



## **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 30 people including the driver. The resulting test load is  $(30 \times 375 \text{ lb}) = 11,250 \text{ lb}$ . 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 -0.240 inches at reference point 12. The maximum permanent deflection after the final loading sequence ranged from -0.005 inches at reference point 1 to 0.004 inches at reference point 12.

# **STRUCTURAL SHAKEDOWN DATA FORM**

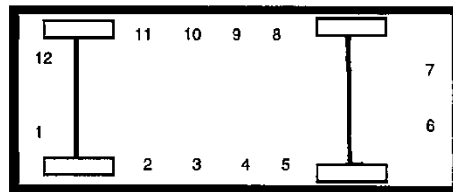
Bus Number: 0706	Date: 5-24-07
Personnel: S.C., P.D. & J.P.	Temperature (°F): 75
Loading Sequence: <input checked="" type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3   (check one)	
Test Load (lbs): 11,250	

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	-.237	-.237	-.002	-.002
2	0	.177	.177	.007	.007
3	0	.170	.170	.006	.006
4	0	.164	.164	.007	.007
5	0	.143	.143	.008	.008
6	0	-.045	-.045	.012	.012
7	0	-.049	-.049	.012	.012
8	0	.140	.140	.000	.000
9	0	.173	.173	.008	.008
10	0	.193	.193	.004	.004
11	0	.073	.073	.009	.009
12	0	-.231	-.231	.010	.010

# **STRUCTURAL SHakedown DATA FORM**

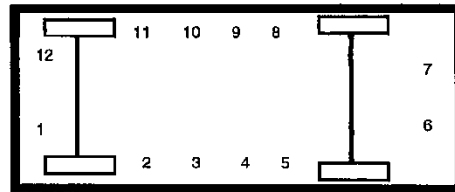
Bus Number: 0706	Date: 5-29-07
Personnel: T.S., S.C., B.S. & T.W.	Temperature (°F): 71
Loading Sequence: <input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 (check one)	
Test Load (lbs): 11,250	

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	-.002	-.229	-.227	.003	-.005
2	.007	.172	.165	.004	-.003
3	.006	.163	.157	.002	-.004
4	.007	.150	.143	.004	-.003
5	.008	.137	.129	.006	-.002
6	.012	-.049	-.061	.011	-.001
7	.012	-.050	-.062	.013	.001
8	.000	.152	.152	.002	.002
9	.008	.186	.178	.005	-.003
10	.004	.207	.203	.002	-.002
11	.009	.082	.073	.009	.000
12	.010	-.230	-.240	.014	.004

## **5.1 STRUCTURAL SHAKEDOWN TEST**



## **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. In two positions of the test, with the kneeling activated the handicap ramp did not contact the ground when deployed. 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: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

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

Right center	_ 6 in higher	_ 6 in lower
Left center	_ 6 in higher	_ 6 in lower
		Comments
_ Windows		No deficiencies.
_ Front Doors		No deficiencies.
_ Rear Doors		No deficiencies.
_ Escape Mechanisms/ Roof Vents		No deficiencies.
_ Engine		No deficiencies.
_ Handicapped Device/ Special Seating		No deficiencies.
_ Undercarriage		No deficiencies.
_ Service Doors		No deficiencies.
_ Body		No deficiencies.
_ Windows/ Body Leakage		No deficiencies.
_ Steering Mechanism		No deficiencies.

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

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

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

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



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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

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 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 type="checkbox"/> Windows	No deficiencies.	
<input type="checkbox"/> Front Doors	No deficiencies.	
<input type="checkbox"/> Rear Doors	No deficiencies.	
<input type="checkbox"/> Escape Mechanisms/ Roof Vents	No deficiencies.	
<input type="checkbox"/> Engine	No deficiencies.	
<input type="checkbox"/> Handicapped Device/ Special Seating	Handicap ramp will not contact ground.	
<input type="checkbox"/> Undercarriage	No deficiencies.	
<input type="checkbox"/> Service Doors	No deficiencies.	
<input type="checkbox"/> Body	No deficiencies.	
<input type="checkbox"/> Windows/ Body Leakage	No deficiencies.	
<input type="checkbox"/> Steering Mechanism	No deficiencies.	

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

Wheel Position : (check one)		
All wheels level	_ before	_ after
Left front	_ 6 in higher	_ 6 in lower
Right front	_ 6 in higher	_ 6 in lower
Right rear	_ 6 in higher	_ 6 in lower
Left rear	_ 6 in higher	_ 6 in lower
Right center	_ 6 in higher	_ 6 in lower
Left center	_ 6 in higher	_ 6 in lower
		Comments
_ Windows		No deficiencies.
_ Front Doors		No deficiencies.
_ Rear Doors		No deficiencies.
_ Escape Mechanisms/ Roof Vents		No deficiencies.
_ Engine		No deficiencies.
_ Handicapped Device/ Special Seating		Handicap ramp will not contact ground.
_ Undercarriage		No deficiencies.
_ Service Doors		No deficiencies.
_ Body		No deficiencies.
_ Windows/ Body Leakage		No deficiencies.
_ Steering Mechanism		No deficiencies.

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

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

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

Wheel Position : (check one)		
All wheels level	_ before	_ after
Left front	_ 6 in higher	_ 6 in lower
Right front	_ 6 in higher	_ 6 in lower
Right rear	_ 6 in higher	_ 6 in lower
Left rear	_ 6 in higher	_ 6 in lower
Right center	_ 6 in higher	_ 6 in lower
Left center	_ 6 in higher	_ 6 in lower
		Comments
_ Windows		No deficiencies.
_ Front Doors		No deficiencies.
_ Rear Doors		No deficiencies.
_ Escape Mechanisms/ Roof Vents		No deficiencies.
_ Engine		No deficiencies.
_ Handicapped Device/ Special Seating		No deficiencies.
_ Undercarriage		No deficiencies.
_ Service Doors		No deficiencies.
_ Body		No deficiencies.
_ Windows/ Body Leakage		No deficiencies.
_ Steering Mechanism		No deficiencies.

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

Wheel Position : (check one)		
All wheels level	_ before	_ after
Left front	_ 6 in higher	_ 6 in lower
Right front	_ 6 in higher	_ 6 in lower
Right rear	_ 6 in higher	_ 6 in lower
Left rear	_ 6 in higher	_ 6 in lower
Right center	_ 6 in higher	_ 6 in lower
Left center	_ 6 in higher	_ 6 in lower
	Comments	
_ Windows	No deficiencies.	
_ Front Doors	No deficiencies.	
_ Rear Doors	No deficiencies.	
_ Escape Mechanisms/ Roof Vents	No deficiencies.	
_ Engine	No deficiencies.	
_ Handicapped Device/ Special Seating	No deficiencies.	
_ Undercarriage	No deficiencies.	
_ Service Doors	No deficiencies.	
_ Body	No deficiencies.	
_ Windows/ Body Leakage	No deficiencies.	
_ Steering Mechanism	No deficiencies.	

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

Wheel Position : (check one)		
All wheels level	_ before	_ after
Left front	_ 6 in higher	_ 6 in lower
Right front	_ 6 in higher	_ 6 in lower
Right rear	_ 6 in higher	_ 6 in lower
Left rear	_ 6 in higher	_ 6 in lower
Right center	_ 6 in higher	_ 6 in lower
Left center	_ 6 in higher	_ 6 in lower
	Comments	
_ Windows	No deficiencies.	
_ Front Doors	No deficiencies.	
_ Rear Doors	No deficiencies.	
_ Escape Mechanisms/ Roof Vents	No deficiencies.	
_ Engine	No deficiencies.	
_ Handicapped Device/ Special Seating	No deficiencies.	
_ Undercarriage	No deficiencies.	
_ Service Doors	No deficiencies.	
_ Body	No deficiencies.	
_ Windows/ Body Leakage	No deficiencies.	
_ Steering Mechanism	No deficiencies.	

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

Bus Number: 0706	Date: 6-5-07
Personnel: T.S., E.D. & S.C.	Temperature(°F): 70

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

## 5.2 STRUCTURAL DISTORTION TEST



**RIGHT FRONT WHEEL SIX INCHES HIGHER**





### **5.3 STRUCTURAL STRENGTH AND DISTORTION TESTS - STATIC TOWING TEST**

#### **5.3-I. TEST OBJECTIVE**

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

#### **5.3-II. TEST DESCRIPTION**

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

#### **5.3-III. DISCUSSION**

The load-distributing yoke was incorporated as the interface between the Static Tow apparatus and the test bus tow hook/eyes. The front test was performed to the full target test weight of 14,784 lbs (1.2 x 12,320 lbs CW). No damage or deformation was observed during all four pulls of the test. The test bus was not equipped with rear tow eyes or tow hooks, therefore, a rear test was not performed.

## STATIC TOWING TEST DATA FORM

Bus Number: 0706	Date: 8-29-07
Personnel: S.C.	Temperature (°F): 78

<b>Inspect right front tow eye and adjoining structure.</b>
<b>Comments:</b> No damage or deformation.
<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.
<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> All four front
pulls were completed to the full target test load of 14,784 lbs. (1.2 x 12,320 lbs CW).
No damage or deformation was observed. The test bus was not equipped with rear
tow eyes or tow hooks, therefore, a rear test was not performed.

### 5.3 STATIC TOWING TEST

**FRONT 20° UPWARD**



**PULL**

**FRONT 20°DOWN**



**PULL**

### 5.3 STATIC TOWING TEST CONT.

**FRONT 20° LEFT**



**PULL**

**FRONT 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: 0706	Date: 8-30-07
Personnel: S.C.	

Temperature (°F): 78	Humidity (%): 74
Wind Direction: S.E.	Wind Speed (mph): 5
Barometric Pressure (in.Hg): 30.12	

<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> No damage or deformation was observed.
<b>General Comments:</b> No problems with the towing interface or tow were encountered during testing.

## 5.4 DYNAMIC TOWING TEST



**TEST BUS IN TOW**

## **5.5 STRUCTURAL STRENGTH AND DISTORTION TESTS – JACKING TEST**

### **5.5-I. TEST OBJECTIVE**

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

### **5.5-II. TEST DESCRIPTION**

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

### **5.5-III. DISCUSSION**

The jack used for this test has a minimum height of 8.75 inches. During the deflated portion of the test, the jacking point clearances ranged from 22.5 inches to 3.5 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	22.5”
Rear axle – one tire flat	4.6”
Rear axle – two tires flat	NA



## JACKING TEST DATA FORM

Bus Number: 0706	Date: 5-21-07
Personnel: T.S. & E.L.	Temperature (°F): 70

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	24.0 " I 22.5 " D	13.0 " I 10.9 " D	
Left front	24.0 " I 22.5 " D	13.0 " I 10.9 " D	
Right rear	7.0 " I 4.6 " D	6.2 " I 3.5 " D	
Right rear—both	NA	NA	
Left rear—outside	7.0 " I 4.6 " D	6.2 " I 3.5 " D	
Left rear---both	NA	NA	
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 noted.			

## **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: 0706	Date: 5-21-07
Personnel: T.S. & E.L.	Temperature (°F): 70

**Comments of any structural damage to the jacking pads or axles while both the front wheels are supported by the jack stands:**

None noted.

**Comments of any structural damage to the jacking pads or axles while both the rear wheels are supported by the jack stands:**

None noted.

**Comments of any structural damage to the jacking pads or axles while both the front and rear wheels are supported by the jack stands:**

None noted.

## **5.7 STRUCTURAL DURABILITY TEST**

### **5.7-I. TEST OBJECTIVE**

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

### **5.7-II. TEST DESCRIPTION**

The test vehicle is driven a total of 7,500 miles; approximately 5,000 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 3,000 miles with the bus operated at GVW. The second segment will consist of approximately 1,500 miles with the bus operated at SLW. The remainder of the test, approximately 3,000 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 June 7, 2007 and was conducted until August 30, 2007. The first 3,000 miles were performed at a GVW of 16,750 lbs. and completed on August 7, 2007. The next 1,500 mile SLW segment was performed at 14,420 lbs and completed on August 15, 2007, and the final 3,000 mile segment was performed at a CW of 12,320 lbs and completed on August 30, 2007.

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 measurements of the different conditions. Finally, photographs illustrating some of the failures that were encountered during the Structural Durability Test are included.

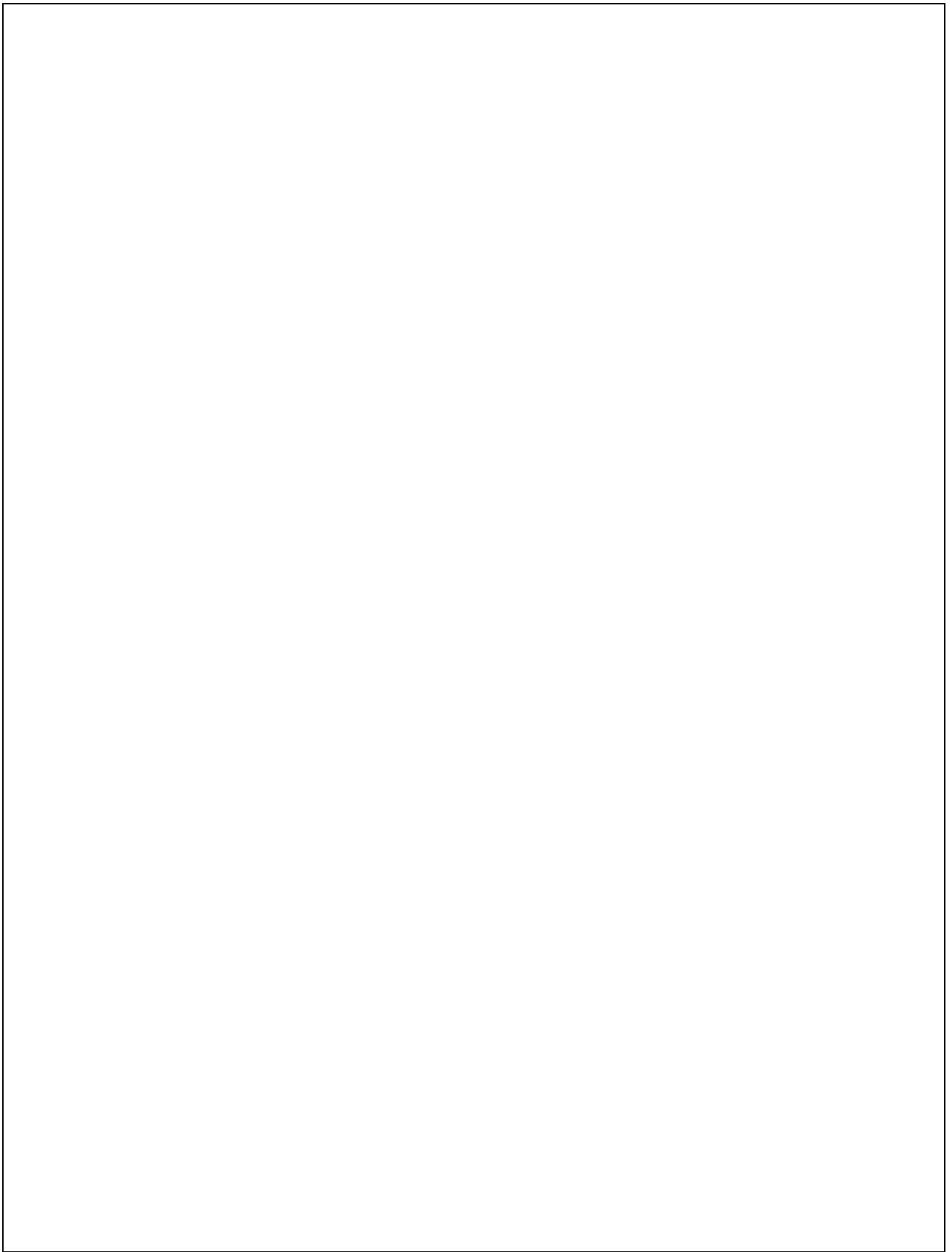




Table 4. Driving Schedule for Bus Operation on the Durability Test Track.

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

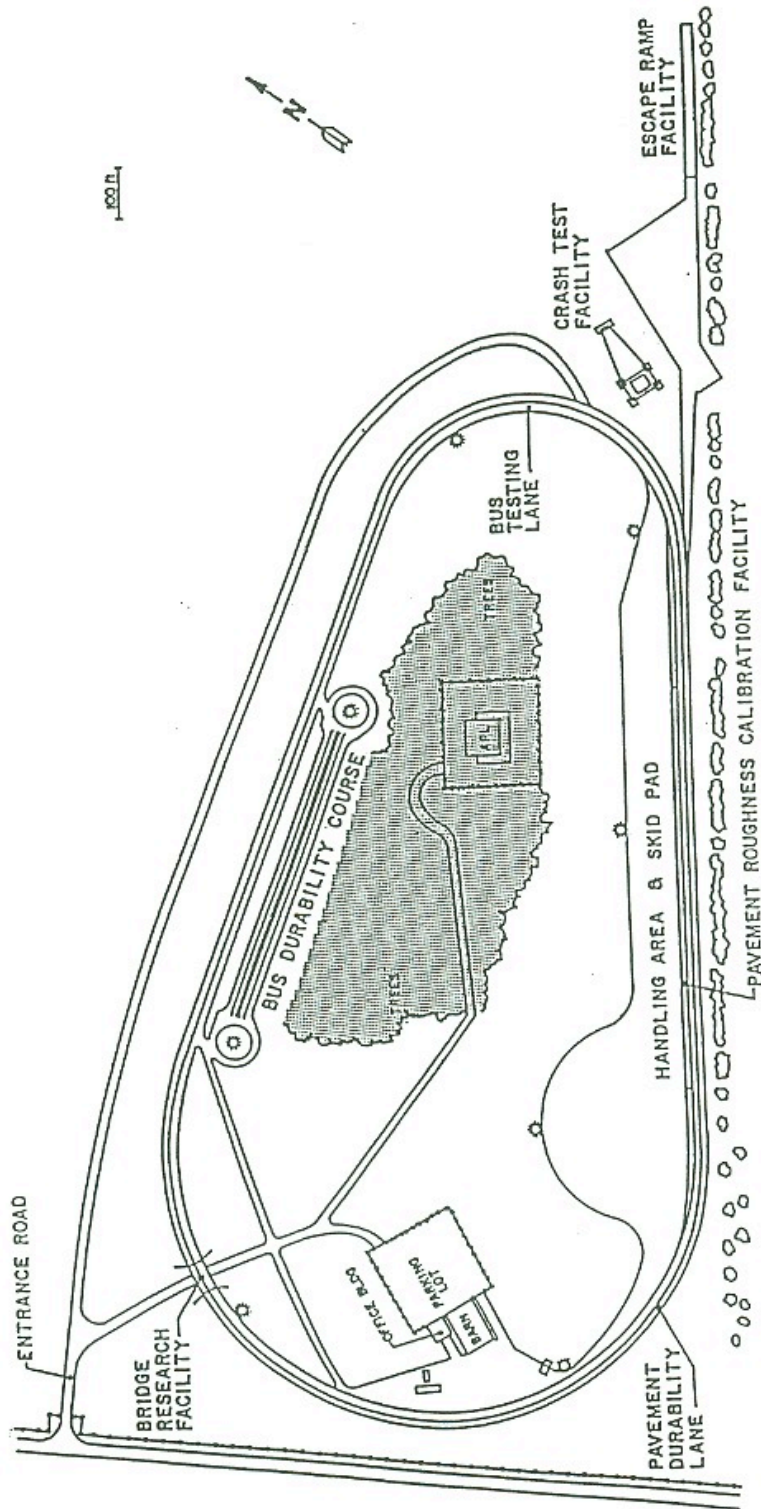
B—Break

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”**

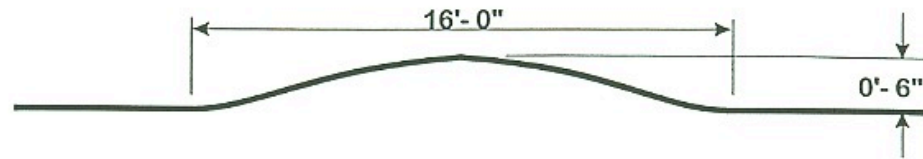


**BUS TESTING AND RESEARCH TEST TRACK  
UNIVERSITY PARK, PA**

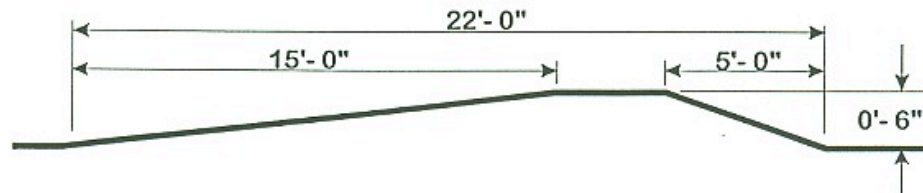




Staggered  
Bumps  
(10 mph)



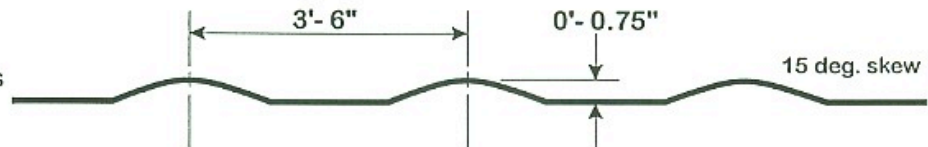
Railroad  
Crossing  
(8 mph)



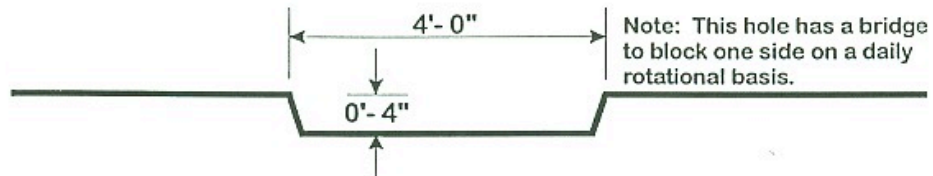
1" Random  
Chuck Holes  
(20 mph)



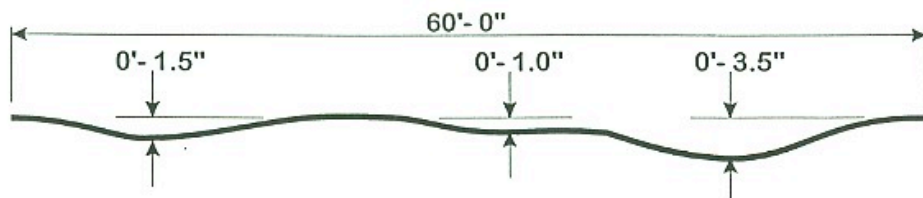
Chatter Bumps  
(20 mph)



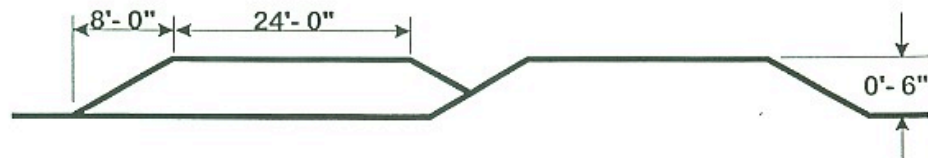
4" Chuck Hole  
(5 mph)



High Crown  
Intersection  
(20 mph)



Frame Twist  
(10 mph)



## Durability Element Profiles

The Pennsylvania Transportation Institute  
Penn State

**UNSCHEDULED MAINTENANCE**

**BROKEN SUSPENSION TRAVEL  
(422 TEST MILES)**



**LIMIT CABLE**

**BROKEN SUSPENSION TRAVEL  
(3,831 TEST MILES)**



**LIMIT CABLE**

**BATTERY CABLE PULLED FROM  
(5,940 TEST MILES)**



**LUG**