

**STURAA TEST**

**12 YEAR**

**500,000 MILE BUS**

**from**

**ELDORADO NATIONAL CALIFORNIA, INC.**

**MODEL AXESS**

**NOVEMBER 2003**

**PTI-BT-R0312**

PENNSTATE



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## EXECUTIVE SUMMARY

ElDorado National California Inc., submitted a model AXESS, CNG-powered 44 seat (including the driver) 40-foot bus, for a 12 yr/500,000 mile STURAA test. The odometer reading at the time of delivery was 513 miles. Testing started on April 8, 2003 and was completed on November 18, 2003. 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 April 20, 2003 and was completed on October 31, 2003.

The interior of the bus is configured with seating for 44 passengers including the driver. Free floor space will accommodate 36 standing passengers resulting in a potential load of 80 persons. At 150 lbs per person, this load results in a measured gross vehicle weight of 31,090 lbs. In order to avoid exceeding the GAWR (15,000 lbs) of the front axle, ballast from six standing passengers was eliminated. This reduction from full capacity resulted in an adjusted measured gross vehicle weight of 41,840 lbs and was used for all dynamic testing. The middle segment was performed at a SLW of 37,500 lbs and the final segment was performed at a CW of 31,090 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), were found to be readily accessible and no restrictions were noted. The only restriction noted during testing was accessing the upper bolts of the left front air bag.

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 44 reported failures, 31 were Class 3 and 13 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 37.00 seconds.

The Shakedown Test produced a maximum final loaded deflection of 0.041 inches with a permanent set ranging between -0.005 to 0.004 inches under a distributed static load of 30,000 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 37,308 lbs. All four front 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 4.8 inches.

A Fuel Economy Test was run on simulated central business district, arterial, and commuter courses. The results were 0.63 M/lb, 0.76 M/lb, and 1.38 M/lb respectively; with an overall average of 0.79 M/lb.

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 an ElDorado National California, Inc., model AXESS. The bus has a front door, equipped with a Ricon model FR2SS-3244 foldout handicap ramp forward of the front axle, and a rear door forward of the rear axle. Power is provided by a CNG-fueled, Cummins Engine Co. model CG 280 engine coupled to an Allison Transmission model B400R transmission.

The measured curb weight is 11,190 lbs for the front axle and 19,900 lbs for the rear axle. These combined weights provide a total measured curb weight of 31,090 lbs. There are 44 seats including the driver and room for 36 standing passengers bringing the total passenger capacity to 80. Gross load is  $150 \text{ lb} \times 80 = 12,000 \text{ lbs}$ . At full capacity, the measured gross vehicle weight is 42,720 lbs. This value was used for all static tests. In order to avoid exceeding the GAWR (15,000 lbs) of the front axle, ballast for 6 standing passengers was eliminated. This reduction from full capacity resulted in an adjusted measured gross vehicle weight of 41,840 lbs and was used for all dynamic testing.

## VEHICLE DATA FORM

Bus Number: 0312	Arrival Date: 4-8-03
Bus Manufacturer: ElDorado National California, Inc.	Vehicle Identification Number (VIN): 1N9APACG13C084105
Model Number: AXESS	Date: 4-8-03
Personnel: 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		Middle Axle		Rear Axle	
	Right	Left	Right	Left	Right	Left
CW	5,470	5,720	N/A	N/A	9,540	10,360
SLW	6,410	6,780	N/A	N/A	12,750	11,560
GVW	7,790 (7,320)	8,300 (7,880)	N/A	N/A	12,640 (12,640)	13,990 (14,000)

Total Weight Details:

Weight (lb)	CW	SLW	GVW	GAWR
Front Axle	11,190	13,190	16,090 (15,200)	15,000
Middle Axle	N/A	N/A	N/A	N/A
Rear Axle	19,900	24,310	26,630 (26,640)	27,760
Total	31,090	37500	42,720 (41,840)	GVWR: 42,760

Dimensions:

Length (ft/in)	40 / 8.0
Width (in)	101.00
Height (in)	134.00
Front Overhang (in)	94.00
Rear Overhang (in)	119.25
Wheel Base (in)	274.75
Wheel Track (in)	Front: 85.0
	Rear: 75.0

Bus Number: 0312	Date: 4-8-03
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**CLEARANCES:**

Lowest Point Outside Front Axle	Location: Frame	Clearance(in): 8.5
Lowest Point Outside Rear Axle	Location: Frame	Clearance(in): 9.6
Lowest Point between Axles	Location: Frame	Clearance(in): 9.6
Ground Clearance at the center (in)	9.6	
Front Approach Angle (deg)	8.6	
Rear Approach Angle (deg)	9.4	
Ramp Clearance Angle (deg)	4.0	
Aisle Width (in)	20.0	
Inside Standing Height at Center Aisle (in)	95.5	

**BODY DETAILS:**

Body Structural Type	Integral		
Frame Material	Steel		
Body Material	Aluminum / fiberglass		
Floor Material	Plywood		
Roof Material	Aluminum		
Windows Type	<input type="checkbox"/> Fixed	<input checked="" type="checkbox"/> Movable	
Window Mfg./Model No.	HEHR / AS3 DOT 389		
Number of Doors	<u>1</u> Front	<u>1</u> Rear	
Mfr. / Model No.	Vapor / Dor-Trol		
Dimension of Each Door (in)	34.3 x 79.2	Rear – 32.4 x 79.6	
Passenger Seat Type	<input type="checkbox"/> Cantilever	<input checked="" type="checkbox"/> Pedestal	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Freedman / Feather Weight		
Driver Seat Type	<input checked="" type="checkbox"/> Air	<input type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Recaro / Ergo Metro		
Number of Seats (including Driver)	44		



Bus Number: 0312	Date: 4-8-03
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#### BODY DETAILS (Contd..)

Free Floor Space ( ft <sup>2</sup> )	55.3
Height of Each Step at Normal Position (in)	Front 1. <u>14.4</u> 2. <u>N/A</u> 3. <u>N/A</u> 4. <u>N/A</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>13.7</u> 2. <u>N/A</u> 3. <u>N/A</u> 4. <u>N/A</u>
Step Elevation Change - Kneeling (in)	4.9

#### ENGINE

Type	<input type="checkbox"/> C.I.	<input type="checkbox"/> Alternate Fuel	
	<input checked="" type="checkbox"/> S.I.	<input type="checkbox"/> Other (explain)	
Mfr. / Model No.	Cummins Engine Co. / CG 280		
Location	<input type="checkbox"/> Front	<input checked="" type="checkbox"/> Rear	<input type="checkbox"/> Other (explain)
Fuel Type	<input type="checkbox"/> Gasoline	<input checked="" type="checkbox"/> CNG	<input type="checkbox"/> Methanol
	<input type="checkbox"/> Diesel	<input type="checkbox"/> LNG	<input type="checkbox"/> Other (explain)
Fuel Tank Capacity (indicate units)	18,140 scf @ 3600 psi		
Fuel Induction Type	<input type="checkbox"/> Injected	<input checked="" type="checkbox"/> Carburetion	
Fuel Injector Mfr. / Model No.	N/A		
Carburetor Mfr. / Model No.	Woodward Fuel Delivery System / Flo Tech 60 mm		
Fuel Pump Mfr. / Model No.	N/A		
Alternator (Generator) Mfr. / Model No.	Leece-Neville / A0014867JB		
Maximum Rated Output (Volts / Amps)	14 / 270		
Air Compressor Mfr. / Model No.	Wabco / 18.7		
Maximum Capacity (ft <sup>3</sup> / min)	18.7		
Starter Type	<input checked="" type="checkbox"/> Electrical	<input type="checkbox"/> Pneumatic	<input type="checkbox"/> Other (explain)
Starter Mfr. / Model No.	Denso / 228000-5311		

Bus Number: 0312	Date: 4-8-03
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#### TRANSMISSION

Transmission Type	<input type="checkbox"/> Manual	<input checked="" type="checkbox"/> Automatic	
Mfr. / Model No.	Allison Transmission / B400R		
Control Type	<input type="checkbox"/> Mechanical	<input checked="" type="checkbox"/> Electrical	<input type="checkbox"/> Other
Torque Converter Mfr. / Model No.	Allison Transmission / B400R		
Integral Retarder Mfr. / Model No.	Allison Transmission / B400R		

#### SUSPENSION

Number of Axles	2		
Front Axle Type	<input type="checkbox"/> Independent	<input checked="" type="checkbox"/> Beam Axle	
Mfr. / Model No.	Meritor / FH 946 RX 125		
Axle Ratio (if driven)	N/A		
Suspension Type	<input checked="" type="checkbox"/> Air	<input type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
No. of Shock Absorbers	2		
Mfr. / Model No.	Koni / 90 2184		
Middle Axle Type	<input type="checkbox"/> Independent	<input type="checkbox"/> Beam Axle	
Mfr. / Model No.	N/A		
Axle Ratio (if driven)	N/A		
Suspension Type	<input type="checkbox"/> Air	<input type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
No. of Shock Absorbers	N/A		
Mfr. / Model No.	N/A		
Rear Axle Type	<input type="checkbox"/> Independent	<input checked="" type="checkbox"/> Beam Axle	
Mfr. / Model No.	Meritor / 71000 RX		
Axle Ratio (if driven)	4.89		
Suspension Type	<input checked="" type="checkbox"/> Air	<input type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
No. of Shock Absorbers	4		
Mfr. / Model No.	Koni / 90-2184X (Front) 90-2102SPIX (Rear)		

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#### WHEELS & TIRES

Front	Wheel Mfr./ Model No.	Accuride / 8.25 x 22.5
	Tire Mfr./ Model No.	Michelin / XZU / 305/70R 22.5
Rear	Wheel Mfr./ Model No.	Accuride / 8.25 x 22.5
	Tire Mfr./ Model No.	Michelin / XZU / 305/70R 22.5

#### BRAKES

Front Axle Brakes Type	<input checked="" type="checkbox"/> Cam	<input type="checkbox"/> Disc	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Meritor / Cast Plus		
Middle Axle Brakes Type	<input type="checkbox"/> Cam	<input type="checkbox"/> Disc	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	N/A		
Rear Axle Brakes Type	<input checked="" type="checkbox"/> Cam	<input type="checkbox"/> Disc	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Meritor / Q-Plus		
Retarder Type	Integral		
Mfr. / Model No.	Allison Transmission / B400R		

#### HVAC

Heating System Type	<input type="checkbox"/> Air	<input checked="" type="checkbox"/> Water	<input type="checkbox"/> Other
Capacity (Btu/hr)	90,000		
Mfr. / Model No.	Thermo King / T-2		
Air Conditioner	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	
Location	Rear, above engine compartment & front dash		
Capacity (Btu/hr)	88,000		
A/C Compressor Mfr. / Model No.	Thermo King Corp. / X430		

#### STEERING

Steering Gear Box Type	Hydraulic gear
Mfr. / Model No.	Shephard Co. / M110
Steering Wheel Diameter	20.0
Number of turns (lock to lock)	4.75

Bus Number: 0312	Date: 4-8-03
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#### OTHERS

Wheel Chair Ramps	Location: Right front	Type: Fold out ramp
Wheel Chair Lifts	Location: N/A	Type: N/A
Mfr. / Model No.	Ricon / FR2SS-3244	
Emergency Exit	Location: Windows Doors Roof hatch	Number: 5 2 1

#### CAPACITIES

Fuel Tank Capacity (units)	18,140 scf @ 3600 psi
Engine Crankcase Capacity (gallons)	4.75
Transmission Capacity (gallons)	4.50
Differential Capacity (gallons)	4.50
Cooling System Capacity (quarts)	2.60
Power Steering Fluid Capacity (gallons)	3

**VEHICLE DATA FORM**

Bus Number: 0312	Date: 4-8-03
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**List all spare parts, tools and manuals delivered with the bus.**

Part Number	Description	Qty.
Michelin XZU 305/70R 22.5	Tires, mounted	2
062891	Air filter	1
W01-358-8874	Air bag	4
13200 504	Rear shock	4
13200 404	Front shock	2
LF 3000	Oil filter	1
NG 5900	Natural gas filter	1
WF 2073	Coolant filter	1
Na	Allison Transmission filter	1
4025416	Spark plug	6
3607166	Filter	1
78-941 (Thermo King)	Belt	2
Na	Belt tensioner	1
Na	Pulley	1
Cummins 3920430	Belt	1
B-83	Belt	2
Tow eyes	Tow eyes	2
OTTO P3-90126 21649 0310	Switch	2

## COMPONENT/SUBSYSTEM INSPECTION FORM

Bus Number: 0312	Date: 4-8-03
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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	✓	CNG
Power Plant	✓	
Accessories	✓	
Lift System	✓	
Interior Fasteners	✓	
Batteries	✓	

## **CHECK - IN**



## **ELDORADO NATIONAL CALIFORNIA, INC. MODEL AXESS**



## **CHECK - IN CONT.**



**ELDORADO NATIONAL CALIFORNIA, INC.  
MODEL AXESS EQUIPPED WITH A RICON MODEL  
FR2SS-3244 HANDICAP RAMP**





# **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), were found to be readily accessible and no restrictions were noted. The only restriction noted during testing was accessing the upper bolts of the left front air bag.

## ACCESSIBILITY DATA FORM

Bus Number: 0312	Date: 11-17-03
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Component	Checked	Comments
<b>ENGINE :</b>		
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	✓	Spark plugs.
Alternator	✓	
Diagnostic Interface Connector	✓	
<b>TRANSMISSION :</b>		
Fluid Dip-Stick	✓	
Filler Hole	✓	
Drain Plug	✓	
<b>SUSPENSION :</b>		
Bushings	✓	
Shock Absorbers	✓	
Air Springs	✓	
Leveling Valves	✓	
Grease Fittings	✓	

## ACCESSIBILITY DATA FORM

Bus Number: 0312	Date: 11-17-03
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Component	Checked	Comments
<b>HVAC :</b>		
A/C Compressor	✓	
Filters	✓	
Fans	✓	
<b>ELECTRICAL SYSTEM :</b>		
Fuses	✓	
Batteries	✓	
Voltage regulator	✓	
Voltage Convertors	✓	
Lighting	✓	
<b>MISCELLANEOUS :</b>		
Brakes	✓	
Handicap Lifts/Ramps	✓	
Instruments	✓	
Axles	✓	
Exhaust	✓	
Fuel System	✓	CNG
<b>OTHERS :</b>		

## **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**  
 ElDorado National 0312

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
05-08-03	1,152	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
06-18-03	2,491	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
06-26-03	3,401	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
07-07-03	4,382	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
07-15-03	5,172	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
07-31-03	5,378	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
08-07-03	6,142	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00

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**SCHEDULED MAINTENANCE**  
 ElDorado National 0312

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
08-18-03	7,300	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
08-29-03	9,158	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
09-05-03	9,558	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
09-15-03	10,810	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
09-24-03	11,609	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-02-03	11,857	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
10-21-03	13,791	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
11-03-03	Complete	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	#2112	URSA Super Plus SAE 30
Transmission oil	#1866	Automatic Trans Fluid Mercon/Dexron II Multipurpose
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>
Air fitting, right rear, rear air bag.	0.50
Start button.	0.50
Both low beam lamps.	1.00
Air dryer.	1.50
Front sway bar, clamps, bushings and links.	1.00
Left front air bag.	1.00
Left rear, inside tire.	0.50
Spark plugs.	1.50

Lower rear sway bar.	1.00
Left, rear, forward shock.	2.00
Right front air bag.	1.00
Right rear inside tire.	1.00

At the end of the test, the remaining items on the list were removed and replaced. The transmission assembly took 8.00 man-hours (two men 4.00 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	8.00 man hours
Wiper Motor	0.75 man hours
Starter	0.75 man hours
Alternator	1.00 man hours
Batteries	0.75 man hours

### **1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS**



#### **TRANSMISSION REMOVAL AND REPLACEMENT (8.00 MAN HOURS)**



#### **WIPER MOTOR REMOVAL AND REPLACEMENT (0.75 MAN HOURS)**

### **1.3 REPLACEMENT AND/OR REPAIR OF SELECTED SUBSYSTEMS CONT.**



#### **STARTER REMOVAL AND REPLACEMENT (0.75 MAN HOURS)**



#### **ALTERNATOR 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 enroute 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 31 Class 3 failures, 26 involved the suspension system, four occurred with the engine/transmission, and one with the wheels & tires. These, and the remaining 13 Class 4 failures are available for review in the Unscheduled Maintenance List, located in Section 5.7 Structural Durability.

# RELIABILITY DATA FORMS

Bus Number: 0312	Date: 10-31-03
Personnel: Bob Reifsteck	

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

Subsystems	Mileage	Mileage	Mileage	Mileage	Man Hours	Down Time
Suspension	794				0.50	0.50
		989			4.00	4.00
		989			0.50	0.50
		2,184			1.00	1.00
		3,172			2.00	2.00
		4,072			0.50	0.50
		4,382			1.00	1.00
		5,022			0.50	0.50
	5,172				2.00	2.00
		5,378			3.00	3.00
	5,569				2.00	2.00
		5,992			3.00	3.00
		6,681			1.00	1.00
	6,681				2.50	2.50
		6,730			2.00	2.00
	7,016				4.00	4.00
	8,975				0.50	0.50
		9,108			1.00	1.00
		9,558			4.00	4.00
		10,464			0.50	0.50
		11,744			0.50	0.50
		11,857			1.00	1.00



# RELIABILITY DATA FORMS

Bus Number: 0312	Date: 10-31-03
Personnel: Bob Reifsteck	

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

Subsystems	Mileage	Mileage	Mileage	Mileage	Man Hours	Down Time
Suspension (continued)		11,857			1.00	1.00
		13,275			2.00	2.00
		13,534			1.00	1.00
	13,644				0.50	0.50
		13,644			1.00	1.00
		13,724			0.50	0.50
		13,791			0.50	0.50
		13,869			0.50	0.50
		13,933			0.50	0.50
		13,974			0.50	0.50
		14,143			0.50	0.50
Engine/Transmission		344			1.00	1.00
		379			1.00	1.00
		2,184			0.50	0.50
		4,247			1.50	1.50
	8,759				1.50	1.50
	12,031				0.50	0.50
Wheels/Tires		8,606			0.50	0.50
	14,889				1.00	1.00
Electrical	3,663				1.00	1.00
	5,992				1.00	1.00
Exhaust System	4,382				0.50	0.50

### **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: 0312	Date: 9-17-03
Personnel: R.C., T.S. & S.C.	

Temperature (°F): 62	Humidity (%): 93
Wind Direction: Calm	Wind Speed (mph): Calm
Barometric Pressure (in.Hg): 30.33	

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

### **3. SAFETY**



**LEFT - HAND APPROACH**



**RIGHT - 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 37.00 seconds.

## PERFORMANCE DATA FORM

Bus Number: 0312		Date: 9-17-03	
Personnel: R.C., T.S. & S.C.			
Temperature (°F): 62		Humidity (%): 93	
Wind Direction: Calm		Wind Speed (mph): Calm	
Barometric Pressure (in.Hg): 30.33			
Air Conditioning compressor-OFF		<u>✓</u> Checked	
Ventilation fans-ON HIGH		<u>✓</u> Checked	
Heater pump motor-Off		<u>✓</u> Checked	
Defroster-OFF		<u>✓</u> Checked	
Exterior and interior lights-ON		<u>✓</u> Checked	
Windows and doors-CLOSED		<u>✓</u> Checked	
<b>ACCELERATION, GRADEABILITY, TOP SPEED</b>			
Counter Clockwise Recorded Interval Times			
Speed	Run 1	Run 2	Run 3
10 mph	5.30	5.18	5.14
20 mph	9.08	8.99	9.08
30 mph	14.02	13.62	13.61
40 mph	24.08	23.74	23.64
Top Test Speed(mph) 50	40.38	39.77	39.42
Clockwise Recorded Interval Times			
Speed	Run 1	Run 2	Run 3
10 mph	5.15	5.40	5.17
20 mph	8.99	9.40	9.02
30 mph	13.02	13.40	13.61
40 mph	21.87	22.37	22.23
Top Test Speed(mph) 50	33.93	34.40	34.08

0312.ACC

PERFORMANCE SUMMARY SHEET

BUS MANUFACTURER :Eldorado National  
 BUS MODEL :AXESS

BUS NUMBER :0312  
 TEST DATE :9/17/03

TEST CONDITIONS :

-----  
 TEMPERATURE (DEG F ) : 62.0  
 WIND DIRECTION : calm  
 WIND SPEED (MPH) : .0  
 HUMIDITY (%) : 93  
 BAROMETRIC PRESSURE (IN. HG) : 30.3

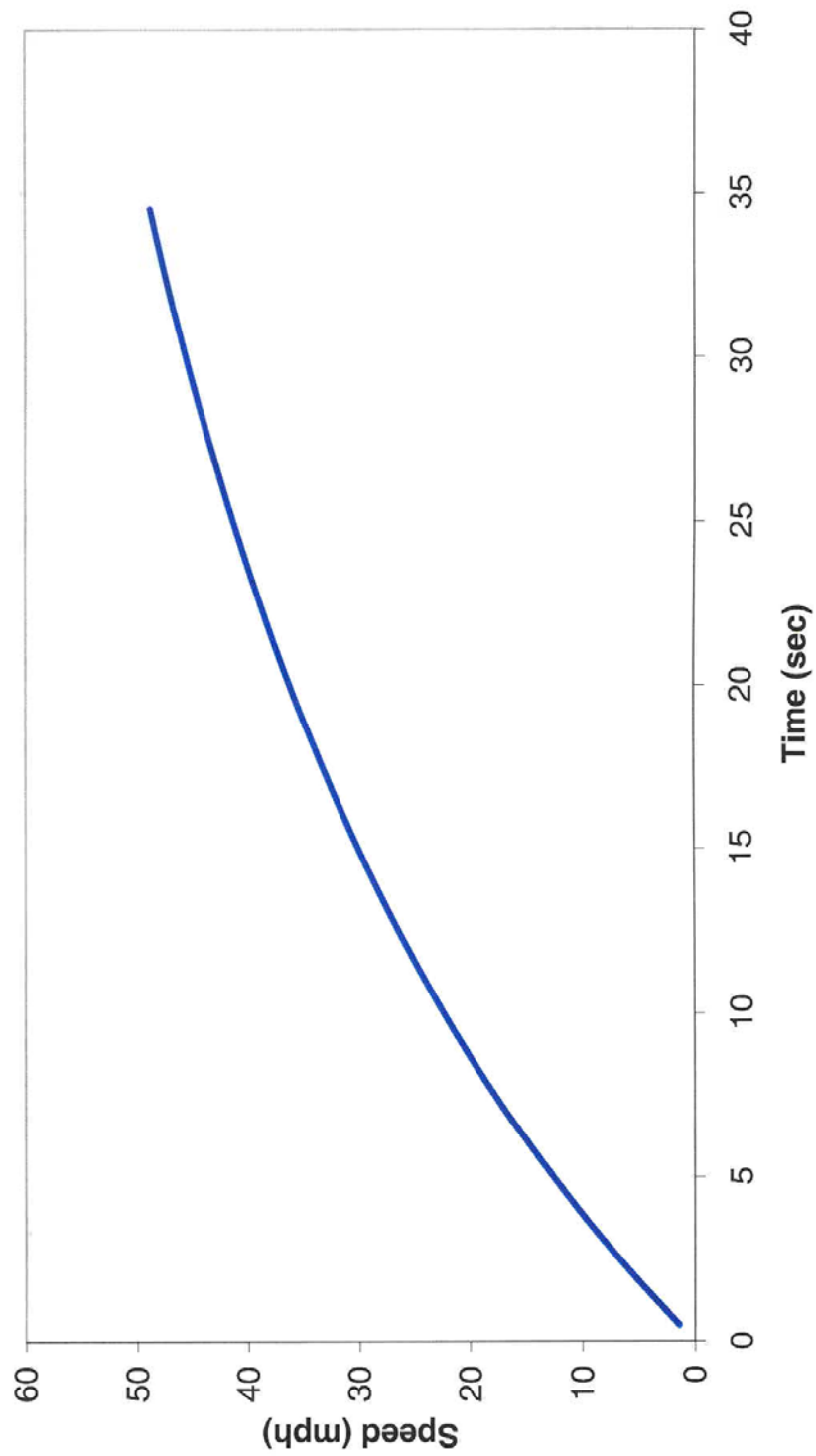
VEHICLE SPEED (MPH)	AVERAGE TIME (SEC)		
	CCW DIRECTION	CW DIRECTION	TOTAL
10.0	5.21	5.24	5.22
20.0	9.05	9.14	9.09
30.0	13.75	13.34	13.55
40.0	23.82	22.16	22.99
50.0	39.86	34.14	37.00

TEST SUMMARY :

VEHICLE SPEED (MPH)	TIME (SEC)	ACCELERATION (FT/SEC^2)	MAX. GRADE (%)
1.0	.35	4.1	12.9
5.0	1.83	3.8	11.9
10.0	3.85	3.4	10.7
15.0	6.11	3.1	9.5
20.0	8.67	2.7	8.4
25.0	11.58	2.4	7.3
30.0	14.94	2.0	6.3
35.0	18.87	1.7	5.3
40.0	23.56	1.4	4.4
45.0	29.25	1.2	3.6
50.0	36.35	.9	2.9

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**  
**Eldorado National #0312**





## 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 80 people including the driver. The resulting test load is  $(80 \times 375 \text{ lb}) = 30,000 \text{ lb}$ . 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 0.041 inches at reference point 11. The maximum permanent deflection after the final loading sequence ranged from -.005 inches at reference point 1 to 0.004 inches at reference points 2 and 11.

# STRUCTURAL SHAKEDOWN DATA FORM

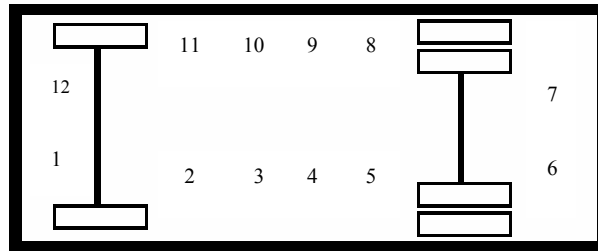
Bus Number: 0312	Date: 4-22-03
Personnel: T.S., E.D., E.L. & S.C.	Temperature (°F): 69
Loading Sequence: <input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3   (check one) Test Load (lbs): 30,000	

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	.050	.050	.030	.030
2	0	.022	.022	-.003	-.003
3	0	.032	.032	.000	.000
4	0	.033	.033	.000	.000
5	0	.029	.029	-.003	-.003
6	0	.014	.014	.000	.000
7	0	.014	.014	.003	.003
8	0	.024	.024	.008	.008
9	0	.055	.055	.017	.017
10	0	.054	.054	.014	.014
11	0	.075	.075	.040	.040
12	0	.062	.062	.040	.040

### STRUCTURAL SHAKEDOWN DATA FORM

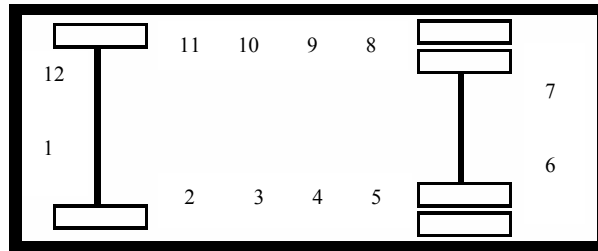
Bus Number: 0312	Date: 4-23-03
Personnel: E.D., D.L., C.S., T.W. & M.R.	Temperature (°F): 55
Loading Sequence: <input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3   (check one) Test Load (lbs): 30,000	

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	.030	.050	.020	.025	-.005
2	-.003	.020	.023	-.007	.004
3	.000	.030	.030	-.004	-.004
4	.000	.033	.033	-.001	-.001
5	-.003	.030	.033	.002	.005
6	.000	.015	.015	.000	.000
7	.003	.015	.012	.003	.000
8	.008	.023	.015	.008	.000
9	.017	.056	.039	.019	.002
10	.014	.054	.040	.014	.000
11	.040	.081	.041	.044	.004
12	.040	.064	.024	.038	-.002

## 5.1 STRUCTURAL SHAKEDOWN TEST



**DIAL INDICATORS IN POSITION**



**BUS LOADED TO 2.5 TIMES GVL  
(30,000 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 eight 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: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input checked="" type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input checked="" type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input checked="" type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.



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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input checked="" type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input checked="" type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input checked="" type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input checked="" type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input checked="" type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input checked="" type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

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

Bus Number: 0312	Date: 4-25-03
Personnel: S.C., E.D., T.S., D.L. & B.T.	Temperature(°F): 69

Wheel Position : (check one)		
All wheels level	<input type="checkbox"/> before	<input checked="" type="checkbox"/> after
Left front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right front	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left rear	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Right center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower
Left center	<input type="checkbox"/> 6 in higher	<input type="checkbox"/> 6 in lower

	Comments
<input checked="" type="checkbox"/> Windows	No deficiencies.
<input checked="" type="checkbox"/> Front Doors	No deficiencies.
<input checked="" type="checkbox"/> Rear Doors	No deficiencies.
<input checked="" type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.
<input checked="" type="checkbox"/> Engine	No deficiencies.
<input checked="" type="checkbox"/> Handicapped Device/ Special Seating	No deficiencies.
<input checked="" type="checkbox"/> Undercarriage	No deficiencies.
<input checked="" type="checkbox"/> Service Doors	No deficiencies.
<input checked="" type="checkbox"/> Body	No deficiencies.
<input checked="" type="checkbox"/> Windows/ Body Leakage	No deficiencies.
<input checked="" type="checkbox"/> Steering Mechanism	No deficiencies.

## 5.2 STRUCTURAL DISTORTION TEST



**RIGHT REAR WHEEL SIX INCHES HIGHER**



**LEFT FRONT WHEEL SIX INCHES LOWER**



## **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 37,308 lbs (1.2 x 31,090 lbs CW). No damage or deformation was observed during all four pulls of the test. Towing is not recommended from the rear, therefore, a rear test was not performed.

### STATIC TOWING TEST DATA FORM

Bus Number: 0312	Date: 11-14-03
Personnel: E.L., E.D. & D.L.	Temperature (°F): 40

<b>Inspect right front tow eye and adjoining structure.</b>
<b>Comments:</b> No damage or deformation observed.
<b>Check the torque of all bolts attaching tow eye and surrounding structure.</b>
<b>Comments:</b> Torques verified.
<b>Inspect left tow eye and adjoining structure.</b>
<b>Comments:</b> No damage or deformation observed.
<b>Check the torque of all bolts attaching tow eye and surrounding structure.</b>
<b>Comments:</b> Torques verified.
<b>Inspect right rear tow eye and adjoining structure.</b>
<b>Comments:</b> N/A
<b>Check the torque of all bolts attaching tow eye and surrounding structure.</b>
<b>Comments:</b> N/A
<b>Inspect left rear tow eye and adjoining structure.</b>
<b>Comments:</b> N/A
<b>Check the torque of all bolts attaching tow eye and surrounding structure.</b>
<b>Comments:</b> N/A
<b>General comments of any other structure deformation or failure:</b>
None noted.

## 5.3 STATIC TOWING TEST



### FRONT 20° UPWARD PULL



### FRONT 20° DOWN PULL

### 5.3 STATIC TOWING TEST CONT.



**20° LEFT PULL**



**20° RIGHT PULL**

## **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.

## DYNAMIC TOWING TEST DATA FORM

Bus Number: 0312	Date: 11-12-03
Personnel: S.C. & T.S.	

Temperature (°F): 52	Humidity (%): 64
Wind Direction: Calm	Wind Speed (mph): Calm
Barometric Pressure (in.Hg): 30.05	

<b>Inspect tow equipment-bus interface.</b>
<b>Comments:</b> A safe and adequate connection was made between the tow equipment and the bus.
<b>Inspect tow equipment-wrecker interface.</b>
<b>Comments:</b> A safe and adequate connection was made between the tow equipment and the wrecker.
<b>Towing Comments:</b> A front lift tow was performed incorporating a hydraulic under lift wrecker.
<b>Description and location of any structural damage:</b> None noted.
<b>General Comments:</b> None



## 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 jack 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 4.8 inches to 9.8 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**

<b>Condition</b>	<b>Frame Point Clearance</b>
Front axle – one tire flat	7.2"
Rear axle – one tire flat	9.7"
Rear axle – two tires flat	7.9"



## JACKING TEST DATA FORM

Bus Number: 0312	Date: 4-22-03
Personnel: E.D., E.L. & T.S.	Temperature: 55

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	12.3 " I 7.4 " D	7.0 " I 4.8 " D	
Left front	10.2 " I 7.2 " D	7.0 " I 4.8 " D	
Right rear—outside	10.4 " I 9.8 " D	7.1 " I 6.7 " D	
Right rear—both	10.4 " I 8.0 " D	7.1 " I 5.4 " D	
Left rear—outside	10.4 " I 9.7 " D	7.1 " I 6.6 " D	
Left rear—both	10.4 " I 7.9 " D	7.1 " I 5.2 " D	
Right middle or tag—outside	NA	NA	
Right middle or tag—both	NA	NA	
Left middle or tag—outside	NA	NA	
Left middle or tag—both	NA	NA	
<b>Additional comments of any deformation or difficulty during jacking:</b>			
None			

## **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: 0312	Date: 4-22-03
Personnel: S.C. & T.S.	Temperature (°F): 60

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

## 5.6 HOISTING TEST



### TEST BUS STABLE ON JACK STANDS



## **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 April 20, 2003 and was conducted until October 31, 2003. The first 6,250 miles were performed at a GVW of 41,840 lbs. The number of standing passengers was reduced from 36 to 30. The ballast for six standing passengers was eliminated. This reduction in passenger weight was necessary to avoid exceeding the GAWR (15,000 lbs) of the front axle. The GVW segment was completed on August 15, 2003. The next 2,500 mile SLW segment was performed at 37,500 lbs and completed on September 5, 2003, and the final 6,250 mile segment was performed at a CW of 31,090 lbs. and was completed on October 31, 2003.

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.

**ELDORADO - TEST BUS #0312**  
**MILEAGE DRIVEN/RECORDED FROM DRIVERS' LOGS**

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
04/16/03 TO 04/22/03	0.00	114.43	114.43
04/21/03 TO 04/27/03	86.11	55.52	141.63
04/28/03 TO 05/04/03	480.39	57.78	538.17
05/05/03 TO 05/11/03	330.84	84.97	415.81
05/12/03 TO 05/18/03	0.00	0.00	0.00
05/19/03 TO 05/25/03	0.00	0.00	0.00
05/26/03 TO 06/01/03	0.00	0.00	0.00
06/02/03 TO 06/08/03	0.00	0.00	0.00
06/09/03 TO 06/15/03	440.74	533.64	974.38
06/16/03 TO 06/22/03	435.09	245.87	680.96
06/23/03 TO 06/29/03	837.30	94.04	931.34
06/30/03 TO 07/06/03	499.66	86.11	585.77
07/07/03 TO 07/13/03	654.88	124.62	779.50
07/14/03 TO 07/20/03	9.06	1.13	10.19
07/21/03 TO 07/27/03	97.44	108.77	206.21
07/28/03 TO 08/03/03	256.06	69.11	325.17
08/04/03 TO 08/10/03	660.55	160.89	821.44

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
08/11/03 TO 08/17/03	504.19	129.16	633.35
08/18/03 TO 08/24/03	1128.46	227.72	1356.18
08/25/03 TO 08/31/03	639.00	149.56	788.56
09/01/03 TO 09/07/03	268.52	129.16	397.68
09/08/03 TO 09/14/03	976.64	132.55	1109.19
09/15/03 TO 09/21/03	612.96	0.00	612.96
09/22/03 TO 09/28/03	433.94	0.00	433.94
09/29/03 TO 10/05/03	87.24	0.00	87.24
10/06/03 TO 10/12/03	1272.35	0.00	1272.35
10/13/03 TO 10/19/03	507.59	0.00	507.59
10/20/03 TO 10/26/03	250.39	0.00	250.39
10/27/03 TO 11/02/03	1027.65	0.00	1027.65
TOTAL	12497.05	2505.03	15002.08

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

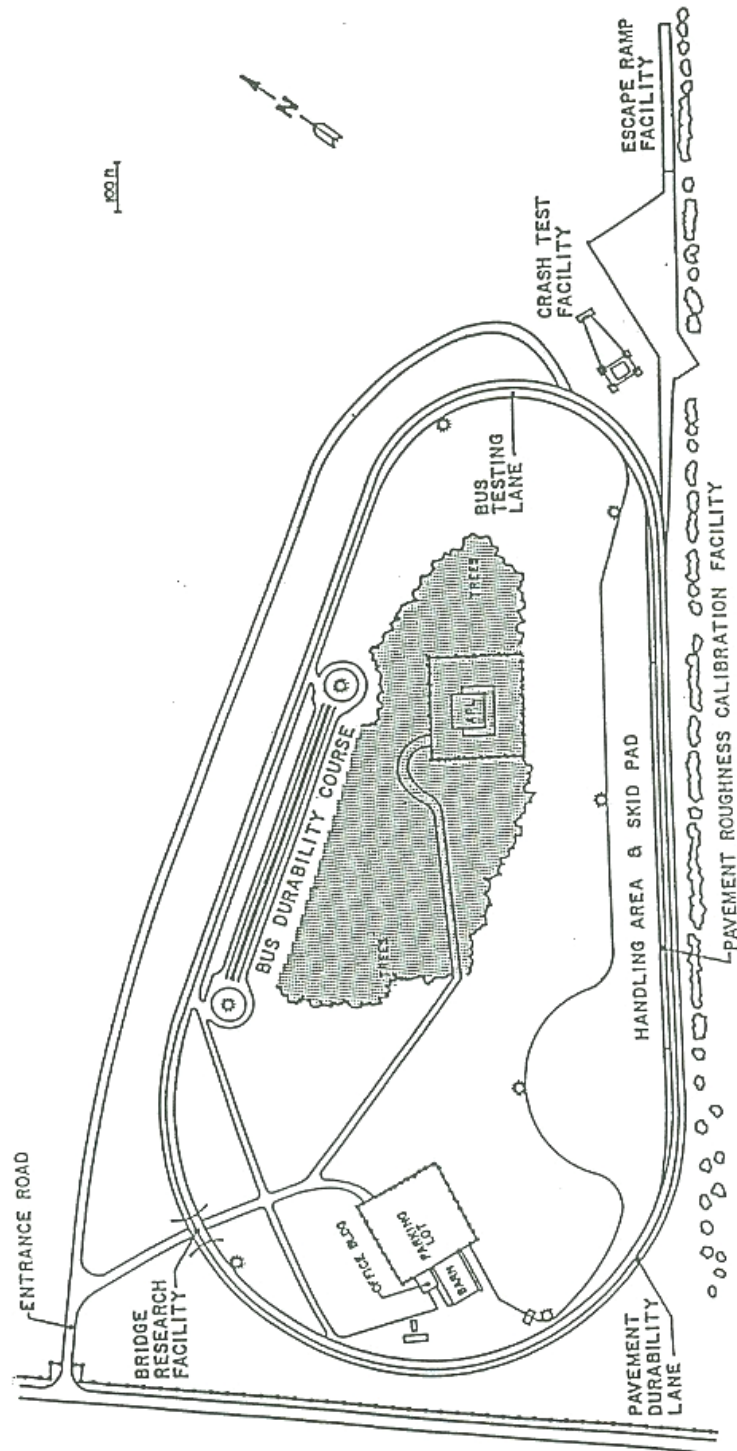
C—Cycle all systems five times, visual inspection, driver's log entries

D—Drive bus as specified by procedure

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



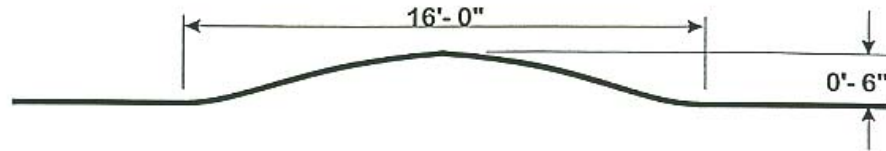
# **“PLAN VIEW OF PENN STATE BUS TESTING AND RESEARCH FACILITY”**



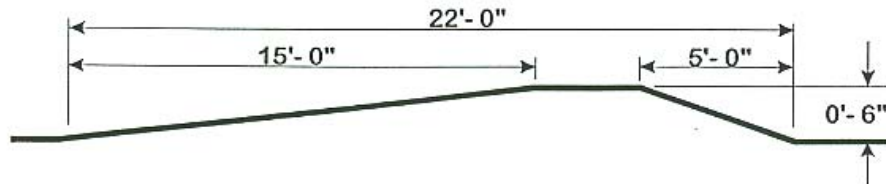
**BUS TESTING AND RESEARCH TEST TRACK  
UNIVERSITY PARK, PA**



Staggered  
Bumps  
(10 mph)



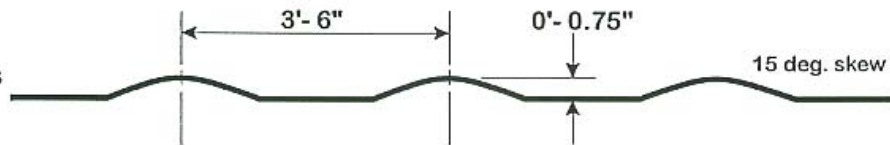
Railroad  
Crossing  
(8 mph)



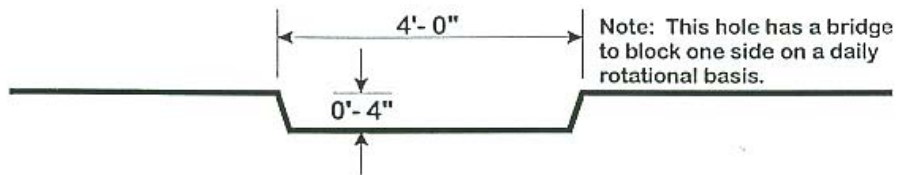
1" Random  
Chuck Holes  
(20 mph)



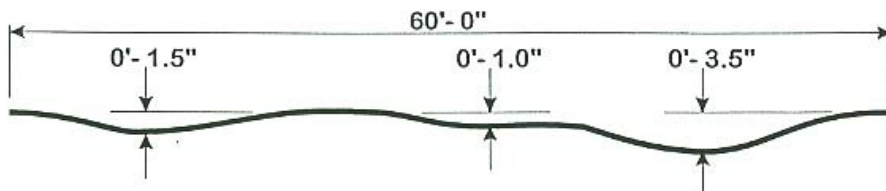
Chatter Bumps  
(20 mph)



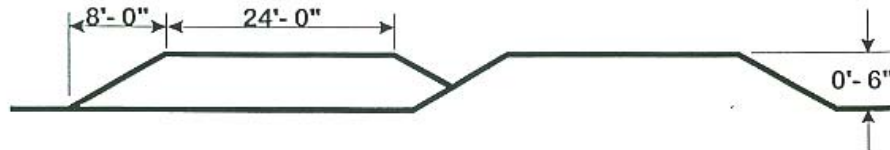
4" Chuck Hole  
(5 mph)



High Crown  
Intersection  
(20 mph)



Frame Twist  
(10 mph)



## Durability Element Profiles

The Pennsylvania Transportation Institute  
Penn State

(Page 1 of 5)  
**UNSCHEDULED MAINTENANCE**  
 ElDorado National 0312

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
04-29-03	344	Transmission will not go into gear, "Check Trans" light is on.	Trouble-shooting with Pro-Link and trouble-shooting the wiring found a loose connection at the transmission. Tightened connection and cleared codes.	1.00	1.00
04-30-03	379	Transmission will not go into gear, "Check Trans" light is on.	Tightened the nut which holds the transmission pigtail socket, re-routed the harness that connects the pigtail, cleaned the socket and connector and reconnected wiring.	1.00	1.00
05-05-03	794	The right side saddle bushing is out of position on the front sway bar.	Saddle bushing reinstalled.	0.50	0.50
05-07-03	989	One mounting bolt is broken and the other is stripped out on the lower right rear radius arm.	Installed helicoil in stripped hole and replaced both bolts.	4.00	4.00
05-07-03	989	The right rear air fitting on the rear air bag is broken.	Air fitting replaced.	0.50	0.50
06-16-03	2,184	The engine will not start from the front controls.	New start button installed in dash.	0.50	0.50
06-16-03	2,184	The right side saddle clamp on the front sway bar is loose. The two lower bolts are broken off and the upper bolts are loose.	Saddle clamp straightened, two broken bolts removed and all four bolts replaced. Left side torqued.	1.00	1.00

(Page 2 of 5)  
**UNSCHEDULED MAINTENANCE**  
 ElDorado National 0312

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
06-25-03	3,172	The two lower bolts on the left saddle clamp of the front sway bar are broken.	Broken bolts removed, saddle clamp straightened and all four bolts replaced.	2.00	2.00
06-27-03	3,663	Both low beam lamps are burned out.	Both low beam lamps replaced.	1.00	1.00
07-01-03	4,072	The front of the bus is bottoming out on the durability track. Ride height is low on the right side.	The right front leveling valve arm is loose. Tightened arm and adjusted ride height.	0.50	0.50
07-02-03	4,247	The air system will not build air. The desiccant cartridge has broken apart.	Air dryer rebuilt.	1.50	1.50
07-08-03	4,382	The front sway bar is broken at the left side radius.	Replaced front sway bar, clamps, bushings and links.	1.00	1.00
07-08-03	4,382	The exhaust pipe is falling out of the muffler.	Exhaust pipe refitted into muffler.	0.50	0.50
07-11-03	5,022	The left lower nut fell off the front sway bar. All four link shackles are bent.	Bent shackles replaced with good used shackles and new bushing installed on the sway bar.	0.50	0.50
07-17-03	5,172	Manufacturer requests installation of new type sway bar bushings to replace current 3 piece bushings.	Installed new sway bar mounting brackets and new single piece, press type bushings.	2.00	2.00
07-31-03	5,378	The front sway bar bushings collapsed.	Replaced front sway bar brackets and bushings.	3.00	3.00

(Page 3 of 5)  
**UNSCHEDULED MAINTENANCE**  
 ElDorado National 0312

<b>DATE</b>	<b>TEST MILES</b>	<b>SERVICE</b>	<b>ACTIVITY</b>	<b>DOWN TIME</b>	<b>HOURS</b>
08-01-03	5,569	The left front air bag is leaking air.	Left front air bag replaced (limited access to upper bolts).	2.00	2.00
08-05-03	5,992	The right side low beam lamp is burned out.	Right side low beam lamp replaced.	1.00	1.00
08-05-03	5,992	The right front, upper shock mount is cracked.	Weld/repair right front, upper shock mount.	3.00	3.00
08-12-02	6,681	The left front air bag is blown.	Left front air bag replaced.	1.00	1.00
08-12-02	6,681	Both front, lower sway bar bushings are worn.	Both front lower sway bar bushings replaced.	2.50	2.50
08-13-03	6,730	The left front air bag separated at the top plate.	Upper mounting plate rounded off, new air bag installed.	2.00	2.00
08-15-03	7,016	Front sway bar bushings and brackets are all worn.	Replaced front sway bar, bushings and brackets.	4.00	4.00
08-25-03	8,606	The left rear inside tire is flat.	Tire/wheel replaced.	0.50	0.50
08-26-03	8,759	Engine has a miss.	Spark plugs replaced.	1.50	1.50
08-27-03	8,975	The left rear, forward shock is loose at the top.	Missing washer replaced.	0.50	0.50

(Page 4 of 5)  
**UNSCHEDULED MAINTENANCE**  
 ElDorado National 0312

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
08-29-03	9,108	The front sway bar is broken.	Front sway bar replaced.	1.00	1.00
09-05-03	9,558	The anchor point at the saddle mounts (for the front sway bar) are cracking at the welds.	Area reinforced with weld.	4.00	4.00
09-11-03	10,464	The lower shock bushing and washer is missing from the left side, forward shock on the rear axle.	New bushing and washer installed.	0.50	0.50
09-25-03	11,744	The right side, front sway bar saddle clamp is broken.	Saddle clamp replaced.	0.50	0.50
10-02-03	11,857	The front sway bar is broken.	Replaced front sway bar and bushings.	1.00	1.00
10-02-03	11,857	The bushings are worn on the right side of the lower rear sway bar.	Lower rear sway bar replaced.	1.00	1.00
10-06-03	12,031	The throttle pedal pivot pin has worked out of the bracket.	Reinstalled pin and added a screw to the end to hold in place.	0.50	0.50
10-13-03	13,275	The left rear forward shock is broken.	Replaced the left rear forward shock.	2.00	2.00
10-15-03	13,534	The left front air bag is blown.	Replaced left front air bag.	1.00	1.00
10-16-03	13,644	The left lower castle nut is loose on the front sway bar.	Castle nut tightened.	0.50	0.50

(Page 5 of 5)  
**UNSCHEDULED MAINTENANCE**  
 ElDorado National 0312

<b>DATE</b>	<b>TEST MILES</b>	<b>SERVICE</b>	<b>ACTIVITY</b>	<b>DOWN TIME</b>	<b>HOURS</b>
10-16-03	13,644	The right front air bag has blown.	Right front air bag replaced.	1.00	1.00
10-20-03	13,724	The sway bar link is broken on the sway bar end.	Sway bar link and stud replaced.	0.50	0.50
10-22-03	13,791	The left front sway bar link is broken.	Left front sway bar link replaced.	0.50	0.50
10-23-03	13,869	The sway bar link is broken on the sway bar end.	Sway bar link and stud replaced.	0.50	0.50
10-24-03	13,933	The sway bar link is broken on the sway bar end.	Sway bar link and stud replaced.	0.50	0.50
10-26-03	13,974	The sway bar link is broken on the sway bar end.	Sway bar link and stud replaced.	0.50	0.50
10-28-03	14,143	The sway bar link is broken on the sway bar end.	Sway bar link and stud replaced.	0.50	0.50
10-31-03	14,889	The right rear inside tire is worn.	Replaced right rear inside tire.	1.00	1.00



## **UNSCHEDULED MAINTENANCE**



**BROKEN LOWER RIGHT REAR RADIUS ROD BOLTS  
(989 TEST MILES)**



**FRONT SWAY BAR; BROKEN SADDLE CLAMP BOLTS  
(2,184 TEST MILES)**

## **UNSCHEDULED MAINTENANCE CONT.**



**BROKEN FRONT SWAY BAR  
(4,382 TEST MILES)**



**BENT FRONT SWAY BAR LINKS  
(5,022 TEST MILES)**

## **UNSCHEDULED MAINTENANCE CONT.**



**CRACKED RIGHT FRONT, UPPER SHOCK MOUNT  
(5,992 TEST MILES)**



**BROKEN FRONT SWAY BAR  
(9,108 TEST MILES)**



## **UNSCHEDULED MAINTENANCE CONT.**



**FRONT SWAY BAR; ANCHOR POINT FOR SADDLE  
MOUNTS ARE CRACKING  
(9,558 TEST MILES)**



**BROKEN LEFT REAR, FORWARD SHOCK  
(13,275 TEST MILES)**

## **UNSCHEDULED MAINTENANCE CONT.**



**BLOWN RIGHT FRONT AIR BAG  
(13,644 TEST MILES)**



**BROKEN LEFT FRONT SWAY BAR LINK  
(13,791 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  $\pm 4$  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, 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 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), liquified 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 60°F (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 60°F. 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

<u>phase</u>	<u>miles per phase</u>	<u>total miles per run</u>
CBD	1.9097	5.7291
ART	1.9097	3.8193
COM	3.8193	3.8193

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



- 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 60°F and multiply by the density of water at 60°F

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

where  $G_s$  = Specific gravity of test fuel at 60°F (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.) Convert 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  $T=60^\circ\text{F}$ ). These combine to give a fuel economy in miles per lb. The energy equivalent

(mile/BTUx10<sup>6</sup>) 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/ft<sup>3</sup>).

**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/BTUx10<sup>6</sup>) 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/BTUx10<sup>6</sup>

H = Volumetric heating value of test fuel at standard conditions

### 6-III. DISCUSSION

This is a comparative test of fuel economy using CNG fuel with a heating value of 1,008.1 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 – 0.63 M/lb, ART – 0.76 M/lb, and COM – 1.38 M/lb. Average fuel consumption at idle was 6.23 lb/hr (148.2 Scf/hr).

## FUEL ECONOMY PRE-TEST MAINTENANCE FORM

Bus Number: 0312	Date: 9-15-03	SLW (lbs): 37,500
Personnel: S.C., T.S., E.L. & E.D.		

FUEL SYSTEM	OK	Date	Initials
Install fuel measurement system	✓	9/15/03	S.C.
Replace fuel filter	✓	9/15/03	S.C.
Check for fuel leaks	✓	9/15/03	S.C.
Specify fuel type (refer to fuel analysis)	CNG		
Remarks: None			
BRAKES/TIRES	OK	Date	Initials
Inspect hoses	✓	9/15/03	E.L.
Inspect brakes	✓	9/15/03	E.L.
Relube wheel bearings	✓	9/15/03	E.L.
Check tire inflation pressures (mfg. specs.)	✓	9/15/03	E.L.
Remarks: None			
COOLING SYSTEM	OK	Date	Initials
Check hoses and connections	✓	9/15/03	E.D.
Check system for coolant leaks	✓	9/15/03	E.D.
Remarks: None			

## FUEL ECONOMY PRE-TEST MAINTENANCE FORM (page 2)

Bus Number: 0312	Date: 9-15-03		
Personnel: S.C., T.S., E.L. & E.D.			
ELECTRICAL SYSTEMS	OK	Date	Initials
Check battery	✓	9/15/03	E.D.
Inspect wiring	✓	9/15/03	E.D.
Inspect terminals	✓	9/15/03	E.D.
Check lighting	✓	9/15/03	E.D.
Remarks: None			
DRIVE SYSTEM	OK	Date	Initials
Drain transmission fluid	✓	9/15/03	S.C.
Replace filter/gasket	✓	9/15/03	S.C.
Check hoses and connections	✓	9/15/03	S.C.
Replace transmission fluid	✓	9/15/03	S.C.
Check for fluid leaks	✓	9/15/03	S.C.
Remarks: None			
LUBRICATION	OK	Date	Initials
Drain crankcase oil	✓	9/15/03	T.S.
Replace filters	✓	9/15/03	T.S.
Replace crankcase oil	✓	9/15/03	T.S.
Check for oil leaks	✓	9/15/03	T.S.
Check oil level	✓	9/15/03	T.S.
Lube all chassis grease fittings	✓	9/15/03	T.S.
Lube universal joints	✓	9/15/03	T.S.
Replace differential lube including axles	✓	9/15/03	T.S.
Remarks: None			

## FUEL ECONOMY PRE-TEST MAINTENANCE FORM (page 3)

Bus Number: 0312	Date: 9-15-03		
Personnel: S.C., T.S., E.L. & E.D.			
EXHAUST/EMISSION SYSTEM	OK	Date	Initials
Check for exhaust leaks	✓	9-15-03	S.C.
Remarks: None			
ENGINE	OK	Date	Initials
Replace air filter	✓	9-15-03	T.S./ E.D.
Inspect air compressor and air system	✓	9-15-03	T.S.
Inspect vacuum system, if applicable	✓	9-15-03	E.L.
Check and adjust all drive belts	✓	9-15-03	E.D.
Check cold start assist, if applicable	NA	9-15-03	E.D.
Remarks: None			
STEERING SYSTEM	OK	Date	Initials
Check power steering hoses and connectors	✓	9-15-03	S.C.
Service fluid level	✓	9-15-03	S.C.
Check power steering operation	✓	9-15-03	S.C.
Remarks: None			
	OK	Date	Initials
Ballast bus to seated load weight	✓	9-15-03	T.S.
TEST DRIVE	OK	Date	Initials
Check brake operation	✓	9-15-03	E.D.
Check transmission operation	✓	9-15-03	E.D.
Remarks: None			

## FUEL ECONOMY PRE-TEST INSPECTION FORM

Bus Number: 0312	Date: 9-15-03
Personnel: S.C., T.S., E.L. & E.D.	
PRE WARM-UP	If OK, Initial
Fuel Economy Pre-Test Maintenance Form is complete	T.S.
Cold tire pressure (psi): Front <u>120</u> Middle <u>N/A</u> Rear <u>120</u>	T.S.
Tire wear:	T.S.
Engine oil level	E.L.
Engine coolant level	E.L.
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	T.S.
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>121</u> Middle <u>N/A</u> Rear <u>122</u>	S.C.
Environmental conditions Average wind speed <12 mph and maximum gusts <15 mph Ambient temperature between 30°(-1°) 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 (Gaseous Fuels)

Bus Number: 0312		Manufacturer: ElDorado		Date: 9-16-03	
Run Number: 1		Personnel: R.C., T.S. & D.L.			
Test Direction: <input type="checkbox"/> CW or <input checked="" type="checkbox"/> CCW		Ambient Temperature (°F): 63		Humidity (%): 77	
SLW (lbs): 37,500		Wind Speed (mph) & Direction: Calm		Barometric Pressure (in.Hg): 30.18	
Cycle Type	Run Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°F)	Total Fuel Used (SCF)
	Start	Finish		Start	
CBD #1	0	8:55	8:55	77.7	73.1
ART #1	0	4:07	4:07	66.5	61.4
CBD #2	0	8:42	8:42	64.3	76.6
ART #2	0	4:06	4:06	69.0	61.0
CBD #3	0	8:31	8:31	66.0	75.6
COMMUTER	0	6:03	6:03	67.3	65.3
Total Fuel: 413.0 SCF					
20 minute idle : Total Fuel Used = 52.0 SCF					
No Load Flow Rate at Idle = 2.71 SCFM			No Load Flow Rate at Full Throttle = 9.27 SCFM		
Heating Value = 1,008.1 BTU/LB					
Comments: None					



## FUEL ECONOMY DATA FORM (Gaseous Fuels)

Bus Number: 0312		Manufacturer: ElDorado		Date: 9-16-03	
Run Number: 2		Personnel: R.C., T.S. & D.L.			
Test Direction: <input checked="" type="checkbox"/> CW or <input type="checkbox"/> CCW		Ambient Temperature (°F): 66		Humidity (%): 77	
SLW (lbs): Calm		Wind Speed (mph) & Direction: Calm		Barometric Pressure (in.Hg): 30.18	
Cycle Type	Run Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°F)	Total Fuel Used (SCF)
	Start	Finish		Start	
CBD #1	0	8:38	8:38	75.8	74.1
ART #1	0	4:00	4:00	77.8	58.4
CBD #2	0	8:28	8:28	70.2	72.2
ART #2	0	4:04	4:04	77.0	58.9
CBD #3	0	8:33	8:33	71.2	70.8
COMMUTER	0	6:01	6:01	79.1	65.0
Total Fuel: 399.4 SCF					
20 minute idle : Total Fuel Used = N/A SCF					
No Load Flow Rate at Idle = N/A SCFM			No Load Flow Rate at Full Throttle = N/A SCFM		
Heating Value = 1,008.1 BTU/LB					
Comments: None					

## FUEL ECONOMY DATA FORM (Gaseous Fuels)

Bus Number: 0312		Manufacturer: ElDorado		Date: 9-16-03	
Run Number: 3		Personnel: R.C., T.S. & D.L.			
Test Direction: <input type="checkbox"/> CW or <input checked="" type="checkbox"/> CCW		Ambient Temperature (°F): 70		Humidity (%): 77	
SLW (lbs): 37,500		Wind Speed (mph) & Direction: Calm		Barometric Pressure (in.Hg): 30.18	

Cycle Type	Run Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°F)	Total Fuel Used (SCF)
	Start	Finish		Start	
CBD #1	0	8:28	8:28	80.5	74.3
ART #1	0	4:00	4:00	80.6	61.0
CBD #2	0	8:27	8:27	75.3	71.1
ART #2	0	4:03	4:03	81.0	60.2
CBD #3	0	8:26	8:26	75.7	72.4
COMMUTER	0	6:04	6:04	87.8	65.1
Total Fuel: 404.1 SCF					
20 minute idle : Total Fuel Used = N/A SCF					
No Load Flow Rate at Idle = N/A SCFM			No Load Flow Rate at Full Throttle = N/A SCFM		
Heating Value = 1,008.1 BTU/LB					
Comments: None					

### FUEL ECONOMY DATA FORM (Gaseous Fuels)

Bus Number: 0312		Manufacturer: ElDorado		Date: 9-16-03	
Run Number: 4		Personnel: R.C., T.S. & D.L.			
Test Direction: <input checked="" type="checkbox"/> CW or <input type="checkbox"/> CCW		Ambient Temperature (°F): 70		Humidity (%): 77	
SLW (lbs): 37,500		Wind Speed (mph) & Direction: Calm		Barometric Pressure (in.Hg): 30.18	
Cycle Type	Run Time (min:sec)		Cycle Time (min:sec)	Fuel Temperature (°F)	Total Fuel Used (SCF)
	Start	Finish		Start	
CBD #1	0	8:19	8:19	83.7	70.2
ART #1	0	4:02	4:02	83.2	59.4
CBD #2	0	8:19	8:19	75.7	68.0
ART #2	0	4:02	4:02	82.3	58.8
CBD #3	0	8:30	8:30	76.3	70.3
COMMUTER	0	6:01	6:01	83.4	67.5
Total Fuel: 394.2 SCF					
20 minute idle : Total Fuel Used = 46.8 SCF					
No Load Flow Rate at Idle = 2.32 SCFM			No Load Flow Rate at Full Throttle = 9.27 SCFM		
Heating Value = 1,008.1 BTU/LB					
Comments: None					

0312.FUL  
FUEL ECONOMY SUMMARY SHEET

BUS MANUFACTURER :Eldorado National      BUS NUMBER :0312  
BUS MODEL :AXESS      TEST DATE :9/16/03

FUEL TYPE : NATURAL GAS  
SP. GRAVITY : .5770  
HEATING VALUE : 1008.10 BTU/cf  
Standard Conditions : 60 deg F and 14.7 psi  
Density of Air : 0.0729 lb/scf

CYCLE	TOTAL FUEL USED (Scf)	TOTAL MILES	FUEL ECONOMY M/Scf(Measured)	FUEL ECONOMY M/Lb(Corrected)
Run # :1, CCW				
CBD	225.3	5.73	.03	.60
ART	122.4	3.82	.03	.74
COM	65.3	3.82	.06	1.39
TOTAL	413.0	13.37	.03	.77
Run # :2, CW				
CBD	217.1	5.73	.03	.63
ART	117.3	3.82	.03	.77
COM	65.0	3.82	.06	1.40
TOTAL	399.4	13.37	.03	.80
Run # :3, CCW				
CBD	217.8	5.73	.03	.63
ART	121.2	3.82	.03	.75
COM	65.1	3.82	.06	1.40
TOTAL	404.1	13.37	.03	.79
Run # :4, CW				
CBD	208.5	5.73	.03	.65
ART	118.2	3.82	.03	.77
COM	67.5	3.82	.06	1.35
TOTAL	394.2	13.37	.03	.81

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IDLE CONSUMPTION

First 20 Minutes Data : 52.0 Scf    Last 20 Minutes Data : 46.8 Scf  
Average Idle Consumption : 148.2 Scf/Hr

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

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Run 1 : -2.6      Run 2 : .8      Run 3 : -.4      Run 4 : 2.1

SUMMARY

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Average Idle Consumption : 6.23 LB/Hr  
Average CBD Phase Consumption : .63 M/Lb  
Average Arterial Phase Consumption : .76 M/Lb  
Average Commuter Phase Consumption : 1.38 M/Lb  
Overall Average Fuel Consumption : .79 M/Lb  
Overall Average Fuel Consumption : 32.95 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 48.9 dB(A); ranging from 42.3 dB(A) at the rear passenger seats to 56.3 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 68.9 dB(A) at the middle passenger seats to 74.5 dB(A) at the rear passenger seats. The overall average was 70.9 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: 0312	Date: 4-8-03
Personnel: S.C.	
Temperature (°F): 41	Humidity (%): 48
Wind Speed (mph): Calm	Wind Direction: Calm
Barometric Pressure (in.Hg): 30.02	
Initial Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.	
Interior Ambient Noise Level dB(A): 34.0	Exterior Ambient Noise Level dB(A): 48.5
Microphone Height During Testing (in): 48.0	

Measurement Location	Measured Sound Level dB(A)
Driver's Seat	56.3
Front Passenger Seats	51.3
In Line with Front Speaker	50.9
In Line with Middle Speaker	48.3
In Line with Rear Speaker	44.2
Rear Passenger Seats	42.3

Final Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.
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<b>Comments:</b> All readings taken in the center aisle.

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

Bus Number: 0312	Date: 9-17-03
Personnel: R.C., T.S. & S.C.	
Temperature (°F): 63	Humidity (%): 82
Wind Speed (mph): Calm	Wind Direction: Calm
Barometric Pressure (in.Hg): 30.33	
Initial Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.	
Interior Ambient Noise Level dB(A): 34.0	Exterior Ambient Noise Level dB(A): 42.8
Microphone Height During Testing (in):	

Measurement Location	Measured Sound Level dB(A)
Driver's Seat	70.0
Front Passenger Seats	70.1
Middle Passenger Seats	68.9
Rear Passenger Seats	74.5

Final Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.
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<b>Comments:</b> All readings taken in the center aisle.



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

Bus Number: 0312	Date: 9-17-03
Personnel: R.C., T.S. & S.C.	
Temperature (°F): 63	Humidity (%): 82
Wind Speed (mph): Calm	Wind Direction: Calm
Barometric Pressure (in.Hg): 30.33	

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.

<b>Comment on any other vibration or noise source which may have occurred that is not described above:</b>

## 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 upshift.
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 42.5 dB(A), the average test result obtained while accelerating from a constant speed was 75.1 dB(A) on the right side and 73.5 dB(A) on the left side.

When accelerating from a standstill with an exterior ambient noise level of 41.8 dB(A), the average of the results obtained were 75.5 dB(A) on the right side and 73.8 dB(A) on the left side.

With the vehicle stationary and the engine, accessories, and air conditioning on, the measurements averaged 63.8 dB(A) at low idle, 66.9 dB(A) at high idle, and 77.2 dB(A) at wide open throttle. With the accessories and air conditioning off, the readings averaged 4.3 dB(A) lower at low idle, 0.6 dB(A) lower at high idle, and 2.3 dB(A) lower at wide open throttle. The exterior ambient noise level measured during this test was 42.7 dB(A).

## EXTERIOR NOISE TEST DATA FORM

### Accelerating from Constant Speed

Bus Number: 0312	Date: 9-17-03
Personnel: R.C., T.S. & S.C.	
Temperature (°F): 65	Humidity (%): 70
Wind Speed (mph): Calm	Wind Direction: Calm
Barometric Pressure (in.Hg): 30.33	
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: <input checked="" type="checkbox"/> checked by: S.C.	
Initial Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.	
Exterior Ambient Noise Level dB(A): 42.5	

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	73.5	1	73.1
2	74.8	2	73.2
3	75.1	3	73.5
4	75.1	4	73.5
5	75.0	5	73.5
Average of two highest actual noise levels = 75.1 dB(A)		Average of two highest actual noise levels = 73.5 dB(A)	
Final Sound Level Meter Calibration Check: <input checked="" type="checkbox"/> checked by: S.C.			
Comments: None			

## EXTERIOR NOISE TEST DATA FORM

### Accelerating from Standstill

Bus Number: 0312	Date: 9-17-03
Personnel: R.C., T.S. & S.C.	
Temperature (°F): 65	Humidity (%): 70
Wind Speed (mph): Calm	Wind Direction: Calm
Barometric Pressure (in.Hg): 30.33	
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: <input checked="" type="checkbox"/> checked by: S.C.	
Initial Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.	
Exterior Ambient Noise Level dB(A): 41.8	

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	75.5	1	73.3
2	75.2	2	73.8
3	75.3	3	73.7
4	75.4	4	73.8
5	75.3	5	73.4
Average of two highest actual noise levels = 75.5 dB(A)		Average of two highest actual noise levels = 73.8 dB(A)	
Final Sound Level Meter Calibration Check: <input checked="" type="checkbox"/> checked by: S.C.			
Comments: None			

## EXTERIOR NOISE TEST DATA FORM

### Stationary

Bus Number: 0312		Date: 9-17-03	
Personnel: R.C., T.S. & S.C.			
Temperature (°F): 65		Humidity (%): 70	
Wind Speed (mph): Calm		Wind Direction: Calm	
Barometric Pressure (in.Hg): 30.33			
Verify that microphone height is 4 feet, wind speed is less than 12 mph and ambient temperature is between 30°F and 90°F: <input checked="" type="checkbox"/> checked by: S.C.			
Initial Sound Level Meter Calibration: <input checked="" type="checkbox"/> checked by: S.C.			
Exterior Ambient Noise Level dB(A): 42.7			
Accessories and Air Conditioning ON			
Throttle Position	Engine RPM	Curb (Right) Side dB(A)	Street (Left) Side db(A)
		Measured	Measured
Low Idle	788	63.1	64.4
High Idle	1,102	66.2	67.6
Wide Open Throttle	2,675	79.2	75.2
Accessories and Air Conditioning OFF			
Throttle Position	Engine RPM	Curb (Right) Side dB(A)	Street (Left) Side db(A)
		Measured	Measured
Low Idle	804	58.9	60.1
High Idle	1,095	67.2	65.4
Wide Open Throttle	2,680	74.9	74.9
Final Sound Level Meter Calibration Check: <input checked="" type="checkbox"/> checked by: S.C.			
Comments: None			

## 7.2 EXTERIOR NOISE TEST



### TEST BUS UNDER GOING EXTERIOR NOISE TESTING

