleona, Pennsylvania, and that the tire had been retreaded during the 35th week of 2007.

Records obtained through Henise Tire Service indicated that the subject tire was received from the MCI Sales and Service facility located in Blackwood, New Jersey on August 30, 2007. The subject tire was inspected and retreaded during the 35th week of 2007 (approximately 11 months prior to the accident) and returned to MCI Sales and Service of Blackwood New Jersey on September 6, 2007.[xiv] It should be noted that the accident coach was located at MCI Sales and Service of Blackwood, New Jersey from December 3, 2007 until January 9, 2008.

According to Henise Tire, the subject tire was subjected to a seven-step visual inspection to assure tread application compatibility and to identify obvious defects or needed repairs. After completing the visual inspection process the casing was subjected to two additional separate machine inspections. The first inspection utilized a Hawkinson NDT-2000 which uses high voltage current to detect nail holes and other penetrations through the tire. The tire is then run through an inspection device known as the Bandag 7400 InsightTM casing analyzer. The 7400 utilizes shearography inspection technology to locate separations and latent defects.

The 7400 device creates an animated display which shows where the defects are to the operator. No damage, previous repairs or the need for repair was noted and this was the first retread of the subject tire.

Based on the known information the tire casing was less than three (3) years old at the time it was retreaded and less than four (4) years old at the time of the accident. The tread package was produced approximately two (2) months before the tire was retreaded.

According to Bridgestone and Goodyear representatives, the ages of the casing, tread rubber, and retreading process were consistent with typical truck/bus tire service and retreading intervals.

The Safety Board requested documentation from MCI regarding the allocation and placement of the subject tire; however, MCI has indicated that they have been unsuccessful in locating any such documents.

As such, a determination as to when the subject tire was mounted upon the steer axle remains unknown. MCI provided photographs of the accident coach while it was in Loudonville, Ohio on January 10, 2008, prior to refurbishment, as well as photos taken June 23, 2008 after the refurbishment process. Careful examination of the January 10, 2008 photographs indicate that the right front tire was that of a Firestone brand tire. Examination of the June 23, 2008 photograph of the right front tire indicated that the right front tire was also most likely that of a Firestone brand.

An additional photograph taken June 23, 2008 depicted the presence of a spare tire located in the coach's spare tire bin. The tread pattern of the spare tire depicted within the photograph failed to match any of the tires on the coach at the time of the accident.

It should be noted that the coach was delivered on July 19, 2008, which is approximately 27days in which the photographically documented right front tire could have been changed.

Post accident inspection of the coach revealed four (4) new tires. The tires were found at the following positions: right drive-axle inner and outer, right tag-axle and as a spare. The motor carrier provided the Safety Board with a receipt for the tires dated July 29, 2008 which is the day before it was presented for its annual inspection.

Due to the extensive damage sustained by the right front tire and wheel assembly, on-scene examination was limited to high resolution digital photography combined with the documentation of tire and wheel identifiers. The tire along with detached sections of tread and belt materials, tire fragments, loose plies and the wheel assembly, were logged into evidence with the Sherman Police Department. These items were then crated and sealed for further examination.

It should be noted, that the fact that a tire suffers a tread belt detachment or other type of failure does not in itself indicate that a tire is of a defective design or manufacturing. Many conditions are known to cause or contribute to tire failure include impact damage, improper inflation, overloading, unrepaired punctures, improper mounting and or demounting, repair, servicing, vehicle alignment, and rim components etc,. Whether a tire is original or a retread, these conditions result in physical changes to the tire and/or affect the stresses and strains subjected to the tire's components.

1.3.3 FORENSIC TIRE INSPECTIONS

The failed tire was transported from the Sherman Police Department to the Goodyear Akron Technical Center in Akron, Ohio. The tire arrived as crated and sealed on November 18, 2008 and was logged into custody and secured in a locked storage area. On November 24, 2008 an inspection of the tire was conducted by Goodyear technical personnel with expertise in original equipment as well as retread manufacturing and construction. The examination was accompanied by representatives from the Safety Board as well as from Motor Coach Industries. Following the examination, the tire, wheel and tire pieces were placed back into the crate and the crate sealed. The crate was then transported under NTSB supervision to Bridgestone in Akron, Ohio, the afternoon of November 24, 2008. Additional inspections were conducted at the Bridgestone facility by representatives from the Safety Board, MCI and Bridgestone.

Goodyear Inspection

On January 24, 2009, the undersigned received a written report from Goodyear detailing critical observations and formulated conclusions based upon the November 24, 2008 examination of the subject tire.[xv]

Notable observations within the submitted report indicated the presence of the following conditions:

- “...multi-layer tearing into the belts and multi-level tearing into the belt coat compound.”
- “...good coarse tear lines and good ply/belt wire cord impressions.”
- “...wheel flange impressions on the face of both beads,...:
- “...circumferential impressions at mid base of both beads,...”
- “...diagonal undulations to the face of both beads,...”
- “...heat discoloration on the serial side bead and on the belt coat stock on the crown...”
- “...circumferential abrasion bands on the wheel taper/bead seat.”
- “...a puncture/cut through the casing on the serial side tread shoulder rib at approximately 4:15.”
- “The tread rubber around the hole is abraded/bruised and torn.”

Based upon these findings and observations during the examination, the following conclusions were presented regarding the failure mode of the subject tire:

“1. No defects in materials, workmanship or manufacture were found in this tire.”

“2. Since the tire had been retreaded, the tire casing had more than likely successfully completed one full service cycle.”

"3. The multi-layer and multi-level tearing through the crown components and the coarse tear lines and ply/belt wire cord impressions indicate good initial component adhesion within the casing and between the casing and the retread."

"4. Stresses from long term over deflected operation weakened the component bonding of the tire."

"5. Short term under inflation caused by the puncture/cut resulted in severe over deflection of the tire. The stress and heat generated from the over deflection and the forces acting on the rotating tire caused loss of adhesion between tire components, and eventual separation and detachment of tread and belt pieces. With tread and belt detachment, the unsupported casing ruptured exhausting any remaining inflation pressure. Additional damage to the tire resulted from subsequent run flat operation."

Bridgestone Inspection

On March 16, 2009, the undersigned received a written report from BridgeStone detailing critical observations made by the parties as well as conclusions based upon examinations conducted during November 25, 26, and 28, 2008.[xvi]

Notable observations within the report indicated the following conditions:

- "...The subject tire failure initiated and propagated within the original casing. Separation began between the 2nd and 3rd steel belt plies and is most pronounced in the area between 8:30 clockwise to about 11:30, peaking at about 10:30."

- ".. Belt edge lift and shoulder rubber tearing occurred along the serial side (outboard facing) shoulder as the tread/belt detachment initiated in this area due to the centrifugal force of highway speed tire rotation. The detachment occurred predominantly between the 2nd and 3rd steel belt plies and between the radial body ply and the 1st steel belt ply as it progressed. Before a full detachment of the belts and tread could occur, the casing ruptured at about 10:00 and the tire rapidly deflated (at location on the highway shown in Figure 1). Continued operation of the tire while flat and the subsequent impact with the bridge curb and guard rail resulted in additional damage to the tire, which is shown in Figure 6."

- "Examination of the separated and detached tread, belt, and casing surfaces reveals multi-plane tear patterns, evidence of adequate adhesion and properties of fatigue, crack propagation, and tear resistance. Such an appearance is typical of a properly designed and manufactured tire that has sustained a tread/belt separation and/or detachment caused by damage or other external factors during use. In addition, numerous exposed rubber surfaces exhibit a blue-tint appearance, indicative of excessive heat generation during operation."

- "Examination of torn lower sidewall and bead areas reveals additional casing fatigue and heat-related damage. In Figure 10, incipient separation of the steel bead reinforcement ply, steel body ply, and fabric chafer is exposed."

- "The beads also exhibit undulating deformations and compression grooving from the rim flange, an example shown in Figure 11."

- "The tread/belt tear patterns, heat discoloration, lower sidewall/bead fatigue, and rim compression grooves are indicative of tire operation in an over-deflected condition. Over-deflection is caused by under inflation, overloading, or a combination of the two. In this case, the most probable cause of over-deflection is under inflation due to an un-repaired puncture to the tire which lead to inflation pressure loss and damaging stress/strain and heat build-up. The puncture is located at 4:00 in the serial side shoulder, shown in Figure 12. The unknown puncturing object gouged and tore the tread surface (Figure 13) and the bulk of the rubber, but did not fully pass through the tire. However, with each deformation and compression of the tread in the contact patch as the tire rotated, the object was penetrated deep enough into the tire to create numerous tears through the inner liner (Figures 14 and 15), causing a gradual loss of inflation pressure. The puncturing object most likely ejected from the tire during the tread/belt detachment process. Although it is difficult to state with precision how long the subject tire operated in an over-deflected manner, the tread/belt tear patterns and a lack of polishing of the separated surfaces indicate relatively short-term operation in such a condition, most likely for less than 1000 miles."

- "The subject tire exhibits proper retread manufacture and there is no indication of separation or detachment of retread material at the splice or along any surface of the casing buffed during retreading. There are no evident repairs. Tearing of the serial side shoulder through the tread splice at 8:30 as shown in Figure 16 reveals fully intact splice interfaces. Proper tread alignment and curing envelope venting at the splice is indicated in Figure 17. Both shoulders exhibit uniform and concentric application of the tread and cushion rubber as exemplified in Figure 18."

Based upon these findings and observations, the following conclusions were presented regarding the failure mode of the subject tire:

"..The subject right front retreaded tire, comprised of a Goodyear G409 MBA casing in size 315/80R22.5 154/151L (Load Range J) with Bandag T4100 tread, does not exhibit a defective or unreasonably dangerous condition in design or manufacture. Construction and materials of the casing and retread are consistent with those found in the tire industry."

"..The tread/belt detachment of the right front tire occurred as a result of damage caused by over-deflected operation. In this case, the most probable cause of over-deflection is under inflation due to an un-repaired puncture to the tire which lead to inflation pressure loss and damaging stress/strain and heat build-up. The puncture which lead to the failure occurred after the tire was retreaded and put back into service."

"..The subject tire exhibits proper retread manufacture and there is no indication that the tire failed due to any reason related to the retreading."

".. In addition to application of a retreaded tire to the steering axle of the motorcoach against Federal regulation, the tag axle tires were improperly applied to the motorcoach and significantly underinflated."

1.4 BRAKE SYSTEM

The coach was equipped with Meritor-Wabco pneumatically actuated 6S/6M [xvii] anti-lock (ABS) S-cam mechanical drum brakes. Numerous supply and application lines were compromised due to the extensive frontal damage, therefore, brake examinations were conducted without utilizing the treadle valve (foot brake). Each brake actuator was individually supplied with externally regulated air.[xviii]

The ABS electronic control unit (ECU) was removed from the coach by Sherman Police and logged into evidence with the Sherman Police Department who maintained custody of the ECU until data interrogation could be arranged.

The Sherman Police Department transferred the ABS ECU into the custody of the undersigned NTSB Group Chairman where it remained until November 19, 2008, when it was transferred (FedEx 833166310834) to the Meritor/WABCO facility in Troy, Michigan, for data extraction. The ECU was downloaded on November 24, 2008, and found to contain eight different diagnostic faults of varying occurrence counts [xix]. The ECU was returned to the custody of the Sherman Police Department via United Parcel Service on December 1, 2008. (UPS 1Z4548890195225508)

Below is a listing of the fault codes retrieved from the ECU. It should be noted that the ABS ECU was not designed to "time stamp" diagnostic fault data, thus identifying time data was unavailable.

Fault #	Description	Status	SID	FMI	Count
1	Left Front ABS Valve - Open circuit	Inactive	7	1	1
2	Right Front ABS Valve - Open circuit	Inactive	8	1	1
3	Right Front Sensor - Open	Inactive	2	5	1
4	Left Front Sensor - Open	Inactive	1	5	1
5	Right 3rd Sensor - Open	Inactive	6	5	10
6	Left Rear Sensor - Open	Inactive	3	5	15
7	SAE 1939 - Open	Inactive	231	5	64
8	SAE 1939 - Time-out	Inactive	231	9	22

1.4.1 STEER AXLE

The steer axle was configured with "clamp type-30" service brake chambers, 5.5 " "Haldex" automatic slack adjusters, and 16.5" X 6" S-cam air mechanical drum brakes with "Webb Wheel" 65600 Rev. "D" brake drums. Inspection of the brake assemblies revealed that both brake assemblies were within established North American Standard Out-Of-Service Criteria adjustment limits. Examination of foundation brake components was unremarkable with the exception of the right brake drum which had fractured [xx].

1.4.2 DRIVE AXLE

The drive axle was configured with MGM MJS 30/30 spring brake actuators with 3-inch "long stroke" service chambers, 6" Haldex automatic slack adjusters, 16.5" X 8.625" S-cam air mechanical drum brakes with Webb Wheel 66854 Rev. "C" brake drums. Inspection revealed that both brake assemblies were within established North American Standard Out-Of-Service Criteria adjustment limits. Examination of foundation brake components was unremarkable.

1.4.3 TAG AXLE

The tag axle was configured with MGM MJS 24/24 spring brake actuators with 3-inch "long stroke" service chambers, 5.5 Haldex automatic slack adjusters and S-cam air mechanical drum brakes with Webb Wheel 65600 Rev. "D" brake drums. Inspection revealed that both brake assemblies were within established North American Standard Out-Of-Service Inspection Criteria adjustment limits. Inspection revealed oil/grease contamination of the left brake drum and lining friction surfaces with considerable caking and buildup of oil/grease material [xxi]. This condition is considered a brake defect under both the North American Standard Out-Of-Service Inspection Criteria and the Minimum Periodic Inspection Standards set forth within Appendix G of the FMCSRs.

BRAKE SYSTEM COMPONENT INSPECTION					
Axle	**Chamber**	**Adjuster**	**Stroke**	**Lining**	**Drum**
1 Right	Clamp 30	5.5 Auto	1-3/4	3/4 & 7/8	16.5 X 6"
1 Left	Clamp 30	5.5 Auto	1-5/8	7/8 & 5/8	16.5 X 6"
2 Right	Clamp 30L / 30	6 Auto	2-1/8	7/8 & 7/8	16.5 X 8.625"
2 Left	Clamp 30L / 30	6 Auto	2-3/8	3/4 & 3/4	16.5 X 8.625"
3 Right	Clamp 24XLs/24	5.5 Auto	1-5/8	5/8 & 1/2	16.5 X 6"
3 Left	Clamp 24XLs/24	5.5 Auto	2-1/4	3/4 & 3/4	16.5 X 6"

1.5 STEERING SYSTEM

The bus was equipped with a hydraulic, power-assist steering system with a "LUK" integral gear driven hydraulic pump mounted at the front of the engine. The control system consisted of a 18" steering wheel mounted to a tilt/telescoping steering column assembly, intermediate steering shaft, a "ZF" re-circulating ball and nut type gearbox, steering arm (pitman arm), drag link, drag link arm, intermediate drag link, tie rod, tie rod ends, tie rod arms and steering knuckles.

A functional inspection of the steering system was not possible due to collision damage sustained by numerous key system components. The intermediate steering shaft was sheared several inched below the floorboard and was disconnected from the steering gear. The steering gear was displaced rearward and to the left. The drag link and pitman arm remained attached however the drag link was bent at approximately 90–degrees. The steering gear assembly exhibited damage at the input shaft as the input shaft and housing were missing.

There were no complaints or statements made by the driver that he ever experienced any problems with the steering system on the coach, nor did the driver make any statements of this nature during his interviews with investigating police as well as NTSB investigators.

Although no driver, passenger or witness statements indicated a problem with the steering prior to the accident; the Safety Board opted to submit the steering pump for mechanical examination and functional testing. The hydraulic pump was removed from the engine by the Sherman Police Department and logged into evidence with the Police Department who maintained custody of the pump until appropriate testing could be arranged.

The Sherman police Department transferred the pump into the custody of the undersigned NTSB Group Chairman where it remained until November 19, 2008, when it was transferred (FedEx 833166310823) to the ixetic USA Inc., facility in Brunswick, Ohio for testing.

The pump was physically examined and tested on November 26, 2008. Examination and testing revealed no physical damage to the pump's external or internal components and performance based testing found the pump functioning within the production parameters of a new pump.[xxii]

1.6 SUSPENSION SYSTEM

The steer axle was a Meritor model FL945LX-4, rated at 16,500 lbs. The suspension utilized two 14-inch rolling lobe type air springs, a single anti-sway bar, two shock absorbers and one pneumatic leveling valve. Axle positioning was accomplished utilizing a single V-link and two radius rods. The steer axle possessed a track width of 84.9-inches.

The drive axle consisted of a Rockwell model RC23162NFLF 11, 4.56:1 ratio, tandem wheel axle rated at 23,000 lbs. The suspension consisted of four 11-inch rolling lobe type air springs, 4 shock absorbers, and two pneumatic leveling valves. Axle positioning was accomplished utilizing a single V-link and two radius rods. The drive axle possessed a track width of 75.4-inches.

The trailing axle (Tag Axle) was a Meritor model FH945LX-5, 16,500 pound axle with two 14-inch rolling lobe type air springs, one anti-sway bar, two shock absorbers and one pneumatic leveling valve. Axle positioning was accomplished utilizing a single V-link and two radius rods. The tag axle also possessed a track width of 84.9-inches.

1.7 VEHICLE / AXLE WEIGHT & TIRE EQUIPMENT

The designed gross vehicle weight rating for the coach was 54,000 lbs. with a front axle weight rating of 16,500 lbs., a drive axle weight rating of 23,000 lbs and a tag axle rating of 16,500 lbs. Due to the coach's extensive frontal deformation, post accident axle weights were not obtained, however, according to the Sherman Police Department, the coach's overall weight including passenger luggage was determined to be approximately 44,000 lbs. [xxiii]

MCI provided the following information in regard to factory axle weights of a new, similarly equipped model J4500 coach. The below weights are without fluids or driver.

Front Axle = 10,362lbs	≈29% weight distribution
Drive = 14,8590lbs	≈4 2% weight distribution
Tag = 10,450lbs.	≈2 9% weight distribution
Total= 35,671lbs.	100%

Federal Motor Vehicle Safety Standard 120 (FMVSS 120), codified at 49CFR 571.120 specifies tire and rim selection requirements to ensure that vehicles are equipped with tires of adequate size and load rating and with rims of appropriate size and type designation. Specifically, FMVSS 120 requires that the sum of the maximum load ratings of the tires fitted to an axle shall be not less than the gross axle weight rating (GAWR) of the axle system as specified on the vehicle's certification label required by 49 CFR part 567.

A review of MCI's standard coach design specifications indicated design changes which included increased axle weight ratings and increased tire load rating and inflation pressure requirements.

From 1999 to 2009, MCI's standard product specifications indicated that gross axle weight ratings for the steering axle increased 2,500 lbs from 14,000 to 16,500 lbs; drive axle weight ratings increased 1,000 lbs from 22,000 to 23,000 lbs and tag axle weight ratings increased 10,500 lbs from 6,000 to 16,500 lbs. The gross vehicle weight ratings for 40-foot coaches increased from 38,800 lbs to 46,000 lbs and from 44,000 lbs to 54,000 lbs for 45-foot model coaches.

In conjunction with these weight increases the recommended tire and rim equipment was changed from 7,300 lbs rated 8.25X22.5 rims and 12R22.5 Load H tires to 9,000 lbs rated 9.00X22.5 rims with 315/80R 22.5 Load J tires. The following specification chart was obtained from MCI.

MCI Coach 40 Foot Coach Standard Product Data

Model	Years	GVWR	GAWR Front	GAWR Drive	GAWR Tag	Rims Size	Rims Load Rating	Tires Size	Tires Load Rating	Pressure [1] Front	Pressure [1] Drive	Pressure [1] Tag	Passenger Capacity [2] w / Lav	Passenger Capacity [2] w /o Lav	Passenger Capacity [2] Driver	Size Length (ft)	Size Width (in)	Size Height (in)	Baggage (Cubic Ft)
MC12	92 - 99	37800	14000	22000	6000	8.25 x 22.5	7300 @ 120	12R22.5	H	115	85	85	47	49	+1	40	96	133.75	300
102D3	93 - 99	44400	14400	22500	10000	8.25 x 22.5	7300 @ 120	12.75R22.5	H	105	85	75	47	49	+1	40	102	137.0	326
102D3	99 - 00	46000	14600	22500	10000	8.25 x 22.5	7300 @ 120	315/80R22.5	J	110	90	75	47	49	+1	40	102	137.0	326
D4000 [3]	00 - 01	46000	14600	22500	10000	8.25 x 22.5	7300 @ 120	12.75R22.5	H	120	95	75	47	49	+1	40	102	137.0	326
D4000 [3]	00 - 01	46000	14600	22500	10000	9 x 22.5	9000 @ 125	315/80R22.5	J	105	85	75	47	49	+1	40	102	137.0	326
D4000	01 - 08	46000	16000	22500	10000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	85	85	47	49	+1	40	102	137.0	326
D4005	07 - 08	46000	16000	22500	10000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	100	85	47	49	+1	40	102	137.0	326

MCI Coach 45 Foot Coach Standard Product Data

Model	Years	GVWR	GAWR Front	GAWR Drive	GAWR Tag	Rims Size	Rims Load Rating	Tires Size	Tires Load Rating	Pressure [1] Front	Pressure [1] Drive	Pressure [1] Tag	Passenger Capacity [2] w / Lav	Passenger Capacity [2] w /o Lav	Passenger Capacity [2] Driver	Size Length (ft)	Size Width (in)	Size Height (in)	Baggage (Cubic Ft)
102DL3	92 - 99	44400	14400	22500	12000	8.25 x 22.5	7300 @ 120	12.75R22.5	H	115	85	85	55	57	+1	45	102	137.0	400
102DL3	99 - 00	48000	14600	22500	12000	8.25 x 22.5	7300 @ 120	315/80R22.5	J	110	90	85	55	57	+1	45	102	137.0	400
D4500 [4]	00 - 01	48000	14600	22500	12000	8.25 x 22.5	7300 @ 120	12.75R22.5	H	120	95	95	55	57	+1	45	102	137.0	400
D4500 [4]	00 - 01	48000	14600	22500	12000	8.25 x 22.5	7300 @ 120	315/80R22.5	J	105	85	85	55	57	+1	45	102	137.0	400
D4500	01 - 08	48000	16000	22500	12000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	100	100	55	57	+1	45	102	137.0	400
D4500	Mar-08	50000	16000	22500	14000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	100	100	55	57	+1	45	102	137.0	400
D4505	07 - 08	48000	16000	22500	12000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	100	100	55	57	+1	45	102	137.0	400
D4505	Mar-08	50000	16000	22500	14000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	100	100	55	57	+1	45	102	137.0	400
102EL3	97 - 00	49900	16000	23000	16000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	90	120	54	N/A	+1	45	102	141.25	418.35
102EL3 [5]	97 - 00	54000	16000	23000	16000	9 x 22.5	9000 @ 125	315/80R22.5	J	120	90	120	54	N/A	+1	45	102	141.25	418.35
E4500 [6]	00 - 08	54000	16500	23000	16500	9 x 22.5	9000 @ 125	315/80R22.5	J	120	90	120	54	N/A	+1	45	102	141.25	418.35
J4500	01 - 08	54000	16500	23000	16500	9 x 22.5	9000 @ 125	315/80R22.5	J	120	90	120	54	N/A	+1	45	102	141.25	418.35

Footnotes:

(1) Minimum inflation pressure may vary depending on tire brand and manufacturer's load rating.
(2) Passenger numbers may vary depending on customer requests for configuration / number of seats and standees.
(3) Model name 102D3 was changed to D4000
(4) Model name 102DL3 was changed to D4500
(5) Supplemental certification plates were issued to all customers for early 102EL3 coaches to increase GVWR to 54000 lbs.
(6) Model name 102EL3 was changed to E4500

Steer Axle

The gross vehicle weight rating of the accident coach was designed such that a maximum weight of 16,500 lbs could be placed upon the steer as well as the tag axles. Most notably, the manufacturer's prescribed tire equipment for the steer axle was that of 315/80R 22.5, Load Range J tires with an inflation pressure of 120 psi.

The prescribed Load Range J tires, with an inflation pressure of 120 psi have a maximum load rating of only 8,270lbs each, for a total available axle load of 16,540lbs. This designed axle and tire configuration provides a reserve load of only 20 axle weight pounds per tire.

Accordingly, if the coach were to be loaded in such a manner that the maximum gross axle weight upon the steer axle was exceeded by as little as 45 lbs., or if the required tire pressure was reduced by as little as 5 psi, the tires become overloaded and subject to harmful over deflection. The observed axle and tire design of the accident coach provides for nearly a zero margin of tire load reserve. This lack of reserve becomes critically important as indicated above should either of the front tires become under-inflated from the required 120 psi, or if the coach is loaded in such a manner that the weight upon the front axle exceeds 16,500 lbs.

For example, the required Load Range J tire with a 10 psi reduction in inflation pressure would suffer a reduction in its load capacity from 8,270 lbs down to that of 7,610 lbs which in effect reduces the tire's load capacity to that of a Load Range H tire.

Values as per Tire and Rim Association Standards Publication, 2009 Year Book									
Size	80psi	85psi	90psi	95ps	100psi	105psi	110psi	115psi	120psi
315/80R22.5 Single Dual (Load Range)	6175lb 5675lb	6415lb 5840lb	6670lb 6070lb	6940lb 6396lb (G)	7190lb 6545lb	7440lb 6770lb	7610lb 6940lb (H)	7920lb 7210lb	8270lb 7610lb (J)

Tag Axle

The coach's tag axle, like the steer axle, also possessed a GAWR of 16,500 lbs. As indicated within Section 1.3.2, the tire inflation chart found within the MCI J4500 maintenance manual, indicated that the tag axle, like the steer axle, was required to be equipped with Load Range J, size 315/80R 22.5 tires mounted on 9.00" wheel assemblies. However, according to the chart, the tag axle tires were only required to be inflated to 105 psi as opposed to the 120 psi needed to provide the required load capacity of the axle.

Based on the inflation pressure of only 105 psi, the tag axle tires when inflated according to the maintenance manual's guidance were under inflated and thus under rated for the tag axle's GAWR of 16,500 lbs. When inflated to 105 psi, the recommended tire was rated to only 7,440 lbs, providing the tag axle with only 14,880 lbs of load capacity compared to the required 16,5000 lbs[xxiv].

Additionally, as discussed in section 1.3.1, the tag axle wheel assemblies on the accident coach were 8 .2 5 " wide, as opposed to the required 9 .0 0 " wheels. While the use of 8.25 wheels with 315/80R22.5 tires in single usage is permissible, the maximum allowable load is reduced to 8,000 lbs when inflated to its maximum permissible pressure of 120 psi. [xxv]

Because the tag axle had a GAWR of 16,500lbs the use of 315/80R22.5 tires mounted to 8.25 wheels would not be appropriate for use on the subject coach's tag axle. Because the use of the 8.25" wheel limits the 315/80R22.5 tire in a single tire application to a maximum load capacity of only 8,000 lbs, the two tires applied to the tag axle of the subject coach could carry a maximum total load of only 16,000 lbs. Considering the GAWR of 16,500 lbs., each of the tires on this axle could potentially be overloaded by 250 lbs even when properly inflated to 120 psi.

However, in addition to the tires on the tag axle being mounted to undersized wheels, inflation pressure measurements taken during post crash inspections indicated that the tires on the tag axle were approximately 30 psi underinflated. (Inflation pressure measurements of the left and right tires on the tag axle were 88 psi and 89 psi respectively. Thus, each tire was subject to being potentially overloaded by approximately 1,580 lbs., or 19% each when inflated to the 90 psi specification provided within the maintenance manual.

1.7.1 Importance of Proper Tire Inflation

Studies conducted by the tire industry as well as the National Highway Traffic Safety Administration (NHTSA) have demonstrated that tire under-inflation and or overloading represent the leading cause of tire failure. Although commercial drivers are required to perform a pre-trip inspection of their vehicle, (with the exception of HAZMAT) they are not required by current regulation to physically ensure proper tire inflation through the use of a tire pressure gauge.

NHTSA as well as the tire manufacturers have indicated that an air pressure gauge is the only method of accurately determining whether a tire is properly inflated.

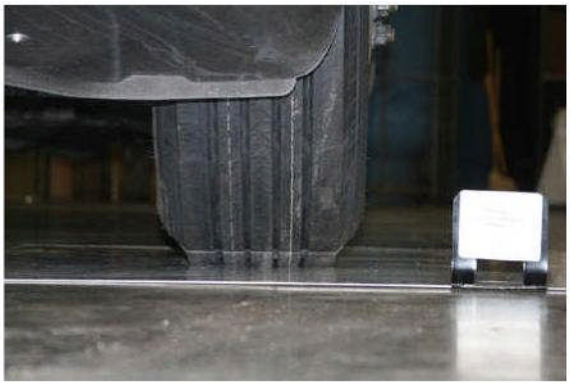
The NHTSA has demonstrated that visual inspection of “passenger car and light truck” tires failed to detect under inflation levels as low as 50%.[xxvi]

Tire inflated to required 32 psi Tire inflated at 50% to 16 psi

Additionally, at the request of the undersigned Group Chairman, Michelin North America, Inc., conducted a similar study as that conducted by the NHTSA on passenger and light truck tires. However, the testing conducted by Michelin was done with a focus specific to the type of tire required on the accident coach’s steer axle. The Michelin study consisted of documenting the visual effects of inflation pressure upon a commercial vehicle tire of similar size and specification of those used upon the accident coach as well as those used on over the road trucks and buses throughout North America.

The two photographs below depict the Michelin XZA2 Energy tire size 315/80R 22.5 inflated at both 130 psi and at 85 psi, in an effort to document the visual difference within the tire when subjected to a 50 psi pressure differential. [xxvii]

Tire Inflated to 130 PSITire Inflated to 85 PSI

Tire Inflated to 130 PSITire Inflated to 85 PSI fix image

As observed within the Michelin study, the difficulty in visually detecting proper tire inflation is not isolated to passenger vehicles but also presents itself in commercial vehicle tires as well. Commercial vehicle tires utilize stronger materials including stiffer sidewalls, steel belting materials and harder rubber compounds.

Additionally critical to routinely checking and maintaining proper tire inflation, is that heavy vehicle tires can lose as much as 2psi per month due to diffusion.[xxviii]

1.7.2 AVAILABLE GUIDENCE

The following are excerpts taken from MCI maintenance and operator manuals for the accident coach.

- *The following checks are in addition to the Bureau of Motor Carrier Safety inspection requirements, not instead of them.*
- *Exterior Inspection:...item #4. Check the tire pressure and inspect the tires for damage. Check that the wheel nuts are tight and inspect the wheels for damage*

- *Check tire inflation pressure with an accurate gauge. Check the pressure before starting a run and as recommended by the tire manufacturer. Always use the same gauge to check the pressure, to eliminate any differences resulting from gauge error (Figure 1). If the pressure loss is greater than normal, remove and inspect the tire to determine the cause. Replace any missing valve caps. NOTE: Check tire pressure with pressure cold. The valve core is a spring loaded check valve in the stem that permits tire inflation. The valve seals the air in the tire. When the valve cap is tightened on the stem, the sealing washer inside the cap presses tightly against the top of the stem, preventing air leaks. All tires on the same axle should always carry the same air pressure."*
- *"A 5 psi (34.5 kPa) under inflation in one front tire can not only cause hard steering, but can create steering hazards which may cause an unsafe condition. An underinflated rear tire can seriously affect braking.*
- *Recommended inflation pressures for max. interstate/interprovincial allowable axle loads are shown below and in the tables at the end of this section."*

1.8 TIRE PRESSURE MONITORING

1.8.1 TIRE PRESSURE MONITORING SYSTEM (TYPES)

There are basically two types of TPMS's available, Direct and In-Direct systems. Direct TPMS's utilize a pressure sensor within the vehicle's wheel assembly, which transmits actual tire inflation pressure information to a receiver. However, with In-Direct TPMS's, no pressure sensing is actually utilized. These systems typically utilize wheel speed sensors from the vehicle's anti-lock brake system, which compare the differences in wheel/tire rotational speeds correlating the differences in a tire's rolling radius, to a loss in inflation pressure. Therefore, In-Direct systems would permit all of a vehicle's tires to be equally under-inflated without detection.

Direct

"Direct" Tire pressure Monitoring Systems (TPMS) utilize pressure sensors, and transmit the tire's inflation pressure data from the tire directly to the driver. Direct systems are capable of identifying simultaneous "under-inflation" conditions of multiple tires in any combination. Direct TPMS can also be designed to compensate for changes in tire pressure due to environmental and tire operating temperature changes by employing threshold pressures that are determined by the tire manufacturers recommended cold inflation pressures.

Indirect

Unlike "Direct" TPMS, "Indirect" systems do not employ actual tire inflation pressure sensing. Indirect systems "calculate", as opposed to "detect" or "monitor" actual tire inflation pressures. Indirect systems calculate a tire's "apparent" state of inflation by sensing and comparing wheel speeds. Indirect systems employ the methodology that an under-inflated tire posses a smaller rolling radius than a properly inflated tire and thus will operate at a greater rate of rotation in comparison to its companion tires which are properly inflated. Indirect systems, which utilize this methodology, are incapable of detecting under-inflated tire conditions which may occur simultaneously.

While detection of simultaneously under-inflated tires can be accomplished by Indirect systems they require additional wheel vibration or load shift analysis using additional advanced signal processing. The addition of this technology to indirect systems would allow for indirect systems to detect instances of simultaneously under-inflated tires. However, these analysis techniques require additional sensors as well as software programming which results in increased system complexity and expense.

Unlike Direct TMPS, Indirect TPMS are generally not independent systems but rather engineered by-products of proprietary software in combination with wheel speed data derived from anti-lock brake systems as well as stability control systems. An additional disadvantage of Indirect TPMS is that these systems require routine calibrations to be performed by the driver. The calibrations are conducted through the use of a dash mounted reset button or through the on-board computer and if this calibration is performed without ensuring that each tire is properly inflated the system will not function properly.

1.8.2 CURRENT TPMS RULEMAKING HISTORY

On November 1, 2000, Congress enacted the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act[xxix]. Section 13 of that Act required the Secretary of Transportation, enactment regulation within one year "to require a warning system in new motor vehicles to indicate to the operator when a tire is significantly under inflated". Responsibility for this rulemaking was delegated to NHTSA.

Initially, NHTSA determined through research and studies that "Direct" TPMS should be installed in all new vehicles. However, the Office of Management and Budget (OMB) raised objections to NHTSA's conclusions claiming that cost-benefit calculations provided a basis for delaying the requirement for "Direct" TPMS.

In June of 2002, NHTSA adopted Federal Motor Vehicle Safety Standard (FMVSS) No. 138, codified as 49 CFR 571.138, Tire Pressure Monitoring System (TPMS). Soon after issuing the final rule, three organizations filed suit challenging the regulation. Within the rulemaking NHTSA allowed for a single tire, 30-percent compliance option, which the U.S. Court of Appeals, Second Circuit, found was contrary to the intent of Congress expressed in the TREAD Act. Subsequently, the Court vacated the rulemaking in August of 2003.

September 15, 2004, NHTSA issued another NPRM, establishing NHTSA's intent to re-establish FMVSS No. 138, Tire Pressure Monitoring System, in a manner consistent with the court's opinion. The proposed standard would require passenger cars, multipurpose passenger vehicles, trucks, and buses with a gross vehicle weight rating (GVRW) of 10,000 pounds or less, except those with dual wheels on an axle, to be equipped with a TPMS capable of alerting a driver when one or more (up to a total of four) of the vehicle's tires, are under-inflated by 25-percent of the vehicle manufacturer's-suggested inflation pressure.

Public Awareness / Education

Although the importance of maintaining proper tire inflation was widely publicized and emphasized during the Firestone tire recalls, an overwhelming majority of drivers fail to check tire pressures on a regular basis, if at all.

In July of 2001, a Department of Transportation, Bureau of Transportation Statistics survey revealed that approximately 65% of people surveyed, (calculated to represent over 128.2 million drivers) will, to a "great extent", or to a "very great extent", *be less* concerned about maintaining their recommended tire pressures if their vehicle was equipped with a TPMS.

An additional 18% of those surveyed (calculated to represent over 36.2 million drivers) said they would be to "some" extent less concerned with maintaining tire inflations pressures if their vehicle was equipped with a TPMS.

In essence approximately 164.5 million drivers would place a considerable degree of reliance on their vehicle's TPMS to ensure their safety.

Section 13 of the Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act, required the Secretary of Transportation to mandate a warning system in new vehicles to alert operators when their tires are underinflated.

NHTSA determined through research and studies that Direct TPMS should be installed in all new vehicles. However, following meetings with industry, the Office of Management and Budget (OMB) raised objections to NHTSA's conclusions claiming cost-benefit calculations provided a basis for delaying the requirement for Direct TPMS. In NHTSA's final rule that was issued in May of 2002, allowed automakers to install Indirect TPMS which based on NHTSA's own testing would have left many drivers unaware of dangerously underinflated tires.

In June of 2002, numerous consumer safety groups moved to sue NHTSA because its final rule would have permitted manufacturers to install either an (Direct) or (Indirect) TPMS.

In August 2003, the United States Court of Appeals ordered NHTSA to rewrite the rule, agreeing with consumer safety groups, in that NHTSA acted in an arbitrary and capricious manner by issuing a standard allowing the installation of ineffective Indirect TPMS.

Because NHTSA failed to act upon the court's order for nearly a year, consumer safety groups returned to the courts in July 2004, asking the court to order the agency to act. In April 2005, NHTSA issued a rule requiring automakers to install systems in all new passenger cars and trucks by the 2008 model year, beginning a phase-in with 2006 model year vehicles.

Current TPMS Regulation Summarized

Current Federal Motor Vehicle Safety Standard (FMVSS) 138, codified at 49 CFR 571.138, specifies performance requirements for TPMS to warn drivers of significant under-inflation of tires and the resulting safety problems.

The current TPMS regulations, requires passenger cars, multipurpose passenger vehicles, trucks, and buses that have a gross vehicle weight rating of 4,536 kilograms (10,000 pounds) or less manufactured on or after September 1,2007, to be equipped with a TPMS which must activate not more than 20 minutes after the inflation pressure in one or more of the vehicle's tires, up to a total of four tires, is equal to or less than either the pressure 25 percent below the vehicle manufacturer's recommended cold inflation pressure, or the pressure specified in the 3rd column of the table below, whichever is higher.

Tables to Sec. 571.138

Table 1--Low Tire Pressure Warning Telltale--Minimum Activation Pressure

Column 1--tire type	Column 2--maximum or rated inflation pressure		Column 3--minimum activation pressure	
	(kPa)	(psi)	(kPa)	(psi)
P-metric--Standard Load	240,	35,	140	20
	300,	44,	140	20
	350	51	140	20
P-metric--Extra Load	280	41	160	23
	340	49	160	23
Load Range C	350	51	200	29
Load Range D	450	65	240	35
Load Range E	550	80	240	35

Currently, no requirement or standard exists for the application of TPMS on commercial vehicles.

1.8.3 COMMERCIAL VEHICLE TIRE INFLATION TECHNOLOGY

Historical research regarding the state of commercial vehicle tire inflation and maintenance has indicated:[xxx]

- That a significant portion of fleet operators do not perform tire inflation inspection and pressure maintenance in accordance with the standards recommended by tire manufacturers.
- That approximately 7-percent of all commercial vehicle tires are underinflated by 20 psi or more, and that only approximately 44-percent of all commercial vehicle tires are within +/-5psi of their correct pressures.
- That a direct link exists between commercial vehicle tire inflation to vehicle stopping distance and handling, and overall safety.
- That properly maintained tires have aided drivers in preventing and or mitigating crash situations.
- That properly inflated tires could help prevent or mitigate crashes even when tires were not the initial cause of the crash.
- That eliminating or mitigating key mechanical problems, including tire issues, would likely yield a significant reduction in the number and severity of injuries sustained in commercial vehicle-related crashes.

Research and studies conducted by NHTSA, FMCSA and the tire industry has demonstrated that improper tire inflation impacts both safety and tire longevity. Improper inflation causes accelerated tire wear which contributes to compromised braking, handling, and stability, increased fuel consumption, an increased propensity for catastrophic failures (blowouts), dangerous roadside debris, and road repairs.

FMCSA's 2003 study demonstrated that despite the known consequences, many fleets have failed to embrace or employ proper tire maintenance.

In January of 2007 the FMCSA published its Tire Pressure Monitoring and Maintenance Systems Performance Report as part of its Commercial Vehicle Safety Technology Diagnostics and Performance Enhancement Program. The objective was to document the performance and operational characteristics of leading-edge technological approaches for monitoring and maintaining commercial vehicle tire pressures.

Testing conducted on TPMS as part of the study indicated the following:

- That the tire pressure monitoring systems were generally accurate to within 2 to 3 psi and that each system tested (valve-, wheel-, or tire-mounted) demonstrated the level of functionality expected of each design.

|

- The tested TPMS possessed both "factory set" as well as user-configurable warning thresholds and were generally within a 2 to 3-psi range of the expected threshold. The systems also demonstrated similar performance in both static as well as dynamic test conditions.

- That many of the TPMS utilized RF communications to transmit data between the sensors and display or control units.
- That the operator interfaces of the TPMS's varied significantly, but all systems used in-cab visual displays and audible alerts (except for tire-mounted TPMS) to warn the operator of inflation issues.

In addition to TPMS, central inflation systems (CIS) were also explored. The CIS testing was conducted in both motorcoach and trailer configurations. Testing revealed:

- That the tested CIS generally performed as designed and specified by the manufacturers and performed well in both static and dynamic environments.
- That during testing involving leak rates, the Vigia CIS was able to keep up with leak rates up to 5 to 8 psi/min. Ultimately, this system was limited by the vehicle's air compressor duty cycle and air system design.
- The CIS tested on the trailer could maintain adequate tire pressures with slow leak rates (less than 1.0 psi/min), but could not maintain adequate tire pressure for higher leak rates. This system appeared to be limited by its ability to flow air to the tires rather than by the vehicle's compressor and air system.
- During testing with heavy braking and simultaneous tire leaks, the vehicles' primary and secondary air reservoirs did not become significantly depleted. The vehicle compressor had no difficulty recharging the reservoirs without having to run continuously. The test data suggests that the vehicles would likely have braking problems due to over-heating of the brakes before they would encounter problems with insufficient air pressure. During the tests, there were no adverse effects on braking performance observed with either CIS subjected to high leakage rates.
- Both CIS tested protected the "intact" tires from deflating if/when a catastrophic air leak was experienced in one of the other tires in the system. In this regard, the systems functioned in a manner similar to the dual tire equalizers' isolation circuits.

The report also recommended future research such as;

- There is a need to subject tire pressure monitoring and maintenance sensors and systems to the rigors of operation that a CMV would experience during the course of revenue service.
- An FMCSA-sponsored field operational test (FOT) involving the use of a transit bus fleet or commercial trucking fleet would serve as a long-term test bed for new equipment and maintenance practices.
- Data collected during the FOT could be used to determine tire pressure monitoring and maintenance systems ease of installation, ergonomics and functionality, accuracy and sensitivity for detecting pressure changes, serviceability, reliability, and overall customer acceptance.

- The utility of these systems could also be evaluated with the help of the fleet operator to determine the potential of using the systems for reducing maintenance costs, increasing performance and safety, and reducing vehicle downtime for scheduled or unscheduled maintenance and repair.

Previous Board Action

Although the Safety Board has not previously recommended TPMS for commercial vehicles, the Board did issue a recommendation in connection with TPMS's in its accident investigations in Henrietta, Texas and Randleman, North Carolina, involving 15-passenger vans. In those investigations the Safety Board issued a recommendation to NHTSA in connection with NHTSA's TPMS rulemaking efforts for passenger vehicles.

> H-03-017
> In developing long-term performance requirements for tire pressure monitoring systems, adopt more stringent detection standards than 25 or 30 percent below manufacturer-recommended levels, since pressures at those levels can have an adverse effect on the handling of vehicles, such as 12- and 15-passenger vans.

During the course of the Henrietta and Randleman investigations, the Safety Board determined that most of the accident vehicle tires were significantly under-inflated. Forensic examinations of the failed tires, as well as several of the non-failed tires, revealed evidence of elevated operating temperatures and cumulative tire damage directly related to recurrent operation in an under-inflated, over-loaded and subsequently over-deflected condition.

1.8 VEHICLE MAINTENANCE

Interviews conducted by the Safety Board's Motor Carrier Group Chairman with representatives of the carrier revealed that the coach was purchased only 21-days prior to the accident and no significant maintenance problems were encountered with the coach within that time frame.

MCI also provided the Safety Board with records regarding the subject coach from the time they took delivery of the coach to the time they delivered the coach to the carrier. A review of these documents indicated extensive inspection and corrective actions to all control systems of the coach being brought into proper operating specifications prior to its sale.

A query of NHTSA's Office of Defect Investigation's Recall and Defect Database revealed that the accident coach was subject to two (2) recall campaigns.

(1) NHTSA Campaign number 06V140000, which affected a reported 4,765 units addressed a potential engine related fire hazard linked to turbocharger failures. Affected J4500 model units manufactured from 8-18-2001 to 1/11/2006 with a VIN series ranging from 61491 to 63545.

According to Detroit Diesel, this campaign consisted of a two-part corrective action. Based on available records the initial action was performed on August 11, 2006. However, the remaining required corrective action had not yet been completed.

(2) NHTSA Campaign number 06V241000, which affected a reported 1,768 units addressed a potential fire hazard related to defroster motor speed controller failures. Affected J4500 model units manufactured from 4/1/2001 to 8/30/2004 with a VIN series ranging from 61639 to 62779.

These necessary repairs / corrections were documented as being performed by MCI on July 27, 2006.

1.9 ADEQUACY OF VEHICLE INSPECTIONS

The Code of Federal Regulations Title 49, Part 396.17, requires every commercial vehicle be inspected utilizing the annual inspection criteria set forth in Appendix G, of Subchapter B of the Federal Motor Carrier Safety Regulations (FMCSRs).

However, under Part 396.23(b)(1), a motor carrier may meet the inspection requirements of 396.17 if the vehicle is subject to a mandatory State inspection program, which has been determined to be as effective of 396.17, then the motor carrier shall meet the requirements of 396.17 through the State's mandatory vehicle inspection program.

The inspection of motor vehicles, including motorcoaches, in the State of Texas, is conducted in approved, privately owned and operated garages and repair facilities, which are designated by the Texas Department of Public Safety under the Texas Vehicle Inspection Act. All authorized inspection facilities are required to operate under the "Rules and Regulations Manual" for the operation of Official Vehicle Inspection Stations. This manual is issued and maintained by the Texas Department of Public Safety. The rules and regulations, which are published within the manual, are promulgated under the authority of the Texas Transportation Code, Compulsory Inspection of Vehicles, and Chapter 548. The fees charged for the inspection of vehicles is set by and regulated by the State. Currently the state regulated fee for a Commercial Vehicle Safety Inspection for a motorcoach is $62.00.

Because the State of Texas has a mandatory vehicle safety inspection program that had been certified by the FMCSA as an equivalent inspection program which would satisfy the annual inspection requirements of 396.17, the accident coach was permitted to satisfy its required annual inspection under the FMCSRs through a state inspection facility.

Additionally, because the accident coach was also to be registered within the State of Texas, it was required to also be inspected to satisfy the requirements within the State of Texas Vehicle Inspection Criteria[xxxi].

According to available records the accident coach was subjected to a State of Texas "Commercial Vehicle Inspection" on July 31, 2008, eight (8) days prior to the accident with an approximate odometer reading of 432,392.2 miles[xxxii]. (3,339 miles prior to the accident) The inspection was conducted at the "5-Minute Inspections" facility located in Houston, Texas. The report indicated that at the time of inspection all required inspection items had passed and the vehicle was issued a valid Commercial Vehicle Inspection Certificate #U02175069.[xxxiii]

However, numerous aspects of the inspection report combined with several findings of the post crash inspection appeared unusual.

- The total inspection time was listed as 24minutes
- Vehicle Odometer reading was entered as 0 miles
- No TXDOT Number was entered
- Insurance expiration was entered as 10/12/2009 (ins policy over 1 year)
- Inspection item for "Tires" was marked as N/A
- As discussed within Section 1.4.3 of this report, post crash inspections revealed the left tag axle brake drum and shoes were significantly contaminated via grease soaking and exhibited considerable buildup and caking.
- The right front tire was determined to be a retread.
- The tag axle tires were significantly under-inflated and mounted on under-sized wheel assemblies.

Due to the above noted items combined with the degree of contamination that was found upon the left tag axle brake assembly, staff contacted the Texas Department of Public Safety's Houston Regional Office to request an audit on the above inspection station as well as the subject inspector.

On March 10, 2009, a representative of the Texas Department of Public Safety interviewed the inspector who conducted the inspection and validated his DOT certification. However, based on the content of the audit report, it would seem no knowledge testing or practical exercises were part of the audit.[xxxiv]

ADDITIONAL MOTORCOACH INSPECTION

In addition to the accident coach, staff located an additional inspection conducted by "5-Minute Inspections" on an additional Angel Tours coach on August 7, 2008. This coach, like the accident coach received an "all items passed" inspection report with a valid State of Texas Commercial Vehicle Inspection Certificate number U02175404 being issued.[xxxv] However, the next day on August 8, 2008, the above coach was subjected to a Motor Carrier Safety Assistance Program (MCSAP) sponsored roadside inspection conducted by the Missouri Highway Patrol[xxxvi] and was placed "out-of-service" with numerous driver and equipment violations. See below.

- Right Side Steer Axle Brake out of Adjustment
- Left Side Steer Axle Brakes (General)
- Right Side Tag Axle Brakes (General)
- Missing or Defective Automatic Brake Adjuster on Air Brake System for vehicles Manufactured after 10/20/1994

A review of the "Rules and Regulations Manual" was conducted with specific attention to Chapter VI, titled "Federal Motor Carrier Safety Regulations Annual Inspection" sections (06.25.00), (06:25.07) and (06:25:08) which are dedicated to the inspection of commercial vehicle tires and brakes.

- Inspection Item 06.25.07 (Brakes)

  Section 1"Inspect for and Reject if:

  (f) Brake linings or pads

  2. Saturated with oil, grease, or brake fluid; or

- Inspection Item 06.25.08 (Tires)

  Section 1"Inspect any tire Steering Axle for and Reject if:

  (e) Labeled "Not for Highway Use" or displaying other marking which would exclude use of steering axle.

  (f) A bus operated with re-grooved, recapped or retreaded tires on the front wheels.

  (m) Weight carried exceeds tire load limit. This includes overloaded tire resulting from low air pressure.

  (o) Any bus equipped with recapped or retreaded tire(s).

  Section 2 Inspect all other tires and reject if:

  (a) Weight carried exceeds tire load limit. This includes overloaded tire resulting from low air pressure.

Because the accident coach was also registered within the state of Texas it was additionally required to be inspected under the state vehicle inspection criteria within Chapter IV of the Rules and Regulations Manual.

The reviewed tire inspection procedures did not have an inspection criterion that addressed the proper inflation of vehicle tires, tire over-loading nor did it address the identification or use of retreaded tires on any vehicles, including motorcoaches. However, the criteria included an advisory instructing inspectors to "refer to the Federal Motor Carrier Safety Regulations (FMCSRs) if required"

Under the FMCSR's the use of retreaded tires upon the steer axle of buses is prohibited and is included within the Annual Inspection Criteria within appendix G of the FMCSR's in addition to current North American Standard Out-of-Service Inspection Criteria employed by roadside inspectors.

It should be noted that within Section IV of the manual, inspectors are provided with the criteria to be used during a state registered Commercial Vehicle Inspection.

- Inspection Item 04.20.28 (Tires), Section I "Inspection Procedure", Sentence 3: "All tires must appear to be properly inflated – even though a gauge check is not required."

- Inspection Items 04.20.02 and 04:20:10 (Brakes & Air Brake System)

The reviewed brake and air brake system inspection procedures did not have an inspection criterion, which addressed the identification of contaminated brake system friction materials, such as those observed upon the accident bus, as a defect. However, the criteria included an advisory instructing inspectors to "refer to the Federal Motor Carrier Safety Regulations if required".

Under the FMCSR's the presence of grease, oil or brake fluid on any of the vehicle's brake linings is considered a defect under which the vehicle will not pass its annual inspection. In addition, the current North American Standard Out-of-Service Inspection Criteria employed by roadside inspectors also indicate that the presence of contaminated friction materials is considered a brake defect.

2 EVENT DATA RECORDER

The accident coach was not, nor was it required to be equipped with an event data recorder.

In accordance with Safety Board procedures, an independent investigative group was formed regarding the examination of electronic/vehicle event data. See Event Data Recorder Group Chairman's Factual Report.

E. ATTACHMENTS

A. Post Accident Photo of Motorcoach
B. Post Accident Photo of Motorcoach
C. Improper Tire Inflation Data Provided in MCI Maintenance Manual
D. Conflicting Tire Data from MCI Maintenance Manual
E. Photo of Right Front Tire/wheel After the Accident, Prior to Removal
F. Henise Tire Documents
G. Goodyear Tire Inspection Report
H. Bridgestone Tire Inspection Report
I. Texas DPS Post Accident Brake Inspection Data
J. ABS ECU Data
K. Photo of Fractured Right Front Brake Drum
L. Photo of Contaminated Left Tag Axle Brake Assembly Components
M. Photo of Contaminated Left Tag Axle Brake Assembly Components
N. Ixetic, Inc. Power Steering Pump Examination Report
O. Photo of Tire from Michelin Tire Inflation Demonstration

P. Photo of Tire from Michelin Tire Inflation Demonstration
Q. Photo of Tire from Michelin Tire Inflation Demonstration
R. Photo of Tire from Michelin Tire Inflation Demonstration
S. July 31, 2008 State of Texas Commercial Vehicle Inspection Report
T. Texas Department of Public Safety Memo
U. Aug 7, 2008 State of Texas Commercial Vehicle Inspection Report
V. Missouri Highway Patrol MCSAP Inspection Report

END OF REPORT

s/s Christopher C Voeglie

Christopher C. Voeglie, Senior Investigator
Vehicle Group Chairman

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i Distance of 610 miles and driving time often hours are based on computer estimates determined by PC Miler.
ii See Attachment – Photo of motorcoach post accident
iii See Event Data Recorder Group Chairman's Report
iv All tread depths are listed from the DOT number sidewall to the non DOT number sidewall, left to right.
v Tire was bi-laterally un-beaded from its wheel assembly. Tire beads were located inside of wheel flanges.
vi CFR 49 393.75(b) Any tire on the front wheels of a bus, truck, or truck tractor shall have a tread groove pattern depth of at least $_{4/32}$ of an inch when measured at any point on a major tread groove. The measurements shall not be made where tie bars, humps, or fillets are located. (c) Except as provided in paragraph (b) of this section, tires shall have a tread groove pattern depth of at least $_{2/32}$ of an inch when measured in a major tread groove. The measurement shall not be made where tie bars, humps or fillets are located.
vii See Attachment – Tire inflation data from MCI maintenance manual
viii See Attachment - Conflicting tire data from MCI maintenance manual
ix Text in bold is in error and provides inaccurate information regarding the accident model coach
x See Attachment – Photo right front tire/wheel after the accident, prior to removal
xi The term retread, refers to a used tire casing which has had new tread rubber applied to it.
xii Bandag, Incorporated, according to its website, www.bandag.com is proclaimed as the world leader in truck tire retreading, with additional services beyond tires aimed toward making fleets more efficient. Bandag serves fleets through almost 1,000 franchisees in nearly 100 different countries.
xiii CFR 49 Part 574.5 stipulates tire identification requirements for tire manufacturers including tire re-treaders. "Each tire re-treader, except tire re-treaders who retread tires solely for their own use, shall conspicuously label one sidewall of each tire it retreads by permanently molding or branding into or onto the sidewall, in the manner and location specified in Figure 2, a tire identification number containing the information set forth in paragraphs (a) through (d) of this section. However, at the option of the re-treader, the information set forth in paragraph (d) of this section may, instead of being permanently molded or branded, be laser etched into or onto the sidewall in the location specified in Figure 2, during the retreading of the tire and not later than 24 hours after the application of the new tread"
xiv See Attachment – Henise Tire Documents
xv See Attachment – Goodyear Tire Inspection Report
xvi See Attachment – Bridgestone Tire Inspection Report
xvii 6S/6M indicates the system was equipped with 6 wheel speed sensors and 6 ABS modulator valves.
xviii Brake adjustment inspection was conducted by the Texas Highway Patrol, Commercial Vehicle Enforcement Division. See Attached Texas Highway Patrol Vehicle Inspection Report
xix See Attachment - ABS ECU Data
xx See Attachment – Photo of Right Front Brake Drum
xxi See Attachment - Photo of Left Tag Axle Brake

[xxii] See Attachment – ixetic examination report
[xxiii] Coach weight was determined by weighing the wrecker with and without the recovered coach.
[xxiv] Tire load limit data obtained from the Tire and Rim Association, Inc. 2009 Yearbook.
[xxv] The Tire and Rim Association, Inc., Engineering Design Information, page 3-41, Rev.5, October 2006.
[xxvi] Data and photographs obtained from NHTSA's safercar.gov website
[xxvii] See Attachment – Photos of tires from Michelin tire inflation demonstration
[xxviii] Diffusion, as indicated on Bridgestone's website www.BridgeStone.com as the process of air molecules passing through or diffusing through the tire's sidewall.
[xxix] Section 13 of the "Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act" states that. Not later than 1 year after the date of the enactment of this Act, the Secretary of Transportation shall complete a rulemaking for a regulation to require a warning system in new motor vehicles to indicate to the operator when a tire is significantly under inflated. Such requirement shall become effective not later than 2 years after the date of the completion of such rulemaking.
[xxx] Federal Motor Carrier Safety Administration's, Task Order #5 *Commercial Vehicle Tire Condition Sensors*, United States Department of Transportation, Washington, DC, 2003
[xxxi] State of Texas "Rules and Regulations Manual" for the operation of Official Vehicle Inspection Stations Chapter 6 section 06:00:00 "Compulsory Inspection of Commercial Motor Vehicles" paragraph (3) states "A commercial motor vehicle required to be inspected under the Federal Motor Carrier Safety Regulations is also subject to the regular state inspection requirements set forth in Chapter 4 of this Rules and Regulations Manual."
[xxxii] Mileage obtained from start mileage for the date from the engine ECM
[xxxiii] See Attachment – July 31, 2008 State of Texas Commercial Vehicle Inspection Report
[xxxiv] See Attachment - Texas Department of Public Safety memo
[xxxv] See Attachment–Aug 7, 2008 State of Texas Commercial Vehicle Inspection Report
[xxxvi] See Attachment – Missouri Highway Patrol MCSAP Inspection Report