

STURAA TEST

12 YEAR

500,000 MILE BUS

from

MOTOR COACH INDUSTRIES

MODEL D4500

DECEMBER 2006

PTI-BT-R0610

PENNSSTATE



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EXECUTIVE SUMMARY

Motor Coach Industries submitted a model D4500, ultra low sulfur diesel-powered 58 seat (including the driver) 45-foot bus, for a 12 yr/500,000 mile STURAA test. Testing started on May 24, 2006 and was completed on December 7, 2006. The Check-In section of the report provides a description of the bus and specifies its major components.

The primary part of the test program is the Structural Durability Test, which also provides the information for the Maintainability and Reliability results. The Structural Durability Test was started on May 24, 2006 and was completed on November 20, 2006.

The interior of the bus is configured with seating for 58 passengers including the driver. Free floor space will accommodate 25 standing passengers resulting in a potential load of 83 persons. At 150 lbs per person, this load results in a measured gross vehicle weight of 49,200 lbs. In order to avoid exceeding the GAWR (22,500 lbs) of the rear axle and (12,000 lbs) of the tag axle, ballast for 4 standing passengers was eliminated. This reduction from full capacity resulted in an adjusted measured gross vehicle weight of 48,540 lbs and was used for all dynamic testing. The middle segment was performed at a SLW of 45,430 lbs and the final segment was performed at a CW of 37,000 lbs. Durability driving resulted in unscheduled maintenance and failures that involved a variety of subsystems. A description of failures, and a complete and detailed listing of scheduled and unscheduled maintenance is provided in the Maintainability section of this report.

Accessibility, in general, was adequate, components covered in Section 1.3 (Repair and/or Replacement of Selected Subsystems) along with all other components encountered during testing, were found to be readily accessible and no restrictions were noted.

The Reliability section compiles failures that occurred during Structural Durability Testing. Breakdowns are classified according to subsystems. The data in this section are arranged so that those subsystems with more frequent problems are apparent. The problems are also listed by class as defined in Section 2. The test bus encountered no Class 1 or Class 2 failures. Of the twenty-six reported failures, eighteen were Class 3 and eight were Class 4.

The Safety Test, (a double-lane change, obstacle avoidance test) was safely performed in both right-hand and left-hand directions up to a maximum test speed of 45 mph. The performance of the bus is illustrated by a speed vs. time plot. Acceleration and gradeability test data are provided in Section 4, Performance. The average time to obtain 50 mph was 28.06 seconds.

The Shakedown Test produced a maximum final loaded deflection of 0.142 inches with a permanent set ranging between -0.006 to 0.005 inches under a distributed static load of 31,125 lbs. The Distortion Test was completed with all subsystems, doors

and escape mechanisms operating properly. No water leakage was observed throughout the test. All subsystems operated properly.

The Static Towing Test was performed using a target load (towing force) of 58,752 lbs. All four front and rear pulls were completed to the full test load with no damage or deformation observed. The Dynamic Towing Test was performed by means of a front-lift tow. The towing interface was accomplished using a hydraulic under-lift wrecker. The bus was towed without incident and no damage resulted from the test. The manufacturer does not recommend towing the bus from the rear, therefore, a rear test was not performed. The Jacking and Hoisting Tests were also performed without incident. The bus was found to be stable on the jack stands, and the minimum jacking clearance observed with a tire deflated was 5.9 inches.

A Fuel Economy Test was run on simulated central business district, arterial, and commuter courses. The results were 2.84 mpg, 3.59 mpg, and 6.67 mpg respectively; with an overall average of 3.66 mpg.

A series of Interior and Exterior Noise Tests was performed. These data are listed in Section 7.1 and 7.2 respectively.

ABBREVIATIONS

ABTC	- Altoona Bus Test Center
A/C	- air conditioner
ADB	- advance design bus
ATA-MC	- The Maintenance Council of the American Trucking Association
CBD	- central business district
CW	- curb weight (bus weight including maximum fuel, oil, and coolant; but without passengers or driver)
dB(A)	- decibels with reference to 0.0002 microbar as measured on the "A" scale
DIR	- test director
DR	- bus driver
EPA	- Environmental Protection Agency
FFS	- free floor space (floor area available to standees, excluding ingress/egress areas, area under seats, area occupied by feet of seated passengers, and the vestibule area)
GVL	- gross vehicle load (150 lb for every designed passenger seating position, for the driver, and for each 1.5 sq ft of free floor space)
GVW	- gross vehicle weight (curb weight plus gross vehicle load)
GVWR	- gross vehicle weight rating
MECH	- bus mechanic
mpg	- miles per gallon
mph	- miles per hour
PM	- Preventive maintenance
PSBRTF	- Penn State Bus Research and Testing Facility
PTI	- Pennsylvania Transportation Institute
rpm	- revolutions per minute
SAE	- Society of Automotive Engineers
SCH	- test scheduler
SEC	- secretary
SLW	- seated load weight (curb weight plus 150 lb for every designed passenger seating position and for the driver)
STURAA	- Surface Transportation and Uniform Relocation Assistance Act
TD	- test driver
TECH	- test technician
TM	- track manager
TP	- test personnel

TEST BUS CHECK-IN

I. OBJECTIVE

The objective of this task is to log in the test bus, assign a bus number, complete the vehicle data form, and perform a safety check.

II. TEST DESCRIPTION

The test consists of assigning a bus test number to the bus, cleaning the bus, completing the vehicle data form, obtaining any special information and tools from the manufacturer, determining a testing schedule, performing an initial safety check, and performing the manufacturer's recommended preventive maintenance. The bus manufacturer must certify that the bus meets all Federal regulations.

III. DISCUSSION

The check-in procedure is used to identify in detail the major components and configuration of the bus.

The test bus consists of a Motor Coach Industries, model D4500. The bus has a front door, forward of the front axle, and a dedicated handicap entrance equipped with a Ricon model F9TFD-DE001 wheelchair lift located rear of the front door. Power is provided by a diesel-fueled, Caterpillar Inc. model C 13 ACERT engine coupled to a Allison model B500 transmission.

The measured curb weight is 10,220 lbs for the front axle, 17,580 lbs for the rear axle and 9,200 lbs for the tag axle. These combined weights provide a total measured curb weight of 37,000 lbs. There are 58 seats including the driver and room for 25 standing passengers bringing the total passenger capacity to 83. Gross load is calculated as $150 \text{ lb} \times 83 = 12,450 \text{ lbs}$. At full capacity, the measured gross vehicle weight is 49,200 lbs. This value was used for all static tests. In order to avoid exceeding the GAWR (22,500 lbs) of the rear axle and (12,000 lbs) of the tag axle, ballast for four standing passengers was eliminated. This reduction from full capacity resulted in an adjusted measured gross vehicle weight of 48,540 lbs and was used for all dynamic testing.

VEHICLE DATA FORM

Bus Number: 0610	Arrival Date: 6-5-06
Bus Manufacturer: Motor Coach Industries	Vehicle Identification Number (VIN): 1M8PDMDA26P057072
Model Number: D4500	Date: 6-5-06
Personnel: T.S. & S.C.	

WEIGHT: *Values in parenthesis indicate the adjusted weights necessary to avoid exceeding the GAWR. These values were used for all dynamic testing.

Individual Wheel Reactions:

Weights (lb)	Front Axle		Rear Axle		Tag Axle	
	Right	Left	Right	Left	Right	Left
CW	4,990	5,230	9,160	8,420	4,600	4,600
SLW	6,440	6,640	10,990	10,210	5,580	5,570
GVW	6,970 (7,000)	7,250 (7,270)	11,850 (11,640)	11,090 (10,870)	6,000 (5,870)	6,040 (5,890)

Total Weight Details:

Weight (lb)	CW	SLW	GVW	GAWR
Front Axle	10,220	13,080	14,220 (14,270)	16,000
Rear Axle	17,580	21,200	22,940 (22,510)	22,500
Tag Axle	9,200	11,150	12,040 (11,760)	12,000
Total	37,000	45,430	49,200 (48,540)	GVWR: 48,000

Dimensions:

Length (ft/in)	45 / 9.0
Width (in)	102.0
Height (in)	135.5
Front Overhang (in)	75.5
Rear Overhang (in)	106.0
Wheel Base (in)	Steering to drive: 318.0 Drive to tag: 49.5
Wheel Track (in)	Front: 85.7
	Rear: 75.6 Tag: 86.4

Bus Number: 0610	Date: 6-5-06
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CLEARANCES:

Lowest Point Outside Front Axle	Location: Skid plate Clearance(in): 7.5
Lowest Point Outside Rear Axle	Location: Frame Clearance(in): 8.0
Lowest Point between Axles	Location: Frame Clearance(in): 11.8
Ground Clearance at the center (in)	11.8
Front Approach Angle (deg)	9.3
Rear Approach Angle (deg)	6.6
Ramp Clearance Angle (deg)	4.2
Aisle Width (in)	14.88
Inside Standing Height at Center Aisle (in)	78.3

BODY DETAILS:

BODY DETAILS:			
Body Structural Type	Monocoque		
Frame Material	Carbon steel & stainless steel		
Body Material	Steel, fiberglass & aluminum		
Floor Material	Plywood		
Roof Material	Aluminum & fiberglass		
Windows Type	☒ Fixed	☐ Movable	
Window Mfg./Model No.	Atwood / Frameless		
Number of Doors	<u>1</u> Front	<u>1 w/c</u> Rear	
Mfr. / Model No.	MCI / Bi-Part Door		
Dimension of Each Door (in)	Front: 27.0 x 85.0	Rear: 36.0 x 65.5	
Passenger Seat Type	☐ Cantilever	☒ Pedestal	☐ Other (explain)
Mfr. / Model No.	American Seating Co. / W2095		
Driver Seat Type	☒ Air	☐ Spring	☐ Other (explain)
Mfr. / Model No.	Recaro / EGRO-METRO		
Number of Seats (including Driver)	58		

Bus Number: 0610	Date: 6-5-06
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BODY DETAILS (Contd..)

Free Floor Space (ft ²)	38.8
Height of Each Step at Normal Position (in)	Front 1. <u>15.6</u> 2. <u>9.7</u> 3. <u>9.4</u> 4. <u>9.7</u>
	Middle 1. <u>N/A</u> 2. <u>N/A</u> 3. <u>N/A</u> 4. <u>N/A</u>
	Rear 1. <u>N/A</u> 2. <u>N/A</u> 3. <u>N/A</u> 4. <u>N/A</u>
Step Elevation Change - Kneeling (in)	3.6

ENGINE

Type	☒ C.I. ☐ S.I.	☐ Alternate Fuel ☐ Other (explain)	
Mfr. / Model No.	Caterpillar Inc. / C13 ACERT 410 HP 1550 ft - lbs		
Location	☐ Front	☒ Rear	☐ Other (explain)
Fuel Type	☐ Gasoline ☒ Diesel Ultra Low Sulfur	☐ CNG ☐ LNG	☐ Methanol ☐ Other (explain)
Fuel Tank Capacity (indicate units)	192 gals		
Fuel Induction Type	☒ Injected	☐ Carburetion	
Fuel Injector Mfr. / Model No.	Caterpillar Inc. / C13 ACERT		
Carburetor Mfr. / Model No.	N/A		
Fuel Pump Mfr. / Model No.	Caterpillar Inc. / C13 ACERT		
Alternator (Generator) Mfr. / Model No.	Delco Remey / 50 DN		
Maximum Rated Output (Volts / Amps)	24 / 270		
Air Compressor Mfr. / Model No.	Caterpillar Inc. / 270		
Maximum Capacity (ft ³ / min)	10.5 @ 1800 @ 125 psi		
Starter Type	☒ Electrical	☐ Pneumatic	☐ Other (explain)
Starter Mfr. / Model No.	Mitsubishi / M009T82378		

Bus Number: 0610	Date: 6-5-06
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TRANSMISSION

Transmission Type	☐ Manual	☒ Automatic	
Mfr. / Model No.	Allison Transmission / B500R		
Control Type	☐ Mechanical	☒ Electrical	☐ Other
Torque Converter Mfr. / Model No.	Allison Transmission / TC 941B500		
Integral Retarder Mfr. / Model No.	Allison Transmission / B500R		

SUSPENSION

Number of Axles	3		
Front Axle Type	☐ Independent	☒ Beam Axle	
Mfr. / Model No.	Arvin Meritor / FH941KX3		
Axle Ratio (if driven)	N/A		
Suspension Type	☒ Air	☐ Spring	☐ Other (explain)
No. of Shock Absorbers	4		
Mfr. / Model No.	Gabriel / MCI #12L-5-58		
Middle Axle Type	☐ Independent	☒ Beam Axle	
Mfr. / Model No.	Arvin Meritor / RC23162NFKF63		
Axle Ratio (if driven)	4:56		
Suspension Type	☒ Air	☐ Spring	☐ Other (explain)
No. of Shock Absorbers	4		
Mfr. / Model No.	Gabriel / MCI #12L-5-89		
Rear Axle Type	☐ Independent	☒ Beam Axle	
Mfr. / Model No.	Arvin Meritor / FG952KX3		
Axle Ratio (if driven)	N/A		
Suspension Type	☒ Air	☐ Spring	☐ Other (explain)
No. of Shock Absorbers	2		
Mfr. / Model No.	Gabriel / MCI #12L-5-100		

Bus Number: 0610	Date: 6-5-06
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WHEELS & TIRES

Front	Wheel Mfr./ Model No.	Alcoa / 22.5 x 9
	Tire Mfr./ Model No.	Michelin XZA2 Energy / 315/80R 22.5
Rear	Wheel Mfr./ Model No.	Alcoa / 22.5 x 9
	Tire Mfr./ Model No.	Michelin XZA2 Energy / 315/80R 22.5

BRAKES

Front Axle Brakes Type	☐ Cam	☒ Disc	☐ Other (explain)
Mfr. / Model No.	Arvin Meritor / EX225		
Drive Axle Brakes Type	☐ Cam	☒ Disc	☐ Other (explain)
Mfr. / Model No.	Arvin Meritor / EX225		
Tag Axle Brakes Type	☐ Cam	☒ Disc	☐ Other (explain)
Mfr. / Model No.	Arvin Meritor / EX225		
Retarder Type	Integral Hydraulic		
Mfr. / Model No.	Allison Transmission / B500R		

HVAC

Heating System Type	☐ Air	☒ Water	☐ Other
Capacity (Btu/hr)	156,000 (under floor) 36,000 (driver's)		
Mfr. / Model No.	Carrier Transicold / Micromax		
Air Conditioner	☒ Yes	☐ No	
Location	Under floor mid under floor front compartment parcel rack (each side)		
Capacity (Btu/hr)	90,000 12,000 2 x 10,000		
A/C Compressor Mfr. / Model No.	Carrier Transicold / 05G		

STEERING

Steering Gear Box Type	Hydraulic gear
Mfr. / Model No.	Ross Gear Division / TRW TAS-85029A
Steering Wheel Diameter	20.0
Number of turns (lock to lock)	5.75

Bus Number: 0610	Date: 6-5-06
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OTHERS

Wheel Chair Ramps	Location: N/A	Type: N/A
Wheel Chair Lifts	Location: Right middle	Type: Hydraulic platform
Mfr. / Model No.	Ricon / F9TF-DE001	
Emergency Exit	Location: Window Door Roof hatch	Number: 16 1 2

CAPACITIES

Fuel Tank Capacity (units)	192 gals
Engine Crankcase Capacity (gallons)	4.5
Transmission Capacity (gallons)	6.25
Differential Capacity (gallons)	4.0
Cooling System Capacity (quarts)	32.5
Power Steering Fluid Capacity (gallons)	2.0

VEHICLE DATA FORM

Bus Number: 0610	Date: 5-30-06
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List all spare parts, tools and manuals delivered with the bus.

Part Number	Description	Qty.
Michelin XZA2	Tires	2
H4651	Headlamp	1
H4656 LL	Headlamp	1
T08-1075	Engine oil filter	1
253-4011	Engine belt	1
8L-27-157	Engine belt	1
8L-27-163	Engine belt	1
1076, 820, 1157, 768, 74	Misc. light bulbs	32
90724	Relay	1
6000 Push-Tite	Coupler	1
8L-27-157	Belt	1
12L-1-140S/A	Air bellows	1
12L-1-215S/A	Air bellows	1
12L-5-67	Shock absorber	3
12L-5-88	Shock absorber	8
12L-5-114	Shock absorber	3
12L-5-95	Sway bars	3
12L-1-219	Air bellows support	1
1R-1808	Engine oil filter	2
12L-5-73	Nuts	24
19-3-78	Lock nuts	4
19-3-152	Lock nuts	2
19-03-064	Castle nuts	12
19-1-1401	Bolts	24

VEHICLE DATA FORM
Cont.

Bus Number: 0610	Date: 5-30-06
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List all spare parts, tools and manuals delivered with the bus.

Part Number	Description	Qty.
19-2-10	Washers	10
19-03-0548	Flange nuts	2
19-03-188	Lock nuts	6
n/a	Surge tank mounts	1
n/a	Sway bar links	6
12L-5-66	Sway bar brackets	12
12L-3-124	Sway bar bushings	12

COMPONENT/SUBSYSTEM INSPECTION FORM

Bus Number: 0610	Date: 6-5-06
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Subsystem	Checked	Comments
Air Conditioning Heating and Ventilation		
Body and Sheet Metal		
Frame		
Steering		
Suspension		
Interior/Seating		
Axles		
Brakes		
Tires/Wheels		
Exhaust		
Fuel System		Ultra Low Sulfur.
Power Plant		
Accessories		
Lift System		
Interior Fasteners		
Batteries		

CHECK - IN



MOTOR COACH INDUSTRIES MODEL D4500



CHECK - IN CONT.



**MOTOR COACH INDUSTRIES
MODEL D4500 EQUIPPED WITH A RICON
MODEL F9TF-DE001 HANDICAP LIFT**

1. MAINTAINABILITY

1.1 ACCESSIBILITY OF COMPONENTS AND SUBSYSTEMS

1.1-I. TEST OBJECTIVE

The objective of this test is to check the accessibility of components and subsystems.

1.1-II. TEST DESCRIPTION

Accessibility of components and subsystems is checked, and where accessibility is restricted the subsystem is noted along with the reason for the restriction.

1.1-III. DISCUSSION

Accessibility, in general, was adequate. Components covered in Section 1.3 (repair and/or replacement of selected subsystems), along with all other components encountered during testing, were found to be readily accessible and no restrictions were noted.

ACCESSIBILITY DATA FORM

Bus Number: 0610	Date: 12-1-06
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Component	Checked	Comments
ENGINE :		
Oil Dipstick		
Oil Filler Hole		
Oil Drain Plug		
Oil Filter		
Fuel Filter		
Air Filter		
Belts		
Coolant Level		
Coolant Filler Hole		
Coolant Drain		
Spark / Glow Plugs		
Alternator		
Diagnostic Interface Connector		
TRANSMISSION :		
Fluid Dip-Stick		
Filler Hole		Fill through dip tube.
Drain Plug		
SUSPENSION :		
Bushings		
Shock Absorbers		
Air Springs		
Leveling Valves		
Grease Fittings		

ACCESSIBILITY DATA FORM

Bus Number: 0610	Date: 12-1-06
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Component	Checked	Comments
HVAC :		
A/C Compressor		
Filters		
Fans		
ELECTRICAL SYSTEM :		
Fuses		
Batteries		
Voltage regulator		
Voltage Converters		
Lighting		
MISCELLANEOUS :		
Brakes		
Handicap Lifts/Ramps		
Instruments		
Axles		
Exhaust		
Fuel System		
OTHERS :		

1.2 SERVICING, PREVENTIVE MAINTENANCE, AND REPAIR AND MAINTENANCE DURING TESTING

1.2-I. TEST OBJECTIVE

The objective of this test is to collect maintenance data about the servicing, preventive maintenance, and repair.

1.2.-II. TEST DESCRIPTION

The test will be conducted by operating the NBM and collecting the following data on work order forms and a driver log.

1. Unscheduled Maintenance
 - a. Bus number
 - b. Date
 - c. Mileage
 - d. Description of malfunction
 - e. Location of malfunction (e.g., in service or undergoing inspection)
 - f. Repair action and parts used
 - g. Man-hours required
2. Scheduled Maintenance
 - a. Bus number
 - b. Date
 - c. Mileage
 - d. Engine running time (if available)
 - e. Results of scheduled inspections
 - f. Description of malfunction (if any)
 - g. Repair action and parts used (if any)
 - h. Man-hours required

The buses will be operated in accelerated durability service. While typical items are given below, the specific service schedule will be that specified by the manufacturer.

- A. Service
 1. Fueling
 2. Consumable checks
 3. Interior cleaning
- B. Preventive Maintenance
 4. Brake adjustments
 5. Lubrication
 6. 3,000 mi (or equivalent) inspection

7. Oil and filter change inspection
8. Major inspection
9. Tune-up

C. Periodic Repairs

1. Brake reline
2. Transmission change
3. Engine change
4. Windshield wiper motor change
5. Stoplight bulb change
6. Towing operations
7. Hoisting operations

1.2-III. DISCUSSION

Servicing and preventive maintenance were performed at manufacturer-specified intervals. The following Scheduled Maintenance Form lists the mileage, items serviced, the service interval, and amount of time required to perform the maintenance. Table 1 is a list of the lubricating products used in servicing. Finally, the Unscheduled Maintenance List along with Unscheduled Maintenance-related photographs is included in Section 5.7, Structural Durability. This list supplies information related to failures that occurred during the durability portion of testing. The Unscheduled Maintenance List includes the date and mileage at which the malfunction occurred, a description of the malfunction and repair, and the time required to perform the repair.

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SCHEDULED MAINTENANCE
MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
06-23-06	189	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed. Oil changed. Oil, fuel, and air filters changed. Transmission oil and filter changed.	8.00	8.00
07-05-06	1,151	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
07-13-06	2,329	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
08-02-06	3,543	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
08-28-06	5,136	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
09-05-06	5,463	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
09-15-06	6,363	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
09-20-06	7,947	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00

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SCHEDULED MAINTENANCE
MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
09-26-06	8,885	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-06-06	9,932	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-16-06	10,728	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-23-06	11,876	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-24-06	12,110	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-31-06	13,070	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00

(Page 3 of 3)
SCHEDULED MAINTENANCE
MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
11-09-06	14,211	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
11-20-06	15,000	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00

Table 1. STANDARD LUBRICANTS

The following is a list of Texaco lubricant products used in bus testing conducted by the Penn State University Altoona Bus Testing Center:

<u>ITEM</u>	<u>PRODUCT CODE</u>	<u>TEXACO DESCRIPTION</u>
Engine oil		15W – 40 CJ4 (Low Ash)
Transmission oil		Automatic Trans Fluid Transynd
Gear oil	#2316	Multigear Lubricant EP SAE 80W90
Wheel bearing & Chassis grease	#1935	Starplex II

1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS

1.3-I. TEST OBJECTIVE

The objective of this test is to establish the time required to replace and/or repair selected subsystems.

1.3-II. TEST DESCRIPTION

The test will involve components that may be expected to fail or require replacement during the service life of the bus. In addition, any component that fails during the NBM testing is added to this list. Components to be included are:

1. Transmission
2. Alternator
3. Starter
4. Batteries
5. Windshield wiper motor

1.3-III. DISCUSSION

During the test, several additional components were removed for repair or replacement. Following is a list of components and total repair/replacement time.

	<u>MAN HOURS</u>
Drive axle pressure relief plug.	0.25
Alternator generator oil seal.	2.5
Coolant surge tank.	1.5
Front sway bar.	0.5
A/C belt.	0.5
Front axle wheel hub gaskets.	1.5
Tag axle tire.	0.25
Both front sway bar links.	1.0
2 ½" flex exhaust pipe.	1.0
Right front forward shock.	0.5

At the end of the test, the remaining items on the list were removed and replaced. The transmission assembly took 9.0 man-hours (two men 4.5 hrs) to remove and replace. The time required for repair/replacement of the four remaining components is given on the following Repair and/or Replacement Form.

REPLACEMENT AND/OR REPAIR FORM

Subsystem	Replacement Time
Transmission	9.00 man hours
Wiper Motor	0.50 man hours
Starter	0.50 man hours
Alternator	0.50 man hours
Batteries	0.50 man hours

1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS



TRANSMISSION REMOVAL AND REPLACEMENT (9.00 MAN HOURS)



WIPER MOTOR REMOVAL AND REPLACEMENT (0.50 MAN HOURS)

1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS CONT.



**STARTER REMOVAL AND REPLACEMENT
(0.5 MAN HOURS)**



**ALTERNATOR/GENERATOR REMOVAL AND
REPLACEMENT
(1.00 MAN HOURS)**

2. RELIABILITY - DOCUMENTATION OF BREAKDOWN AND REPAIR TIMES DURING TESTING

2-I. TEST OBJECTIVE

The objective of this test is to document unscheduled breakdowns, repairs, down time, and repair time that occur during testing.

2-II. TEST DESCRIPTION

Using the driver log and unscheduled work order forms, all significant breakdowns, repairs, man-hours to repair, and hours out of service are recorded on the Reliability Data Form.

CLASS OF FAILURES

Classes of failures are described below:

- (a) Class 1: Physical Safety. A failure that could lead directly to passenger or driver injury and represents a severe crash situation.
- (b) Class 2: Road Call. A failure resulting in an en route interruption of revenue service. Service is discontinued until the bus is replaced or repaired at the point of failure.
- (c) Class 3: Bus Change. A failure that requires removal of the bus from service during its assignments. The bus is operable to a rendezvous point with a replacement bus.
- (d) Class 4: Bad Order. A failure that does not require removal of the bus from service during its assignments but does degrade coach operation. The failure shall be reported by driver, inspector, or hostler.

2-III. DISCUSSION

A listing of breakdowns and unscheduled repairs is accumulated during the Structural Durability Test. The following Reliability Data Form lists all unscheduled repairs under classes as defined above. These classifications are somewhat subjective as the test is performed on a test track with careful inspections every two hours. However, even on the road, there is considerable latitude on deciding how to handle many failures.

The Unscheduled Repair List is also attached to provide a reference for the repairs that are included in the Reliability Data Forms.

The classification of repairs according to subsystem is intended to emphasize those systems which had persistent minor or more serious problems. There were no Class 1 or 2 failures. Of the 18 Class 3 failures, seven involved the engine/transmission, six occurred with the suspension system, two each with the axles and exhaust system and one with tires. These, and the remaining eight Class 4 failures are available for review in the Unscheduled Maintenance List, located in Section 5.7 Structural Durability.

RELIABILITY DATA FORMS

Bus Number: 0610				Date: 11-14-06		
Personnel: Bob Reifsteck						
	Failure Type					
	Class 4 Bad	Class 3 Bus	Class 2	Class 1		
	Order	Change	Road Call	Physical Safety		
Subsystems	Mileage	Mileage	Mileage	Mileage	Man Hours	Down Time
Engine/Transmission	857				0.25	0.25
		857			0.50	1.00
		1,151			3.00	72.00
		2,329			4.00	48.00
		3,226			2.50	80.00
	4,099				1.50	16.00
		5,463			2.00	88.00
		6,363			1.00	1.00
		8,976			2.50	8.50
	10,728				2.50	2.50
Suspension		2,329			1.50	4.00
		5,124			0.50	17.50
		7,734			0.50	0.50
		8,319			1.00	7.00
		12,119			1.00	1.00
		13,040			0.50	8.00
Tires		7,734			0.25	7.00
	7,947				1.50	1.50
	10,728				1.50	1.50

RELIABILITY DATA FORMS

Bus Number: 0610				Date: 11-14-06		
Personnel: Bob Reifsteck						

	Failure Type					
	Class 4 Bad	Class 3 Bus	Class 2	Class 1		
	Order	Change	Road Call	Physical Safety		

Subsystems	Mileage	Mileage	Mileage	Mileage	Man Hours	Down Time
Axles		857			0.25	4.00
		6,363			1.50	16.00
Air conditioning	3,226				6.00	80.00
	5,463				0.50	0.50
Exhaust System		9,944			1.00	5.00
		12,119			1.00	1.00
Doors	857				1.00	1.00

3. SAFETY - A DOUBLE-LANE CHANGE (OBSTACLE AVOIDANCE)

3-I. TEST OBJECTIVE

The objective of this test is to determine handling and stability of the bus by measuring speed through a double lane change test.

3-II. TEST DESCRIPTION

The Safety Test is a vehicle handling and stability test. The bus will be operated at SLW on a smooth and level test track. The bus will be driven through a double lane change course at increasing speed until the test is considered unsafe or a speed of 45 mph is reached. The lane change course will be set up using pylons to mark off two 12 foot center to center lanes with two 100 foot lane change areas 100 feet apart. The bus will begin in one lane, change to the other lane in a 100 foot span, travel 100 feet, and return to the original lane in another 100 foot span. This procedure will be repeated, starting first in the right-hand and then in the left-hand lane.

3-III. DISCUSSION

The double-lane change was performed in both right-hand and left-hand directions. The bus was able to safely negotiate the test course in both the right-hand and left-hand directions up to the maximum test speed of 45 mph.

SAFETY DATA FORM

Bus Number: 0610	Date: 6-20-06
Personnel: B.S., T.S. & S.C.	

Temperature (°F): 72	Humidity (%): 56
Wind Direction: W	Wind Speed (mph): 8
Barometric Pressure (in.Hg): 29.97	

SAFETY TEST: DOUBLE LANE CHANGE	
Maximum safe speed tested for double-lane change to left	45 mph
Maximum safe speed tested for double-lane change to right	45 mph
Comments of the position of the bus during the lane change: A safe profile was maintained through all portions of testing.	
Comments of the tire/ground contact patch: Tire/ground contact was maintained through all portions of testing.	

3. SAFETY



RIGHT - HAND APPROACH



LEFT - HAND APPROACH

4. PERFORMANCE - AN ACCELERATION, GRADEABILITY, AND TOP SPEED TEST

4-I. TEST OBJECTIVE

The objective of this test is to determine the acceleration, gradeability, and top speed capabilities of the bus.

4-II. TEST DESCRIPTION

In this test, the bus will be operated at SLW on the skid pad at the PSBRTF. The bus will be accelerated at full throttle from a standstill to a maximum "geared" or "safe" speed as determined by the test driver. The vehicle speed is measured using a Correvit non-contacting speed sensor. The times to reach speed between ten mile per hour increments are measured and recorded using a stopwatch with a lap timer. The time to speed data will be recorded on the Performance Data Form and later used to generate a speed vs. time plot and gradeability calculations.

4-III. DISCUSSION

This test consists of three runs in both the clockwise and counterclockwise directions on the Test Track. Velocity versus time data is obtained for each run and results are averaged together to minimize any test variability which might be introduced by wind or other external factors. The test was performed up to a maximum speed of 50 mph. The fitted curve of velocity vs. time is attached, followed by the calculated gradeability results. The average time to obtain 50 mph was 28.06 seconds.

PERFORMANCE DATA FORM

Bus Number: 0610	Date: 6-20-06
Personnel: B.S., T.S. & S.C.	

Temperature (°F): 72	Humidity (%): 56
Wind Direction: W	Wind Speed (mph): 8
Barometric Pressure (in.Hg): 29.97	

Air Conditioning compressor-OFF	☐ Checked
Ventilation fans-ON HIGH	☐ Checked
Heater pump motor-Off	☐ Checked
Defroster-OFF	☐ Checked
Exterior and interior lights-ON	☐ Checked
Windows and doors-CLOSED	☐ Checked

ACCELERATION, GRADEABILITY, TOP SPEED

Counter Clockwise Recorded Interval Times			
Speed	Run 1	Run 2	Run 3
10 mph	3.89	3.76	3.54
20 mph	7.42	9.20	7.01
30 mph	12.02	11.83	11.92
40 mph	20.02	19.26	19.26
Top Test Speed(mph) 50	29.36	28.58	29.01
Clockwise Recorded Interval Times			
Speed	Run 1	Run 2	Run 3
10 mph	3.79	3.55	3.42
20 mph	6.91	6.83	6.67
30 mph	11.32	10.89	10.76
40 mph	19.04	17.70	17.42

Top Test Speed(mph) 50	28.10	26.53	26.76
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PERFORMANCE SUMMARY SHEET

BUS MANUFACTURER :MCI
BUS MODEL :D4500

BUS NUMBER :0610
TEST DATE :6/20/06

TEST CONDITIONS :

TEMPERATURE (DEG F) : 72.0
WIND DIRECTION : W
WIND SPEED (MPH) : 8.0
HUMIDITY (%) : 56
BAROMETRIC PRESSURE (IN. HG) : 30.0

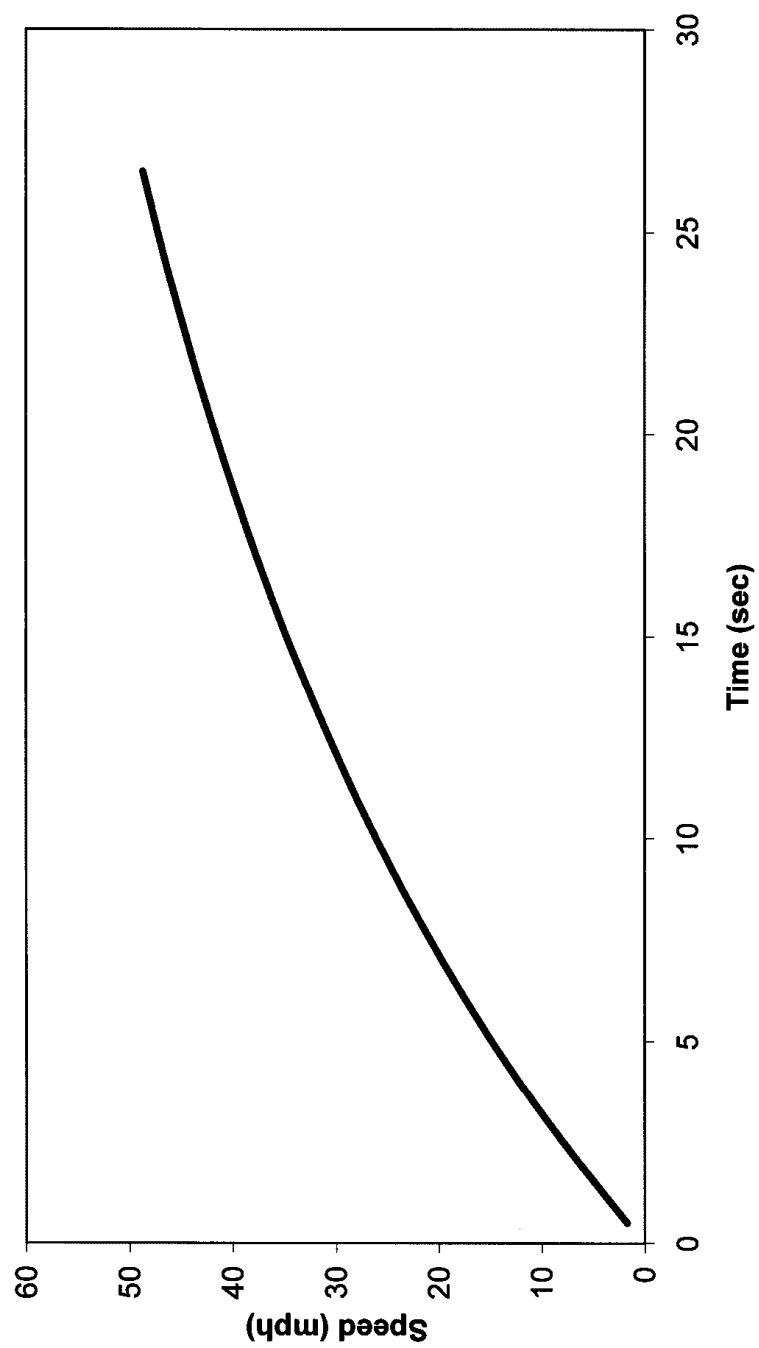
VEHICLE SPEED (MPH)	AVERAGE TIME (SEC)		
	CCW DIRECTION	CW DIRECTION	TOTAL
10.0	3.73	3.59	3.66
20.0	7.88	6.80	7.34
30.0	11.92	10.99	11.46
40.0	19.51	18.05	18.78
50.0	28.98	27.13	28.06

TEST SUMMARY :

VEHICLE SPEED (MPH)	TIME (SEC)	ACCELERATION (FT/SEC^2)	MAX. GRADE (%)
1.0	.30	4.9	15.5
5.0	1.53	4.6	14.4
10.0	3.20	4.2	13.1
15.0	5.06	3.8	11.7
20.0	7.13	3.3	10.5
25.0	9.46	3.0	9.2
30.0	12.10	2.6	8.1
35.0	15.15	2.2	7.0
40.0	18.70	1.9	5.9
45.0	22.89	1.6	5.0
50.0	27.95	1.3	4.1

NOTE : Gradeability results were calculated from performance test data. Actual sustained gradeability performance for vehicles equipped with auto transmission may be lower than the values indicated here.

Velocity vs. Time
MCI #0610



5. STRUCTURAL INTEGRITY

5.1 STRUCTURAL STRENGTH AND DISTORTION TESTS - STRUCTURAL SHAKEDOWN TEST

5.1-I. DISCUSSION

The objective of this test is to determine certain static characteristics (e.g., bus floor deflection, permanent structural deformation, etc.) under static loading conditions.

5.1-II. TEST DESCRIPTION

In this test, the bus will be isolated from the suspension by blocking the vehicle under the suspension points. The bus will then be loaded and unloaded up to a maximum of three times with a distributed load equal to 2.5 times gross load. Gross load is 150 lb for every designed passenger seating position, for the driver, and for each 1.5 sq ft of free floor space. For a distributed load equal to 2.5 times gross load, place a 375-lb load on each seat and on every 1.5 sq ft of free floor space. The first loading and unloading sequence will "settle" the structure. Bus deflection will be measured at several locations during the loading sequences.

5.1-III. DISCUSSION

This test was performed based on a maximum passenger capacity of 83 people including the driver. The resulting test load is $(83 \times 375 \text{ lb}) = 31,125 \text{ lb}$. The load is distributed evenly over the passenger space. Deflection data before and after each loading and unloading sequence is provided on the Structural Shakedown Data Form.

The unloaded height after each test becomes the original height for the next test. Some initial settling is expected due to undercoat compression, etc. After each loading cycle, the deflection of each reference point is determined. The bus is then unloaded and the residual (permanent) deflection is recorded. On the final test, the maximum loaded deflection was 0.142 inches at reference point 10. The maximum permanent deflection after the final loading sequence ranged from -0.006 inches at reference point 6 to 0.005 inches at reference point 12.

STRUCTURAL SHAKEDOWN DATA FORM

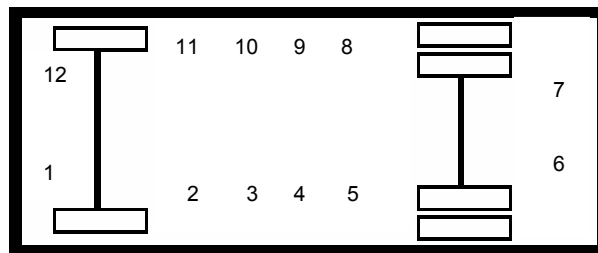
Bus Number: 0610	Date: 6-14-06
Personnel: T.S., S.C., E.L., G.P. & D.V.	Temperature (°F): 71
Loading Sequence: ☒ 1 ☐ 2 ☐ 3 (check one)	
Test Load (lbs): 31,125	

Indicate Approximate Location of Each Reference Point

Right

Front
of
Bus

Left



Top View

Reference Point No.	A (in) Original Height	B (in) Loaded Height	B-A (in) Loaded Deflection	C (in) Unloaded Height	C-A (in) Permanent Deflection
1	0	-.018	-.018	-.005	-.005
2	0	.084	.084	.014	.014
3	0	.121	.121	.016	.016
4	0	.114	.114	.015	.015
5	0	.062	.062	.010	.010
6	0	.043	.043	.016	.016
7	0	.022	.022	.013	.013
8	0	.073	.073	.013	.013
9	0	.135	.135	.028	.028
10	0	.164	.164	.038	.038
11	0	.132	.132	.038	.038
12	0	.014	.014	.022	.022

STRUCTURAL SHAKEDOWN DATA FORM

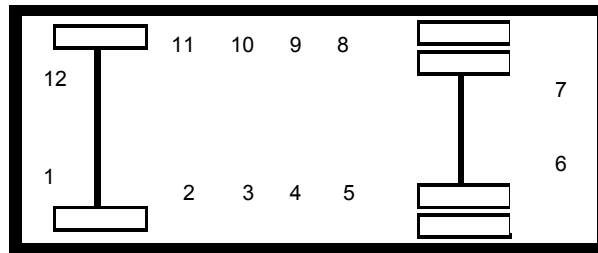
Bus Number: 0610	Date: 6-15-06
Personnel: S.C., E.L., G.P. & D.V.	Temperature (°F):
Loading Sequence: ☐ 1 ☒ 2 ☐ 3 (check one)	
Test Load (lbs): 31,125	

Indicate Approximate Location of Each Reference Point

Right

Front
of
Bus

Left



Top View

Reference Point No.	A (in) Original Height	B (in) Loaded Height	B-A (in) Loaded Deflection	C (in) Unloaded Height	C-A (in) Permanent Deflection
1	-.005	-.018	.013	-.003	.002
2	.014	.089	.075	.012	-.002
3	.016	.126	.110	.014	-.002
4	.015	.118	.103	.015	.000
5	.010	.064	.054	.011	.001
6	.016	.043	.027	.010	-.006
7	.013	.020	.007	.012	-.001
8	.013	.074	.061	.011	-.002
9	.028	.133	.105	.025	-.003
10	.038	.180	.142	.036	-.002
11	.038	.137	.099	.037	-.001
12	.022	.014	-.008	.027	.005

5.1 STRUCTURAL SHAKEDOWN TEST



DIAL INDICATORS IN POSITION



**BUS LOADED TO 2.5 TIMES GVL
(31,125 LBS)**

5.2 STRUCTURAL STRENGTH AND DISTORTION TESTS - STRUCTURAL DISTORTION

5.2-I. TEST OBJECTIVE

The objective of this test is to observe the operation of the bus subsystems when the bus is placed in a longitudinal twist simulating operation over a curb or through a pothole.

5.2-II. TEST DESCRIPTION

With the bus loaded to GVWR, each wheel of the bus will be raised (one at a time) to simulate operation over a curb and the following will be inspected:

1. Body
2. Windows
3. Doors
4. Roof vents
5. Special seating
6. Undercarriage
7. Engine
8. Service doors
9. Escape hatches
10. Steering mechanism

Each wheel will then be lowered (one at a time) to simulate operation through a pothole and the same items inspected.

5.2-III. DISCUSSION

The test sequence was repeated ten times. The first and last test is with all wheels level. The other twelve tests are with each wheel 6 inches higher and 6 inches lower than the other three wheels.

All doors, windows, escape mechanisms, engine, steering and handicapped devices operated normally throughout the test. The undercarriage and body indicated no deficiencies. No water leakage was observed during the test. The results of this test are indicated on the following data forms.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☒ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
☒ Windows	No deficiencies.
☒ Front Doors	No deficiencies.
☒ Rear Doors	No deficiencies.
☒ Escape Mechanisms/ Roof Vents	No deficiencies.
☒ Engine	No deficiencies.
☒ Handicapped Device/ Special Seating	No deficiencies.
☒ Undercarriage	No deficiencies.
☒ Service Doors	No deficiencies.
☒ Body	No deficiencies.
☒ Windows/ Body Leakage	No deficiencies.
☒ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☒ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☒ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☒ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☒ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☒ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☒ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☒ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☒ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☒ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☒ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☒ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☐ after
Left front	☐ 6 in higher	☒ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
■ Windows	No deficiencies.
■ Front Doors	No deficiencies.
■ Rear Doors	No deficiencies.
■ Escape Mechanisms/ Roof Vents	No deficiencies.
■ Engine	No deficiencies.
■ Handicapped Device/ Special Seating	No deficiencies.
■ Undercarriage	No deficiencies.
■ Service Doors	No deficiencies.
■ Body	No deficiencies.
■ Windows/ Body Leakage	No deficiencies.
■ Steering Mechanism	No deficiencies.

DISTORTION TEST INSPECTION FORM
(Note: Ten copies of this data sheet are required)

Bus Number: 0610	Date: 7-5-06
Personnel: B.S., T.S., G.P., A.V. & S.C.	Temperature(°F):

Wheel Position : (check one)		
All wheels level	☐ before	☒ after
Left front	☐ 6 in higher	☐ 6 in lower
Right front	☐ 6 in higher	☐ 6 in lower
Right rear	☐ 6 in higher	☐ 6 in lower
Left rear	☐ 6 in higher	☐ 6 in lower
Right tag	☐ 6 in higher	☐ 6 in lower
Left tag	☐ 6 in higher	☐ 6 in lower

	Comments
☒ Windows	No deficiencies.
☒ Front Doors	No deficiencies.
☒ Rear Doors	No deficiencies.
☒ Escape Mechanisms/ Roof Vents	No deficiencies.
☒ Engine	No deficiencies.
☒ Handicapped Device/ Special Seating	No deficiencies.
☒ Undercarriage	No deficiencies.
☒ Service Doors	No deficiencies.
☒ Body	No deficiencies.
☒ Windows/ Body Leakage	No deficiencies.
☒ Steering Mechanism	No deficiencies.

5.2 STRUCTURAL DISTORTION TEST



RIGHT FRONT WHEEL SIX INCHES HIGHER



RIGHT REAR WHEEL SIX INCHES HIGHER

5.3 STRUCTURAL STRENGTH AND DISTORTION TESTS - STATIC TOWING TEST

5.3-I. TEST OBJECTIVE

The objective of this test is to determine the characteristics of the bus towing mechanisms under static loading conditions.

5.3-II. TEST DESCRIPTION

Utilizing a load-distributing yoke, a hydraulic cylinder is used to apply a static tension load equal to 1.2 times the bus curb weight. The load will be applied to both the front and rear, if applicable, towing fixtures at an angle of 20 degrees with the longitudinal axis of the bus, first to one side then the other in the horizontal plane, and then upward and downward in the vertical plane. Any permanent deformation or damage to the tow eyes or adjoining structure will be recorded.

5.3-III. DISCUSSION

The load-distributing yoke was incorporated as the interface between the Static Tow apparatus and the test bus tow hook/eyes. The test was performed to the full target test weight of 58,752 lbs (1.2 x 48,960 lbs CW). No damage or deformation was observed during all four front, and rear pulls of the test.

STATIC TOWING TEST DATA FORM

Bus Number: 0610	Date: 12-5-06
Personnel: T.S., S.C. & T.W.	Temperature (°F): 30

Inspect right front tow eye and adjoining structure.
Comments: No damage or deformation observed.
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: All torques verified.
Inspect left tow eye and adjoining structure.
Comments: No damage or deformation observed.
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: All torques verified.
Inspect right rear tow eye and adjoining structure.
Comments: No damage or deformation observed.
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: All torques verified.
Inspect left rear tow eye and adjoining structure.
Comments: No damage or deformation observed.
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments: All torques verified.
General comments of any other structure deformation or failure: None noted.

5.3 STATIC TOWING TEST



FRONT 20° UPWARD PULL



FRONT 20° LEFT PULL

5.3 STATIC TOWING TEST CONT.



REAR 20° DOWN PULL



**REAR 20° LEFT PULL
TEST TERMINATED AT APPROXIMATELY 9,000 LBS
WHEN THE REAR BUMPER ASSEMBLY DEFORMED
UPWARD**

5.4 STRUCTURAL STRENGTH AND DISTORTION TESTS - DYNAMIC TOWING TEST

5.4-I. TEST OBJECTIVE

The objective of this test is to verify the integrity of the towing fixtures and determine the feasibility of towing the bus under manufacturer specified procedures.

5.4-II. TEST DESCRIPTION

This test requires the bus be towed at curb weight using the specified equipment and instructions provided by the manufacturer and a heavy-duty wrecker. The bus will be towed for 5 miles at a speed of 20 mph for each recommended towing configuration. After releasing the bus from the wrecker, the bus will be visually inspected for any structural damage or permanent deformation. All doors, windows and passenger escape mechanisms will be inspected for proper operation.

5.4-III. DISCUSSION

The bus was towed using a heavy-duty wrecker. The towing interface was accomplished by incorporating a hydraulic under lift. A front lift tow was performed. Rear towing is not recommended. No problems, deformation, or damage was noted during testing. Caution was taken not to damage the sir dryer located directly above and forward of the front axle.

DYNAMIC TOWING TEST DATA FORM

Bus Number: 0610	Date: 11-15-06
Personnel: S.C. & T.S.	

Temperature (°F): 45	Humidity (%): 88
Wind Direction: SW	Wind Speed (mph): 5
Barometric Pressure (in.Hg): 29.97	

Inspect tow equipment-bus interface.
Comments: A safe and adequate connection was made between the tow equipment and the bus.
Inspect tow equipment-wrecker interface.
Comments: A safe and adequate connection was made between the tow equipment and the wrecker.
Towing Comments: A front lift tow was performed incorporating a hydraulic under lift wrecker.
Description and location of any structural damage: No damage or deformation observed.
General Comments: Caution was taken not to damage the sir dryer located directly above and forward of the front axle.

5.4 DYNAMIC TOWING TEST



TOWING INTERFACE



TEST BUS IN TOW

5.5 STRUCTURAL STRENGTH AND DISTORTION TESTS – JACKING TEST

5.5-I. TEST OBJECTIVE

The objective of this test is to inspect for damage due to the deflated tire, and determine the feasibility of jacking the bus with a portable hydraulic jack to a height sufficient to replace a deflated tire.

5.5-II. TEST DESCRIPTION

With the bus at curb weight, the tire(s) at one corner of the bus are replaced with deflated tire(s) of the appropriate type. A portable hydraulic floor jack is then positioned in a manner and location specified by the manufacturer and used to raise the bus to a height sufficient to provide 3-in clearance between the floor and an inflated tire. The deflated tire(s) are replaced with the original tire(s) and the hack is lowered. Any structural damage or permanent deformation is recorded on the test data sheet. This procedure is repeated for each corner of the bus.

5.5-III. DISCUSSION

The jack used for this test has a minimum height of 8.75 inches. During the deflated portion of the test, the jacking point clearances ranged from 5.9 inches to 12.4 inches. No deformation or damage was observed during testing. A complete listing of jacking point clearances is provided in the Jacking Test Data Form.

JACKING CLEARANCE SUMMARY

Condition	Frame Point Clearance
Front axle – one tire flat	6.7"
Rear axle – one tire flat	9.9"
Rear axle – two tires flat	8.9"
Tag axle	9.5"

JACKING TEST DATA FORM

Bus Number: 0610	Date: 6-5-06
Personnel: S.C. & D.V.	Temperature (°F): 69

Record any permanent deformation or damage to bus as well as any difficulty encountered during jacking procedure.

Deflated Tire	Jacking Pad Clearance Body/Frame (in)	Jacking Pad Clearance Axle/Suspension (in)	Comments
Right front	9.2 " I 6.7 " D	12.1 " I 8.8 " D	
Left front	9.0 " I 6.8 " D	12.1 " I 8.7 " D	
Right rear—outside	10.3 " I 9.9 " D	13.0 " I 12.4 " D	
Right rear—both	10.3 " I 8.9 " D	13.0 " I 11.3 " D	
Left rear—outside	10.2 " I 9.9 " D	13.0 " I 12.5 " D	
Left rear—both	10.2 " I 9.0 " D	13.0 " I 11.5 " D	
Right tag	10.3" I 9.5" D	7.5" I 5.9" D	
Right middle or tag—both	NA	NA	
Left tag	10.2" I 10.2" D	7.5" I 7.5" D	
Left middle or tag—both	NA	NA	
Additional comments of any deformation or difficulty during jacking:			

5.6 STRUCTURAL STRENGTH AND DISTORTION TESTS - HOISTING TEST

5.6-I. TEST OBJECTIVE

The objective of this test is to determine possible damage or deformation caused by the jack/stands.

5.6-II. TEST DESCRIPTION

With the bus at curb weight, the front end of the bus is raised to a height sufficient to allow manufacturer-specified placement of jack stands under the axles or jacking pads independent of the hoist system. The bus will be checked for stability on the jack stands and for any damage to the jacking pads or bulkheads. The procedure is repeated for the rear end of the bus. The procedure is then repeated for the front and rear simultaneously.

5.6-III. DISCUSSION

The test was conducted using four posts of a six-post electric lift and standard 19 inch jack stands. The bus was hoisted from the front wheel, rear wheel, and then the front and rear wheels simultaneously and placed on jack stands.

The bus easily accommodated the placement of the vehicle lifts and jack stands and the procedure was performed without any instability noted.

HOISTING TEST DATA FORM

Bus Number: 0610	Date: 6-8-06
Personnel: T.S. & S.C.	Temperature (°F): 73

Comments of any structural damage to the jacking pads or axles while both the front wheels are supported by the jack stands:
None noted.
Comments of any structural damage to the jacking pads or axles while both the rear wheels are supported by the jack stands:
None noted.
Comments of any structural damage to the jacking pads or axles while both the front and rear wheels are supported by the jack stands:
None noted.

5.7 STRUCTURAL DURABILITY TEST

5.7-I. TEST OBJECTIVE

The objective of this test is to perform an accelerated durability test that approximates up to 25 percent of the service life of the vehicle.

5.7-II. TEST DESCRIPTION

The test vehicle is driven a total of 15,000 miles; approximately 12,500 miles on the PSBRTF Durability Test Track and approximately 2,500 miscellaneous other miles. The test will be conducted with the bus operated under three different loading conditions. The first segment will consist of approximately 6,250 miles with the bus operated at GVW. The second segment will consist of approximately 2,500 miles with the bus operated at SLW. The remainder of the test, approximately 6,250 miles, will be conducted with the bus loaded to CW. If GVW exceeds the axle design weights, then the load will be adjusted to the axle design weights and the change will be recorded. All subsystems are run during these tests in their normal operating modes. All recommended manufacturers servicing is to be followed and noted on the vehicle maintainability log. Servicing items accelerated by the durability tests will be compressed by 10:1; all others will be done on a 1:1 mi/mi basis. Unscheduled breakdowns and repairs are recorded on the same log as are any unusual occurrences as noted by the driver. Once a week the test vehicle shall be washed down and thoroughly inspected for any signs of failure.

5.7-III. DISCUSSION

The Structural Durability Test was started on May 24, 2006 and was conducted until November 20, 2006. The first 6,250 miles were performed at a GVW of 48,540 lbs. The number of standing passengers was reduced from 25 to 21. The ballast for 4 standing passengers (600 lbs) was eliminated. This reduction in passenger weight was necessary to avoid exceeding the GAWR (22,500 lbs) of the rear axle and (12,000 lbs) of the tag axle. The GVW signet was completed on September 8, 2006. The next 2,500 mile SLW segment was performed at 45,430 lbs and completed on September 26, 2006, and the final 6,250 mile segment was performed at a CW of 37,000 lbs and completed on November 20, 2006.

The following mileage summary presents the accumulation of miles during the Structural Durability Test. The driving schedule is included, showing the operating duty cycle. A detailed plan view of the Test Track Facility and Durability Test Track are attached for reference also, a durability element profile detail shows all the measurement of the different conditions. Finally, photographs illustrating some of the failures that were encountered during the Structural Durability Test are included.

MCI - #0610
MILEAGE DRIVEN/RECORDED FROM DRIVER'S LOGS

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
05/22/06 05/28/06	0.00	106.00	106.00
05/29/06 06/04/06	0.00	0.00	0.00
06/05/06 06/11/06	0.00	0.00	0.00
06/12/06 06/18/06	0.00	0.00	0.00
06/19/06 06/25/06	0.00	83.00	83.00
06/26/06 07/02/06	635.00	273.00	908.00
07/03/06 07/09/06	611.00	82.00	693.00
07/10/06 07/16/06	461.00	78.00	539.00
07/17/06 07/23/06	718.00	179.00	897.00
07/24/06 07/30/06	0.00	0.00	0.00
07/31/06 08/06/06	611.00	115.00	726.00
08/07/06 08/13/06	250.00	130.00	380.00
08/14/06 08/20/06	0.00	0.00	0.00
08/21/06 08/27/06	747.00	45.00	792.00

MCI - #0610
MILEAGE DRIVEN/RECORDED FROM DRIVER'S LOGS

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
8/28/2006 9/3/2006	454.00	74.00	528.00
9/4/2006 9/10/2006	824.00	94.00	918.00
9/11/2006 9/17/2006	797.00	254.00	1051.00
9/18/2006 9/24/2006	754.00	238.00	992.00
9/25/2006 10/1/2006	492.00	144.00	636.00
10/2/2006 10/8/2006	813.00	71.00	884.00
10/9/2006 10/15/2006	554.00	83.00	637.00
10/16/2006 10/22/2006	1048.00	149.00	1197.00
10/23/2006 10/29/2006	1048.00	158.00	1206.00
10/30/2006 11/5/2006	647.00	29.00	676.00
11/6/2006 11/12/2006	712.00	164.00	876.00
11/13/2006 11/19/2006	324.00	0.00	324.00
TOTAL	12500.00	2360.00	14860.00

Table 4. Driving Schedule for Bus Operation on the Durability Test Track.

STANDARD OPERATING SCHEDULE

Monday through Friday		
	HOUR	ACTION
Shift 1	midnight	D
	1:40 am	C
	1:50 am	B
	2:00 am	D
	3:35 am	C
	3:45 am	B
	4:05 am	D
	5:40 am	C
	5:50 am	B
	6:00 am	D
	7:40 am	C
	7:50 am	F
Shift 2	8:00 am	D
	9:40 am	C
	9:50 am	B
	10:00 am	D
	11:35 am	C
	11:45 am	B
	12:05 pm	D
	1:40 pm	C
	1:50 pm	B
	2:00 pm	D
	3:40 pm	C
	3:50 pm	F
Shift 3	4:00 pm	D
	5:40 pm	C
	5:50 pm	B
	6:00 pm	D
	7:40 pm	C
	7:50 pm	B
	8:05 pm	D
	9:40 pm	C
	9:50 pm	B
	10:00 pm	D
	11:40 pm	C
	11:50 pm	F

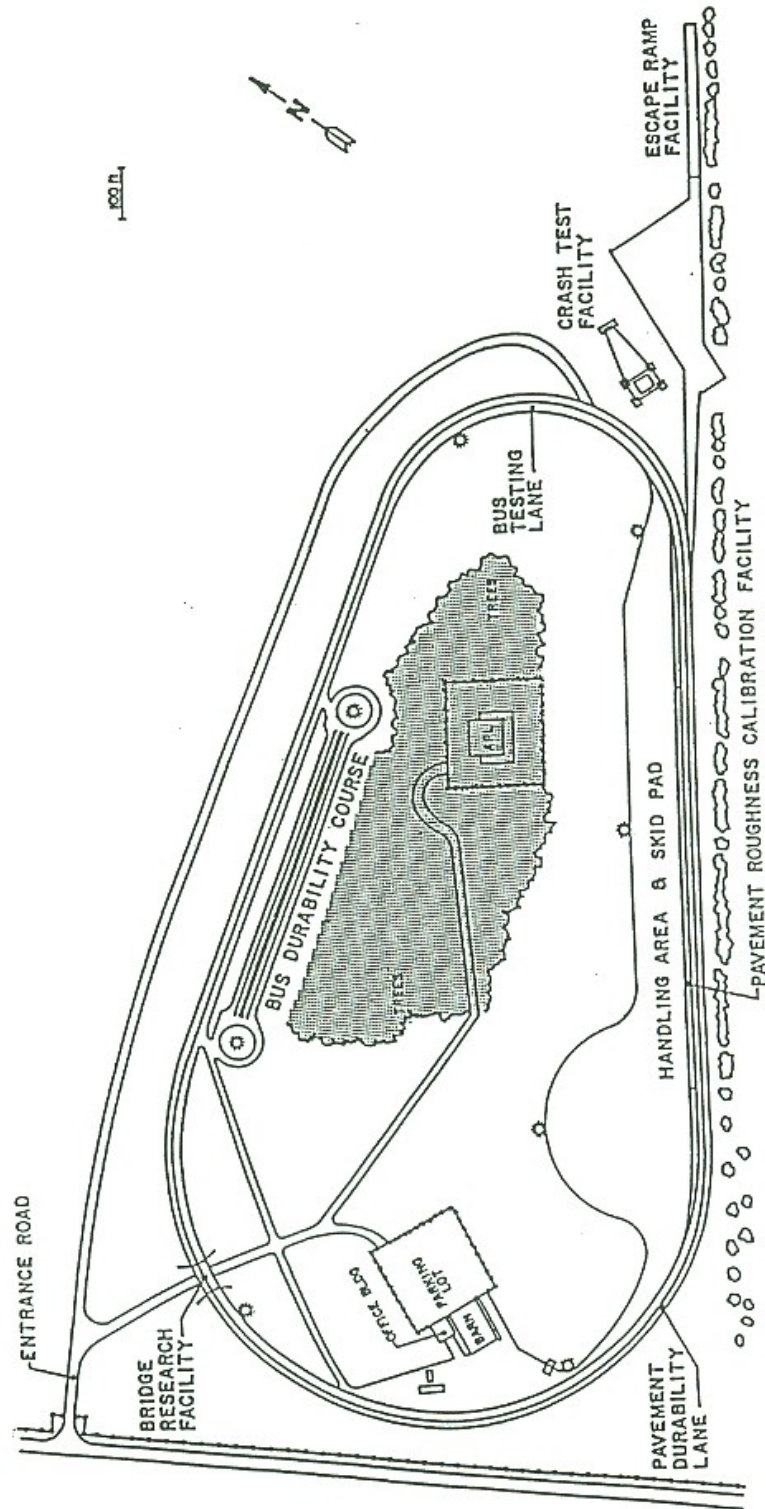
B—Break

C—Cycle all systems five times, visual inspection, driver's log entries

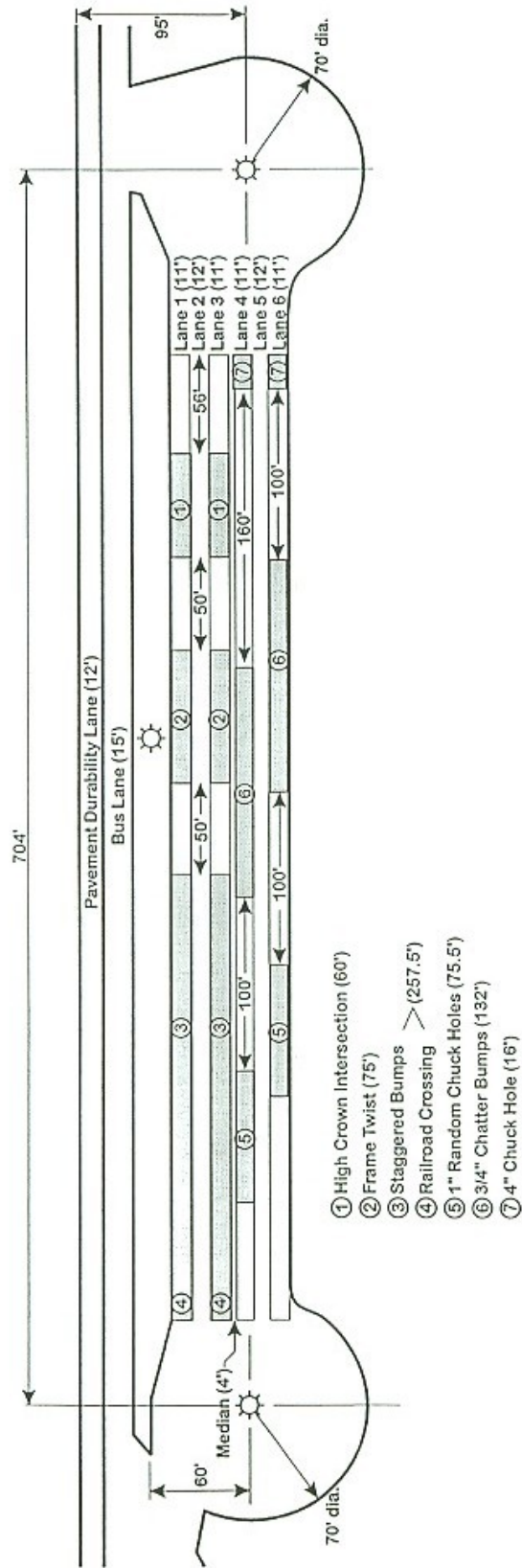
D—Drive bus as specified by procedure

F—Fuel bus, complete driver's log shift entries

“PLAN VIEW OF PENN STATE BUS TESTING AND RESEARCH FACILITY”



**BUS TESTING AND RESEARCH TEST TRACK
UNIVERSITY PARK, PA**

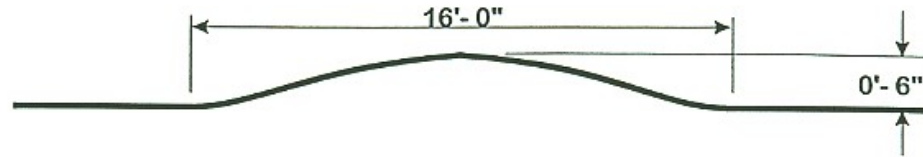


Plan View

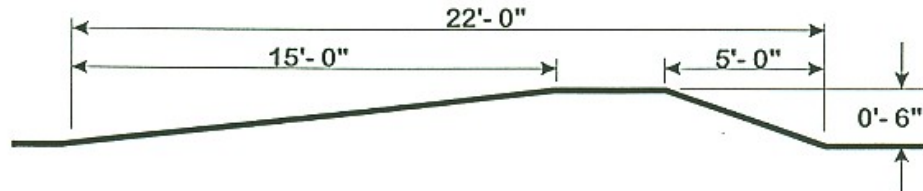
Vehicle Durability Test Track

The Pennsylvania Transportation Institute
Penn State

Staggered
Bumps
(10 mph)



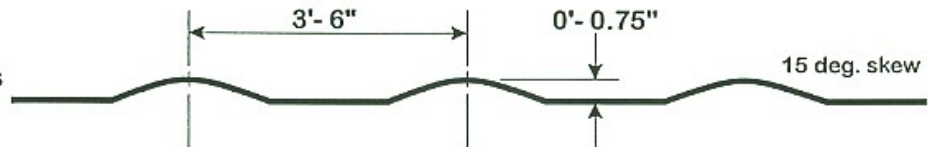
Railroad
Crossing
(8 mph)



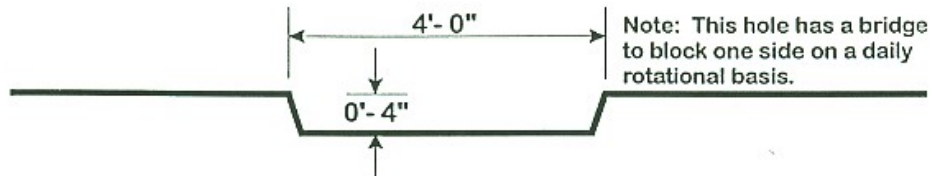
1" Random
Chuck Holes
(20 mph)



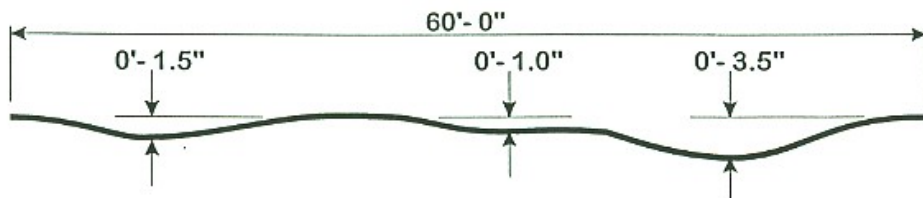
Chatter Bumps
(20 mph)



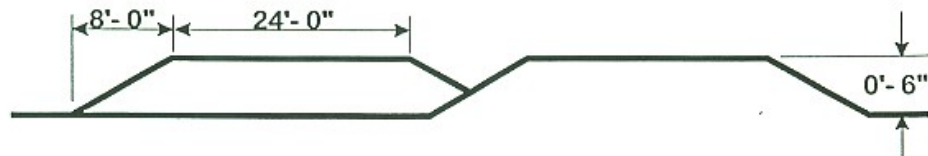
4" Chuck Hole
(5 mph)



High Crown
Intersection
(20 mph)



Frame Twist
(10 mph)



Durability Element Profiles

The Pennsylvania Transportation Institute
Penn State

(Page 1 of 4)
UNSCHEDULED MAINTENANCE
 Bus Name: MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
06-29-06	857	The pressure relief plug is missing from the drive axle housing and leaking oil.	Replaced pressure relief plug.	4.00	0.25
06-29-06	857	The transmission dipstick tube is loose.	Repositioned tube and tightened union fitting.	0.25	0.25
06-29-06	857	The flange clamp is loose on the air charge connection at the engine.	Verified fit and tightened clamp.	1.00	0.50
06-29-06	857	The engine compartment doors are not fitting properly.	Adjusted doors and fitted properly.	1.00	1.00
07-05-06	1,151	The coolant surge tank is leaking at a crack in the weld on the mount.	Welded/repaired crack.	72.00	3.00
07-14-06	2,329	The front sway bar is cracked on the right side. The lower shock washers are pounded out on the drive and tag axles.	Replaced front sway bar and bushings. Replaced all six lower shock washers on the drive and tag axles.	4.00	1.50

(Page 2 of 4)
UNSCHEDULED MAINTENANCE
 Bus Name: MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
07-14-06	2,329	Test bus sent to Caterpillar warranty dealer for oil leak at the turbo drain tube.	Warranty dealer found a pin hole in the solder joint in the turbo drain tube. Drained oil, replaced drain tube and refilled with 40 quarts of oil.	48.00	4.00
07-28-06	3,226	The A/C compressor head came loose. Freon leaked out.	Warranty dealer replaced both left and right side A/C compressor head gaskets. Recharged system with freon. Replaced blown 110 amp fuse for condenser fan relays #1 and #2.	80.00	6.00
07-28-06	3,226	The alternator generator plate is leaking oil.	Warranty dealer removed plate, replaced oil seal and oil.	80.00	2.50
08-08-06	4,099	Coolant surge tank repaired on 7/5/06.	Repaired tank replaced with new tank.	16.00	1.50
08-28-06	5,124	The front sway bar is broken approx. 11" to the left of center.	Replaced front sway bar.	17.50	0.50
09-05-06	5,463	The coolant surge tank is leaking at the weld on the right bracket.	Replaced Coolant surge tank.	88.00	2.00
09-05-06	5,463	The A/C belt is worn.	Replaced A/C belt.	0.50	0.50

(Page 3 of 4)
UNSCHEDULED MAINTENANCE
 Bus Name: MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
09-15-06	6,363	The front axle wheel hubs are leaking oil.	Replaced front axle wheel hub gaskets.	16.00	1.50
09-15-06	6,363	The framework under the oil pan is bent.	Removed and straightened framework.	1.00	1.00
09-19-06	7,734	The right tag axle tire is flat.	Replaced tire with used tire.	7.00	0.25
09-19-06	7,734	The front sway bar is broken at the left radius.	Replaced sway bar.	0.50	0.50
09-20-06	7,947	The front and tag axle tires are worn.	Replaced the front and tag axle tires.	1.50	1.50
09-22-06	8,319	The left link on the front sway bar is broken.	Replaced both front sway bar links.	7.00	1.00
09-27-06	8,976	The coolant surge tank is leaking at the weld on the right bracket.	Welded/repaired crack.	8.50	2.50
10-06-06	9,944	Two left side mount bolts for the muffler support are broken.	Drilled out and replaced broken bolts.	5.00	1.00
10-16-06	10,728	The rear axle tires are worn.	Replaced with new tires.	1.50	1.50

(Page 4 of 4)
UNSCHEDULED MAINTENANCE
 Bus Name: MCI #0610

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
10-16-06	10,728	Coolant surge tank repaired on 9/27/06	Repaired tank replaced with a new tank.	2.50	2.50
10-24-06	12,119	The front sway bar is cracking.	Replaced front sway bar.	1.00	1.00
10-24-06	12,119	The 2 1/2" flex exhaust pipe is broken.	Replaced flex pipe.	1.00	1.00
10-30-06	13,040	The right front, forward shock is bent.	Repalced shock.	8.00	0.50

UNSCHEDULED MAINTENANCE



**CRACKED COOLANT SURGE TANK
(1,151 TEST MILES)**



**CRACKED FRONT SWAY BAR
(2,329 TEST MILES)**

UNSCHEDULED MAINTENANCE CONT.



**LEAKING TURBO DRAIN LINE
(2,329 TEST MILES)**



**BROKEN FRONT SWAY BAR
(5,124 TEST MILES)**

UNSCHEDULED MAINTENANCE CONT.



**FRONT SWAY BAR BROKEN AT THE LEFT RADIUS
(7,734 TEST MILES)**



**BROKEN MUFFLER MOUNT BOLTS
(9,944 TEST MILES)**

UNSCHEDULED MAINTENANCE CONT.



**BROKEN 2 ½" EXHAUST FLEX PIPE
(12,119 TEST MILES)**



**BENT RIGHT FRONT SHOCK
(13,040 TEST MILES)**

6. FUEL ECONOMY TEST - A FUEL CONSUMPTION TEST USING AN APPROPRIATE OPERATING CYCLE

6-I. TEST OBJECTIVE

The objective of this test is to provide accurate comparable fuel consumption data on transit buses produced by different manufacturers. This fuel economy test bears no relation to the calculations done by the Environmental Protection Agency (EPA) to determine levels for the Corporate Average Fuel Economy Program. EPA's calculations are based on tests conducted under laboratory conditions intended to simulate city and highway driving. This fuel economy test, as designated here, is a measurement of the fuel expended by a vehicle traveling a specified test loop under specified operating conditions. The results of this test will not represent actual mileage but will provide data that can be used by recipients to compare buses tested by this procedure.

6-II. TEST DESCRIPTION

This test requires operation of the bus over a course based on the Transit Coach Operating Duty Cycle (ADB Cycle) at seated load weight using a procedure based on the Fuel Economy Measurement Test (Engineering Type) For Trucks and Buses: SAE 1376 July 82. The procedure has been modified by elimination of the control vehicle and by modifications as described below. The inherent uncertainty and expense of utilizing a control vehicle over the operating life of the facility is impractical.

The fuel economy test will be performed as soon as possible (weather permitting) after the completion of the GVW portion of the structural durability test. It will be conducted on the bus test lane at the Penn State Test Facility. Signs are erected at carefully measured points which delineate the test course. A test run will comprise 3 CBD phases, 2 Arterial phases, and 1 Commuter phase. An electronic fuel measuring system will indicate the amount of fuel consumed during each phase of the test. The test runs will be repeated until there are at least two runs in both the clockwise and counterclockwise directions in which the fuel consumed for each run is within ∇ 4 percent of the average total fuel used over the 4 runs. A 20-minute idle consumption test is performed just prior to and immediately after the driven portion of the fuel economy test. The amount of fuel consumed while operating at normal/low idle is recorded on the Fuel Economy Data Form. This set of four valid runs along with idle consumption data comprise a valid test.

The test procedure is the ADB cycle with the following four modifications:

1. The ADB cycle is structured as a set number of miles in a fixed time in the following order: CBD, Arterial, CBD, Arterial, CBD, and Commuter. A separate idle fuel consumption measurement is performed at the beginning and end of the fuel economy test. This phase sequence permits the reporting of fuel consumption for each of these phases separately, making the data more useful to bus manufacturers and transit properties.
2. The operating profile for testing purposes shall consist of simulated transit type service at seated load weight. The three test phases (figure 6-1) are: a central business district (CBD) phase of 2 miles with 7 stops per mile and a top speed of 20 mph; an arterial phase of 2 miles with 2 stops per mile and a top speed of 40 mph; and a commuter phase of 4 miles with 1 stop and a maximum speed of 40 mph. At each designated stop the bus will remain stationary for seven seconds. During this time, the passenger doors shall be opened and closed.
3. The individual ADB phases remain unaltered with the exception that 1 mile has been changed to 1 lap on the Penn State Test Track. One lap is equal to 5,042 feet. This change is accommodated by adjusting the cruise distance and time.
4. The acceleration profile, for practical purposes and to achieve better repeatability, has been changed to "full throttle acceleration to cruise speed".

Several changes were made to the Fuel Economy Measurement Test (Engineering Type) For Trucks and Buses: SAE 1376 July 82:

1. Sections 1.1, and 1.2 only apply to diesel, gasoline, methanol, and any other fuel in the liquid state (excluding cryogenic fuels).

1.1 SAE 1376 July 82 requires the use of at least a 16-gal fuel tank. Such a fuel tank when full would weigh approximately 160 lb. It is judged that a 12-gal tank weighing approximately 120 lb will be sufficient for this test and much easier for the technician and test personnel to handle.

1.2 SAE 1376 July 82 mentions the use of a mechanical scale or a flowmeter system. This test procedure uses a load cell readout combination that provides an accuracy of 0.5 percent in weight and permits on-board weighing of the gravimetric tanks at the end of each phase. This modification permits the determination of a fuel economy value for each phase as well as the overall cycle.

2. Section 2.1 applies to compressed natural gas (CNG), liquefied natural gas (LNG), cryogenic fuels, and other fuels in the vapor state.

2.1 A laminar type flowmeter will be used to determine the fuel consumption. The pressure and temperature across the flow element will be monitored by the flow computer. The flow computer will use this data to calculate the gas flow rate. The flow computer will also display the flow rate (scfm) as well as the total fuel used (scf). The total fuel used (scf) for each phase will be recorded on the Fuel Economy Data Form.

3. Use both Sections 1 and 2 for dual fuel systems.

FUEL ECONOMY CALCULATION PROCEDURE

A. For diesel, gasoline, methanol and fuels in the liquid state.

The reported fuel economy is based on the following: measured test quantities-- distance traveled (miles) and fuel consumed (pounds); standard reference values-- density of water at 60EF (8.3373 lbs/gal) and volumetric heating value of standard fuel; and test fuel specific gravity (unitless) and volumetric heating value (BTU/gal). These combine to give a fuel economy in miles per gallon (mpg) which is corrected to a standard gallon of fuel referenced to water at 60EF. This eliminates fluctuations in fuel economy due to fluctuations in fuel quality. This calculation has been programmed into a computer and the data processing is performed automatically.

The fuel economy correction consists of three steps:

- 1.) Divide the number of miles of the phase by the number of pounds of fuel consumed

phase	miles per phase	total miles per run
CBD	1.9097	5.7291
ART	1.9097	3.8193
COM	3.8193	3.8193

$$FE_{o_{mi/lb}} = \text{Observed fuel economy} = \frac{\text{miles}}{\text{lb of fuel}}$$

- 2.) Convert the observed fuel economy to miles per gallon [mpg] by multiplying by the specific gravity of the test fuel G_s (referred to water) at 60EF and multiply by the density of water at 60EF

$$FE_{\text{mpg}} = FE_{\text{mi/lb}} \times G_s \times G_w$$

where G_s = Specific gravity of test fuel at 60EF (referred to water)
 G_w = 8.3373 lb/gal

- 3.) Correct to a standard gallon of fuel by dividing by the volumetric heating value of the test fuel (H) and multiplying by the volumetric heating value of standard reference fuel (Q). Both heating values must have the same units.

$$FE_c = FE_{\text{mpg}} \times \frac{Q}{H}$$

where

H = Volumetric heating value of test fuel [BTU/gal]
 Q = Volumetric heating value of standard reference fuel

Combining steps 1-3 yields

$$\Rightarrow FE_c = \frac{\text{miles}}{\text{lbs}} \times (G_s \times G_w) \times \frac{Q}{H}$$

- 4.) Covert the fuel economy from mpg to an energy equivalent of miles per BTU. Since the number would be extremely small in magnitude, the energy equivalent will be represented as miles/BTU $\times 10^6$.

Eq = Energy equivalent of converting mpg to mile/BTU $\times 10^6$.

$$Eq = ((\text{mpg})/(H)) \times 10^6$$

B. CNG, LNG, cryogenic and other fuels in the vapor state.

The reported fuel economy is based on the following: measured test quantities-- distance traveled (miles) and fuel consumed (scf); density of test fuel, and volumetric heating value (BTU/lb) of test fuel at standard conditions ($P=14.73$ psia and $T=60$ EF).

These combine to give a fuel economy in miles per lb. The energy equivalent (mile/BTUx10⁶) will also be provided so that the results can be compared to buses that use other fuels.

- 1.) Divide the number of miles of the phase by the number of standard cubic feet (scf) of fuel consumed.

phase	miles per phase	total miles per run
CBD	1.9097	5.7291
ART	1.9097	3.8193
COM	3.8193	3.8193

$$\text{FEO}_{\text{mi/scf}} = \text{Observed fuel economy} = \frac{\text{miles}}{\text{scf of fuel}}$$

- 2.) Convert the observed fuel economy to miles per lb by dividing FEO by the density of the test fuel at standard conditions (Lb/ft³).

Note: The density of test fuel must be determined at standard conditions as described above. If the density is not defined at the above standard conditions, then a correction will be needed before the fuel economy can be calculated.

$$\text{FEO}_{\text{mi/lb}} = \text{FEO} / \text{Gm}$$

where Gm = Density of test fuel at standard conditions

- 3.) Convert the observed fuel economy (FEOmi/lb) to an energy equivalent of (miles/BTUx10⁶) by dividing the observed fuel economy (FEOmi/lb) by the heating value of the test fuel at standard conditions.

$$\text{Eq} = ((\text{FEOmi/lb})/\text{H}) \times 10^6$$

where

Eq = Energy equivalent of miles/lb to mile/BTUx10⁶

H = Volumetric heating value of test fuel at standard conditions

6-III. DISCUSSION

This is a comparative test of fuel economy using Ultra Low Sulfur diesel fuel with a heating value of 19,631 btu/lb. The driving cycle consists of Central Business District (CBD), Arterial (ART), and Commuter (COM) phases as described in 6-II. The fuel consumption for each driving cycle and for idle is measured separately. The results are corrected to a reference fuel with a volumetric heating value of 127,700.0 btu/gal.

An extensive pretest maintenance check is made including the replacement of all lubrication fluids. The details of the pretest maintenance are given in the first three Pretest Maintenance Forms. The fourth sheet shows the Pretest Inspection. The next sheet shows the correction calculation for the test fuel. The next four Fuel Economy Forms provide the data from the four test runs. Finally, the summary sheet provides the average fuel consumption. The overall average is based on total fuel and total mileage for each phase. The overall average fuel consumption values were; CBD – 2.84 mpg, ART – 3.59 mpg, and COM – 6.67 mpg. Average fuel consumption at idle was 0.8 gph.

FUEL ECONOMY PRE-TEST MAINTENANCE FORM

Bus Number: 0610	Date: 6-23-06	SLW (lbs): 45,430
Personnel: T.S. & S.C.		

FUEL SYSTEM	OK	Date	Initials
Install fuel measurement system		6/23/06	S.C.
Replace fuel filter		6/23/06	S.C.
Check for fuel leaks		6/23/06	S.C.
Specify fuel type (refer to fuel analysis)	Ultra Low Sulfur Diesel		
Remarks: Serviced by MCI.			
BRAKES/TIRES	OK	Date	Initials
Inspect hoses		6/23/06	S.C.
Inspect brakes		6/23/06	S.C.
Relube wheel bearings		6/23/06	S.C.
Check tire inflation pressures (mfg. specs.)		6/23/06	S.C.
Remarks: Serviced by MCI.			
COOLING SYSTEM	OK	Date	Initials
Check hoses and connections		6/23/06	S.C.
Check system for coolant leaks		6/23/06	S.C.
Remarks: None noted.			

FUEL ECONOMY PRE-TEST MAINTENANCE FORM (page 2)

Bus Number: 0610	Date: 6-23-06
Personnel: T.S. & S.C.	

ELECTRICAL SYSTEMS	OK	Date	Initials
Check battery		6-23-06	S.C.
Inspect wiring		6-23-06	S.C.
Inspect terminals		6-23-06	S.C.
Check lighting		6-23-06	S.C.
Remarks: None noted.			
DRIVE SYSTEM	OK	Date	Initials
Drain transmission fluid		6-23-06	T.S.
Replace filter/gasket		6-23-06	T.S.
Check hoses and connections		6-23-06	T.S.
Replace transmission fluid		6-23-06	T.S.
Check for fluid leaks		6-23-06	T.S.
Remarks: Serviced by MCI.			
LUBRICATION	OK	Date	Initials
Drain crankcase oil		6-23-06	T.S.
Replace filters		6-23-06	T.S.
Replace crankcase oil		6-23-06	T.S.
Check for oil leaks		6-23-06	T.S.
Check oil level		6-23-06	T.S.
Lube all chassis grease fittings		6-23-06	T.S.
Lube universal joints		6-23-06	T.S.
Replace differential lube including axles		6-23-06	T.S.
Remarks: Serviced by MCI.			

FUEL ECONOMY PRE-TEST MAINTENANCE FORM (page 3)

Bus Number: 0610	Date: 6-23-06
Personnel: T.S. & S.C.	

EXHAUST/EMISSION SYSTEM	OK	Date	Initials
Check for exhaust leaks		6-23-06	S.C.
Remarks: None noted.			
ENGINE	OK	Date	Initials
Replace air filter		6-23-06	T.S.
Inspect air compressor and air system		6-23-06	T.S.
Inspect vacuum system, if applicable		6-23-06	T.S.
Check and adjust all drive belts		6-23-06	T.S.
Check cold start assist, if applicable		6-23-06	T.S.
Remarks: Serviced by MCI.			
STEERING SYSTEM	OK	Date	Initials
Check power steering hoses and connectors		6-23-06	T.S.
Service fluid level		6-23-06	T.S.
Check power steering operation		6-23-06	T.S.
Remarks: None noted.			
	OK	Date	Initials
Ballast bus to seated load weight		6-23-06	S.C.
TEST DRIVE	OK	Date	Initials
Check brake operation		6-23-06	S.C.
Check transmission operation		6-23-06	S.C.
Remarks: None noted.			



FUEL ECONOMY PRE-TEST INSPECTION FORM

Bus Number: 0610	Date: 6-27-06
Personnel: S.C.	

PRE WARM-UP	If OK, Initial
Fuel Economy Pre-Test Maintenance Form is complete	S.C.
Cold tire pressure (psi): Front <u>120</u> Drive <u>100</u> Tag <u>85</u>	S.C.
Tire wear:	S.C.
Engine oil level	S.C.
Engine coolant level	S.C.
Interior and exterior lights on, evaporator fan on	S.C.
Fuel economy instrumentation installed and working properly.	S.C.
Fuel line -- no leaks or kinks	S.C.
Speed measuring system installed on bus. Speed indicator installed in front of bus and accessible to TECH and Driver.	S.C.
Bus is loaded to SLW	S.C.
WARM-UP	If OK, Initial
Bus driven for at least one hour warm-up	S.C.
No extensive or black smoke from exhaust	S.C.
POST WARM-UP	If OK, Initial
Warm tire pressure (psi): Front <u>120</u> Drive <u>102</u> Tag <u>86</u>	S.C.
Environmental conditions Average wind speed <12 mph and maximum gusts <15 mph Ambient temperature between 30°F(-1C°) and 90°F(32°C) Track surface is dry Track is free of extraneous material and clear of interfering traffic	S.C.

FUEL ECONOMY DATA FORM (Liquid Fuels)

Bus Number: 0610		Manufacturer: MCI		Date: 6-26-06			
Run Number: 1		Personnel: G.M., T.S. & S.C.					
Test Direction: ☐ CW or ☒ CCW		Temperature (°F): 73		Humidity (%): 78			
SLW (lbs): 45,430		Wind Speed (mph) & Direction: 5 / E		Barometric Pressure (in. Hg): 29.95			
Cycle Type	Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°C)	Load Cell Reading (lb)		Fuel Used (lbs)
	Start	Finish			Start	Finish	
CBD #1	0	9:15	9:15	40.0	0	.639	.639
ART #1	0	4:20	4:20	41.5	0	.510	.510
CBD #2	0	9:19	9:19	41.5	0	.649	.649
ART #2	0	4:16	4:16	42.0	0	.522	.522
CBD #3	0	9:10	9:10	42.5	0	.646	.646
COMPUTER	0	6:46	6:46	43.0	0	.537	.537
Total Fuel = 3,503 lbs							
20 minute idle : Total Fuel Used = .292 lbs							
Heating Value = 19,631 BTU/LB							
Comments: None noted.							

FUEL ECONOMY DATA FORM (Liquid Fuels)

Bus Number: 0610		Manufacturer: MCI		Date: 6-26-06			
Run Number: 2		Personnel: G.M., T.S. & S.C.					
Test Direction: ☒ CW or ☐ CCW		Temperature (°F): 78		Humidity (%): 74			
SLW (lbs): 45,430		Wind Speed (mph) & Direction: 5 / SE		Barometric Pressure (in.Hg): 29.95			
Cycle Type	Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°C)	Load Cell Reading (lb)		Fuel Used (lbs)
	Start	Finish			Start	Finish	
CBD #1	0	9:17	9:17	43.0	0	.613	.613
ART #1	0	4:17	4:17	43.5	0	.480	.480
CBD #2	0	8:55	8:55	43.5	0	.640	.640
ART #2	0	4:16	4:16	44.5	0	.487	.487
CBD #3	0	9:00	9:00	44.5	0	.641	.641
COMMUTER	0	6:30	6:30	44.5	0	.531	.531
Total Fuel = 3.392 lbs							
20 minute idle : Total Fuel Used = N/A lbs							
Heating Value = 19,631 BTU/LB							
Comments: None noted.							

FUEL ECONOMY DATA FORM (Liquid Fuels)

Bus Number: 0610		Manufacturer: MCI		Date: 6-27-06	
Run Number: 3		Personnel: G.M., T.S. & S.C.			
Test Direction: ☐ CW or ☒ CCW		Temperature (°F): 73		Humidity (%): 78	
SLW (lbs): 45,430		Wind Speed (mph) & Direction: 7 / S		Barometric Pressure (in.Hg): 30.03	

Cycle Type	Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°C)	Load Cell Reading (lb)		Fuel Used (lbs)
	Start	Finish		Start	Start	Finish	
CBD #1	0	9:17	9:17	35.0	0	.614	.614
ART #1	0	4:15	4:15	35.5	0	.480	.480
CBD #2	0	9:21	9:21	36.5	0	.608	.608
ART #2	0	4:21	4:21	37.5	0	.507	.507
CBD #3	0	9:22	9:22	38.5	0	.625	.625
COMMUTER	0	6:30	6:30	39.5	0	.546	.546
Total Fuel = 3.380 lbs							

20 minute idle : Total Fuel Used = N/A lbs
Heating Value = 19,631 BTU/LB
Comments: Ran engine re-gen.

FUEL ECONOMY DATA FORM (Liquid Fuels)

Bus Number: 0610		Manufacturer: MCI		Date: 6-27-06			
Run Number: 4		Personnel: G.M., T.S. 7 S.C.					
Test Direction: ■ CW or □ CCW		Temperature (°F): 75		Humidity (%): 69			
SLW (lbs): 45,430		Wind Speed (mph) & Direction: 8 / S		Barometric Pressure (in.Hg): 30.03			
Cycle Type	Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°C)	Load Cell Reading (lb)		Fuel Used (lbs)
	Start	Finish			Start	Finish	
CBD #1	0	9:24	9:24	44.5	0	.610	.610
ART #1	0	4:20	4:20	44.5	0	.490	.490
CBD #2	0	9:17	9:17	45.0	0	.611	.611
ART #2	0	4:22	4:22	45.0	0	.505	.505
CBD #3	0	9:20	9:20	45.5	0	.635	.635
COMMUTER	0	6:34	6:34	45.5	0	.525	.525
Total Fuel = 3.376 lbs							
20 minute idle : Total Fuel Used = .284 lbs							
Heating Value = 19,631 BTU/LB							
Comments: None noted.							

FUEL ECONOMY SUMMARY SHEET

BUS MANUFACTURER :MCI
BUS MODEL :D4500

BUS NUMBER :0610
TEST DATE :06/26/06

FUEL TYPE : DIESEL
SP. GRAVITY : .8095
HEATING VALUE : 19631.00 BTU/Lb
FUEL TEMPERATURE : ***** deg F
Standard Conditions : 60 deg F and 14.7 psi
Density of Water : 8.3373 lb/gallon at 60 deg F

	CYCLE	TOTAL FUEL USED(GAL)	TOTAL MILES	FUEL ECONOMY MPG(Measured)	FUEL ECONOMY MPG (Corrected)
Run # :1, CCW					
CBD		1.934	5.73	2.963	2.77
ART		1.032	3.82	3.702	3.46
COM		.537	3.82	7.114	6.64
TOTAL		3.503	13.37	3.817	3.56
Run # :2, CW					
CBD		1.894	5.73	3.025	2.83
ART		.967	3.82	3.950	3.69
COM		.531	3.82	7.194	6.72
TOTAL		3.392	13.37	3.942	3.68
Run # :3, CCW					
CBD		1.847	5.73	3.102	2.90
ART		.987	3.82	3.870	3.61
COM		.546	3.82	6.996	6.53
TOTAL		3.380	13.37	3.956	3.69
Run # :4, CW					
CBD		1.856	5.73	3.087	2.88
ART		.995	3.82	3.839	3.59
COM		.525	3.82	7.276	6.79
TOTAL		3.376	13.37	3.960	3.70

IDLE CONSUMPTION (MEASURED)

First 20 Minutes Data : .29GAL Last 20 Minutes Data : .28GAL
Average Idle Consumption : .86GAL/Hr

RUN CONSISTENCY: % Difference from overall average of total fuel used

Run 1 : -2.6 Run 2 : .6 Run 3 : 1.0 Run 4 : 1.1

SUMMARY (CORRECTED VALUES)

Average Idle Consumption : .93 G/Hr
Average CBD Phase Consumption : 2.84 MPG
Average Arterial Phase Consumption : 3.59 MPG
Average Commuter Phase Consumption : 6.67 MPG
Overall Average Fuel Consumption : 3.66 MPG
Overall Average Fuel Consumption : 27.62 Miles/ Million BTU

7. NOISE

7.1 INTERIOR NOISE AND VIBRATION TESTS

7.1-I. TEST OBJECTIVE

The objective of these tests is to measure and record interior noise levels and check for audible vibration under various operating conditions.

7.1-II. TEST DESCRIPTION

During this series of tests, the interior noise level will be measured at several locations with the bus operating under the following three conditions:

1. With the bus stationary, a white noise generating system shall provide a uniform sound pressure level equal to 80 dB(A) on the left, exterior side of the bus. The engine and all accessories will be switched off and all openings including doors and windows will be closed. This test will be performed at the ABTC.
2. The bus accelerating at full throttle from a standing start to 35 mph on a level pavement. All openings will be closed and all accessories will be operating during the test. This test will be performed on the track at the Test Track Facility.
3. The bus will be operated at various speeds from 0 to 55 mph with and without the air conditioning and accessories on. Any audible vibration or rattles will be noted. This test will be performed on the test segment between the Test Track and the Bus Testing Center.

All tests will be performed in an area free from extraneous sound-making sources or reflecting surfaces. The ambient sound level as well as the surrounding weather conditions will be recorded in the test data.

7.1-III. DISCUSSION

This test is performed in three parts. The first part exposes the exterior of the vehicle to 80.0 dB(A) on the left side of the bus and the noise transmitted to the interior is measured. The overall average of the six measurements was 52.5 dB(A); ranging from 50.3 dB(A) at the front passenger seats to 61.0 dB(A) at the driver's seat. The interior ambient noise level for this test was < 34.0 dB(A).

The second test measures interior noise during acceleration from 0 to 35 mph. This noise level ranged from 64.3 dB(A) at the driver's seat to 69.8 dB(A) at the rear passenger seats. The overall average was 67.2 dB(A). The interior ambient noise level for this test was < 34.0 dB(A).

The third part of the test is to listen for resonant vibrations, rattles, and other noise sources while operating over the road. No vibrations or rattles were noted.

INTERIOR NOISE TEST DATA FORM
Test Condition 1: 80 dB(A) Stationary White Noise

Bus Number: 0610	Date: 5-30-06
Personnel: T.S. & P.D.	
Temperature (°F): 77	Humidity (%): 69
Wind Speed (mph): Calm	Wind Direction: Calm
Barometric Pressure (in.Hg): 30.14	
Initial Sound Level Meter Calibration: ■ checked by: S.C.	
Interior Ambient Noise Level dB(A): 21.9	Exterior Ambient Noise Level dB(A): 66.1
Microphone Height During Testing (in): 48	

Measurement Location	Measured Sound Level dB(A)
Driver's Seat	61.0
Front Passenger Seats	50.3
In Line with Front Speaker	51.2
In Line with Middle Speaker	50.8
In Line with Rear Speaker	50.9
Rear Passenger Seats	51.0

Final Sound Level Meter Calibration: ■ checked by: S.C.

Comments: All readings taken in the center aisle.

INTERIOR NOISE TEST DATA FORM
Test Condition 2: 0 to 35 mph Acceleration Test

Bus Number: 0610	Date: 6-20-06
Personnel: B.S., T.S. & S.C.	
Temperature (°F): 72	Humidity (%): 54
Wind Speed (mph): 5	Wind Direction: W
Barometric Pressure (in.Hg): 29.97	
Initial Sound Level Meter Calibration: ■ checked by: S.C.	
Interior Ambient Noise Level dB(A): < 34.0	Exterior Ambient Noise Level dB(A): 45.7
Microphone Height During Testing (in): 48	

Measurement Location	Measured Sound Level dB(A)
Driver's Seat	64.3
Front Passenger Seats	66.2
Middle Passenger Seats	68.6
Rear Passenger Seats	69.8

Final Sound Level Meter Calibration: ■ checked by: S.C.

Comments: All readings taken in the center aisle.

INTERIOR NOISE TEST DATA FORM
Test Condition 3: Audible Vibration Test

Bus Number: 0610	Date: 6-20-06
Personnel: B.S., T.S. & S.C.	
Temperature (°F): 72	Humidity (%): 54
Wind Speed (mph): 5	Wind Direction: W
Barometric Pressure (in.Hg): 29.97	

Describe the following possible sources of noise and give the relative location on the bus.

Source of Noise	Location
Engine and Accessories	None noted.
Windows and Doors	None noted.
Seats and Wheel Chair lifts	None noted.

Comment on any other vibration or noise source which may have occurred that is not described above: None noted.

7.1 INTERIOR NOISE TEST



**TEST BUS SET-UP FOR 80 dB(A)
INTERIOR NOISE TEST**

7.2 EXTERIOR NOISE TESTS

7.2-I. TEST OBJECTIVE

The objective of this test is to record exterior noise levels when a bus is operated under various conditions.

7.2-II. TEST DESCRIPTION

In the exterior noise tests, the bus will be operated at a SLW in three different conditions using a smooth, straight and level roadway:

1. Accelerating at full throttle from a constant speed at or below 35 mph and just prior to transmission up shift.
2. Accelerating at full throttle from standstill.
3. Stationary, with the engine at low idle, high idle, and wide open throttle.

In addition, the buses will be tested with and without the air conditioning and all accessories operating. The exterior noise levels will be recorded.

The test site is at the PSBRTF and the test procedures will be in accordance with SAE Standards SAE J366b, Exterior Sound Level for Heavy Trucks and Buses. The test site is an open space free of large reflecting surfaces. A noise meter placed at a specified location outside the bus will measure the noise level.

During the test, special attention should be paid to:

1. The test site characteristics regarding parked vehicles, signboards, buildings, or other sound-reflecting surfaces
2. Proper usage of all test equipment including set-up and calibration
3. The ambient sound level

7.2-III. DISCUSSION

The Exterior Noise Test determines the noise level generated by the vehicle under different driving conditions and at stationary low and high idle, with and without air conditioning and accessories operating. The test site is a large, level, bituminous paved area with no reflecting surfaces nearby.

With an exterior ambient noise level of 44.7 dB(A), the average test result obtained while accelerating from a constant speed was 77.1 dB(A) on the right side and 77.8 dB(A) on the left side.

When accelerating from a standstill with an exterior ambient noise level of 45.5 dB(A), the average of the results obtained were 77.6 dB(A) on the right side and 77.9 dB(A) on the left side.

With the vehicle stationary and the engine, accessories, and air conditioning on, the measurements averaged 64.7 dB(A) at low idle, 71.2 dB(A) at high idle, and 75.3 dB(A) at wide open throttle. With the accessories and air conditioning off, the readings averaged 1.9 dB(A) lower at low idle, 2.9 dB(A) lower at high idle, and 0.1 dB(A) lower at wide open throttle. The exterior ambient noise level measured during this test was 44.8 dB(A).

EXTERIOR NOISE TEST DATA FORM

Accelerating from Constant Speed

Bus Number: 0610	Date: 6-20-06
Personnel: B.S., T.S. & S.C.	
Temperature (°F): 72	Humidity (%): 54
Wind Speed (mph): 5	Wind Direction: W
Barometric Pressure (in.Hg): 29.97	
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: ■ checked by: S.C.	
Initial Sound Level Meter Calibration: ■ checked by: S.C.	
Exterior Ambient Noise Level dB(A): 44.7	

Accelerating from Constant Speed Curb (Right) Side		Accelerating from Constant Speed Street (Left) Side	
Run #	Measured Noise Level dB(A)	Run #	Measured Noise Level dB(A)
1	76.7	1	77.7
2	77.4	2	77.4
3	76.3	3	77.4
4	76.3	4	77.0
5	76.1	5	77.8
Average of two highest actual noise levels = 77.1 dB(A)		Average of two highest actual noise levels = 77.8 dB(A)	

Final Sound Level Meter Calibration Check: ■ checked by: S.C.

Comments: None noted.

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EXTERIOR NOISE TEST DATA FORM **Accelerating from Standstill**

Bus Number: 0610	Date: 6-20-06
Personnel: B.S., T.S. & S.C.	
Temperature (°F): 72	Humidity (%): 54
Wind Speed (mph): 5	Wind Direction: W
Barometric Pressure (in.Hg): 29.97	
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: ■ checked by: S.C.	
Initial Sound Level Meter Calibration: ■ checked by: S.C.	
Exterior Ambient Noise Level dB(A): 45.5	

Accelerating from Standstill Curb (Right) Side		Accelerating from Standstill Street (Left) Side	
Run #	Measured Noise Level dB(A)	Run #	Measured Noise Level dB(A)
1	77.8	1	77.4
2	77.2	2	77.9
3	77.3	3	77.5
4	76.9	4	77.9
5	77.1	5	77.3
Average of two highest actual noise levels = 77.6 dB(A)		Average of two highest actual noise levels = 77.9 dB(A)	

Final Sound Level Meter Calibration Check: ■ checked by: S.C.

Comments: None noted.

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EXTERIOR NOISE TEST DATA FORM

Stationary

Bus Number: 0610		Date: 6-20-06	
Personnel: B.S., T.S. & S.C.			
Temperature (°F): 72		Humidity (%): 54	
Wind Speed (mph): 5		Wind Direction: W	
Barometric Pressure (in.Hg): 29.97			
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: ■ checked by: S.C.			
Initial Sound Level Meter Calibration: ■ checked by: S.C.			
Exterior Ambient Noise Level dB(A): 44.8			
Accessories and Air Conditioning ON			
Throttle Position	Engine RPM	Curb (Right) Side dB(A)	Street (Left) Side db(A)
		Measured	Measured
Low Idle	700	64.8	64.6
High Idle	1,399	71.0	71.3
Wide Open Throttle	2,118	75.2	75.3
Accessories and Air Conditioning OFF			
Throttle Position	Engine RPM	Curb (Right) Side dB(A)	Street (Left) Side db(A)
		Measured	Measured
Low Idle	700	63.1	62.4
High Idle	1,399	68.5	68.1
Wide Open Throttle	2,118	74.7	75.7
Final Sound Level Meter Calibration Check: ■ checked by: S.C.			
Comments: None noted.			

7.2 EXTERIOR NOISE TESTS



**TEST BUS UNDERGOING
EXTERIOR NOISE TEST**

