

**PARTIAL**  
**STURAA TEST**  
**7 YEAR**  
**200,000 MILE BUS**  
**from**  
**ELDORADO NATIONAL, INC.**  
**MODEL 240 AEROTECH**  
**OCTOBER 2000**  
**PTI-BT-R2014-13-00-P**



**The Pennsylvania Transportation Institute**

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The Pennsylvania State University  
University Park, PA 16802

**Bus Testing and Research Center**

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## **EXECUTIVE SUMMARY**

Eldorado National submitted a model 240 Aerotech, diesel powered 17 seat bus, for a Partial STURAA Test in the 7yr/200,000 mile category. The Federal Transit Administration determined that the following tests would be performed: 1.2 Servicing, Preventive Maintenance, Repair & Maintenance, 2. Reliability and 5.7 Structural Durability Test. The odometer reading at the time of delivery was 1,196 miles. Testing started on August 1, 2000 and was completed on October 6, 2000. The Check-In section of the report provides a description of the bus and specifies its major components.

The primary part of this partial test was the Structural Durability Test, which also provides the information for the Maintainability and Reliability results. The Structural Durability Test was started on August 7, 2000 and was completed on September 26, 2000.

The first segment of the Structural Durability Test was performed with the bus loaded to a GVW of 14,000 lbs. The number of standing passengers was reduced from 17 standees and one wheelchair position, to 5 standees and one wheelchair position (600 lb per. wheelchair position). The reduction in passenger weight was necessary to avoid exceeding the GAWR (9,450 lbs.) of the rear axle. The middle segment was performed at a SLW of 13,275 lbs. The final segment was performed at a curb weight of 10,150 lbs. Durability driving resulted in no unscheduled maintenance failures.

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. Problems also are listed by class as defined in Section 2. The test bus encountered no failures during the Structural Durability Test.

## 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 is manufactured using a Ford E-350 Super Duty Chassis. The bus has a front door, located to the rear of the front axle, and a dedicated wheelchair access door equipped with a Ricon Corp. model S2005-510 wheelchair lift to the rear of the rear axle. The engine type is a diesel fueled Ford Power Stroke 7.3 L. The transmission is a Ford 4R100E.

The measured curb weight is 3,800 lbs for the front axle and 6,350 lbs for the rear axle. These combined weights provide a total measured curb weight of 10,150 lbs. There are 17 seats including the driver, 1 wheelchair position, and room for 27 standing passengers bringing the total passenger capacity to 44 and one wheelchair position. Gross load is  $150 \text{ lb} \times 44 = 6,600 \text{ lbs.} + 600 \text{ lb (wheelchair position)} = 7,200 \text{ lbs.}$  At full capacity, the measured gross vehicle weight is 14,850 lbs. This value was used for all static tests. In order to avoid exceeding the GAWR (9,450 lbs) of the rear axle, the ballast for 22 standing passengers was eliminated. The reduction from full capacity resulted in an adjusted measured gross vehicle weight of 14,000 lbs and was used for all dynamic testing.

### VEHICLE DATA FORM

Bus Number: 2014	Arrival Date: 8-1-00
Bus Manufacturer: 2014	Vehicle Identification Number (VIN): 1FDXE45F1YHB55119
Model Number: 240 Aerotech	Date: 8-1-00
Personnel: S.C.	

WEIGHT: \* Values in parentheses 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	2,000	1,800	N/A	N/A	3,400	2,950
SLW	2,175	2,075	N/A	N/A	4,625	4,400
GVW	2,300 (2,300)	2,200 (2,200)	N/A	N/A	5,300 (4,875)	5,050 (4,625)

Total Weight Details:

Weight (lb)	CW	SLW	GVW	GAWR
Front Axle	3,800	4,250	4,500 (4,500)	4,600
Middle Axle	N/A	N/A	N/A	N/A
Rear Axle	6,350	9,025	10,350 (9,500)	9,450
Total	10,150	13,275	14,850 (14,000)	GVWR: 14,050

Dimensions:

Length (ft/in)	24 / 7.25
Width (in)	94.25
Height (in)	113.00
Front Overhang (in)	30.25
Rear Overhang (in)	87.75
Wheel Base (in)	177.25
Wheel Track (in)	Front: 68.50
	Rear: 78.00

Bus Number: 2014	Date: 8-1-00
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CLEARANCES:

Lowest Point Outside Front Axle	Location: Steering stabilizer Clearance(in): 11.5
Lowest Point Outside Rear Axle	Location: Tailpipe Clearance(in): 13.0
Lowest Point between Axles	Location: Step well Clearance(in): 8.8
Ground Clearance at the center (in)	11.40
Front Approach Angle (deg)	28.00
Rear Approach Angle (deg)	9.60
Ramp Clearance Angle (deg)	9.20
Aisle Width (in)	17.75
Inside Standing Height at Center Aisle (in)	79.10

BODY DETAILS:

Body Structural Type	Integral		
Frame Material	Steel		
Body Material	Fiberglass		
Floor Material	Plywood		
Roof Material	Aluminum & fiberglass		
Windows Type	<input type="checkbox"/> Fixed	<input checked="" type="checkbox"/> Movable	
Window Mfg./Model No.	KTG / AS3 M3 DOT 620		
Number of Doors	<u>1</u> Front	<u>1</u> Rear	
Mfr. / Model No.	ENC / 315000GM		
Dimension of Each Door (in)	Front-26.2 x 80.0	Rear-44.7 x 72.0	
Passenger Seat Type	<input type="checkbox"/> Cantilever	<input checked="" type="checkbox"/> Pedestal	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Freedman / Midback FWT		
Driver Seat Type	<input type="checkbox"/> Air	<input type="checkbox"/> Spring	<input checked="" type="checkbox"/> Other (Cushion)
Mfr. / Model No.	Freedman / 6813000M		
Number of Seats (including Driver)	17 + 1 wheelchair position		
Bus Number: 2014		Date: 8-1-00	

**BODY DETAILS (Contd..)**

Free Floor Space ( ft <sup>2</sup> )	41.6			
Height of Each Step at Normal Position (in)	Front	1. <u>10.8</u>	2. <u>8.0</u>	3. <u>8.6</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>N/A</u>	2. <u>N/A</u>	3. <u>N/A</u> 4. <u>N/A</u>
Step Elevation Change - Kneeling (in)	N/A			

**ENGINE**

Type	<input checked="" type="checkbox"/> C.I.	<input type="checkbox"/> Alternate Fuel			
	<input type="checkbox"/> S.I.	<input type="checkbox"/> Other (explain)			
Mfr. / Model No.	Ford / Power Stroke 7.3 L				
Location	<input checked="" type="checkbox"/> Front	<input type="checkbox"/> Rear	<input type="checkbox"/> Other (explain)		
Fuel Type	<input type="checkbox"/> Gasoline	<input type="checkbox"/> CNG	<input type="checkbox"/> Methanol		
	<input checked="" type="checkbox"/> Diesel	<input type="checkbox"/> LNG	<input type="checkbox"/> Other (explain)		
Fuel Tank Capacity (indicate units)	55 gals.				
Fuel Induction Type	<input checked="" type="checkbox"/> Injected	<input type="checkbox"/> Carburetion			
Fuel Injector Mfr. / Model No.	Ford / Power Stroke 7.3 L				
Carburetor Mfr. / Model No.	N/A				
Fuel Pump Mfr. / Model No.	Ford / Power Stroke 7.3 L				
Alternator (Generator) Mfr. / Model No.	Penntex / PX-5				
Maximum Rated Output (Volts / Amps)	14 / 200				
Air Compressor Mfr. / Model No.	N/A				
Maximum Capacity (ft <sup>3</sup> / min)	N/A				
Starter Type	<input checked="" type="checkbox"/> Electrical	<input type="checkbox"/> Pneumatic	<input type="checkbox"/> Other (explain)		
Starter Mfr. / Model No.	Ford / OEM				



Bus Number: 2014	Date: 8-1-00
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#### TRANSMISSION

Transmission Type	<input type="checkbox"/> Manual	<input checked="" type="checkbox"/> Automatic	
Mfr. / Model No.	Ford / 4R100E		
Control Type	<input checked="" type="checkbox"/> Mechanical	<input type="checkbox"/> Electrical	<input type="checkbox"/> Other (explain)
Torque Converter Mfr. / Model No.	Ford / 4R100E		
Integral Retarder Mfr. / Model No.	N/A		

#### SUSPENSION

Number of Axles	2		
Front Axle Type	<input checked="" type="checkbox"/> Independent	<input type="checkbox"/> Beam Axle	
Mfr. / Model No.	Ford / Twin I-Beam		
Axle Ratio (if driven)	N/A		
Suspension Type	<input type="checkbox"/> Air	<input checked="" type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
No. of Shock Absorbers	2		
Mfr. / Model No.	Motorcraft / F5UA-18045-NC		
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.	Dana / 80HD		
Axle Ratio (if driven)	4.10		
Suspension Type	<input type="checkbox"/> Air	<input checked="" type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
No. of Shock Absorbers	2		
Mfr. / Model No.	Motorcraft / XC25-18080-EA		
Bus Number: 2014	Date: 8-1-00		

#### WHEELS & TIRES

Front	Wheel Mfr./ Model No.	Accuride / 16 x 6
	Tire Mfr./ Model No.	Firestone R4S / LT225/75R16
Rear	Wheel Mfr./ Model No.	Accuride / 16 x 6
	Tire Mfr./ Model No.	Firestone R4S / LT225/75R16

#### BRAKES

Front Axle Brakes Type	<input type="checkbox"/> Cam	<input checked="" type="checkbox"/> Disc	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Ford / OEM		
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 type="checkbox"/> Cam	<input checked="" type="checkbox"/> Disc	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Kelsey Hayes / KH12068401		
Retarder Type	N/A		
Mfr. / Model No.	N/A		

#### HVAC

Heating System Type	<input type="checkbox"/> Air	<input checked="" type="checkbox"/> Water	<input type="checkbox"/> Other
Capacity (Btu/hr)	65,000(body) 35,000(chassis)		
Mfr. / Model No.	N/A		
Air Conditioner	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	
Location	Front - dash Rear - Interior roof mount		
Capacity (Btu/hr)	52,000 - body		
A/C Compressor Mfr. / Model No.	Carrier / 3M-1 CM3		

#### STEERING

Steering Gear Box Type	Hydraulic gear
Mfr. / Model No.	Ford / XR-50 H.D.
Steering Wheel Diameter	15.2
Number of turns (lock to lock)	4

Bus Number: 2014	Date: 8-1-00
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#### OTHERS

Wheel Chair Ramps	Location: N/A	Type: N/A
Wheel Chair Lifts	Location: Right rear	Type: Hydraulic platform
Mfr. / Model No.	Ricon Corp. / S2005-510	
Emergency Exit	Location: Windows Doors	Number: 3 1

#### CAPACITIES

Fuel Tank Capacity (units)	55 gals.
Engine Crankcase Capacity (gallons)	3.75
Transmission Capacity (gallons)	4.10
Differential Capacity (gallons)	1.00
Cooling System Capacity (gallons)	7.50
Power Steering Fluid Capacity (gallons)	N/A

# VEHICLE DATA FORM

Bus Number: 2014	Date: 8-1-00
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**List all spare parts, tools and manuals delivered with the bus.**

[illegible]

# COMPONENT/SUBSYSTEM INSPECTION FORM

Bus Number: 2014	Date: 8-1-00
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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	✓	
Power Plant	✓	
Accessories	✓	
Lift System	✓	
Interior Fasteners	✓	
Batteries	✓	

## **CHECK-IN**



## **ELDORADO NATIONAL'S MODEL 240 AEROTECH**



## **CHECK-IN CONT.**

**ELDORAD  
NATIONA**



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L'S**

**MODEL 240 AEROTECH EQUIPPED  
WITH A RICON CORPORATION  
MODEL S2005-510 WHEELCHAIR LIFT**



## **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 bus 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. Note: the test bus submitted for testing encountered no failures during Structural Durability Testing.

**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

## **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. 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 classification of repairs according to subsystem is intended to emphasize those systems which had persistent minor or more serious problems. There were no failures encountered during the Structural Durability Test.

## **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 August 7, 2000 and was conducted until September 26, 2000. The first 3,000 miles were performed at a GVW of 14,000 lbs. The number of standing passengers was reduced from 27 standees and one wheelchair position, to 5 standees and one wheelchair position (600 lb per. wheelchair position). This reduction in passenger weight was necessary to avoid exceeding the GAWR (9,450 lbs) of the rear axle. The GVW segment was completed on August 14, 2000. The next 1,500 mile SLW segment was performed at 13,275 lbs and completed on September 14, 2000. The final 3,000 mile segment was performed at a CW of 10,150 lbs and completed on September 26, 2000.

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 PSBRTF and Durability Test Track are attached for reference. Also, a durability element profile detail shows all the measurement of the different conditions. There were no failures encountered during the Structural Durability Test.

**ELDORADO - TEST BUS #2014**  
**MILEAGE DRIVEN/RECORDED FROM DRIVERS' LOGS**

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
08/07/00 TO 08/13/00	201.00	59.00	260.00
08/14/00 TO 08/20/00	455.00	21.00	476.00
08/21/00 TO 08/27/00	1038.00	150.00	1188.00
08/28/00 TO 09/03/00	557.00	571.00	1128.00
09/04/00 TO 09/10/00	671.00	178.00	849.00
09/11/00 TO 09/17/00	785.00	320.00	1105.00
09/18/00 TO 09/24/00	1034.00	145.00	1179.00
09/25/00 TO 10/01/00	0.00	952.00	952.00
TOTAL	4741.00	2396.00	7137.00

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

STANDARD OPERATING SCHEDULE

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

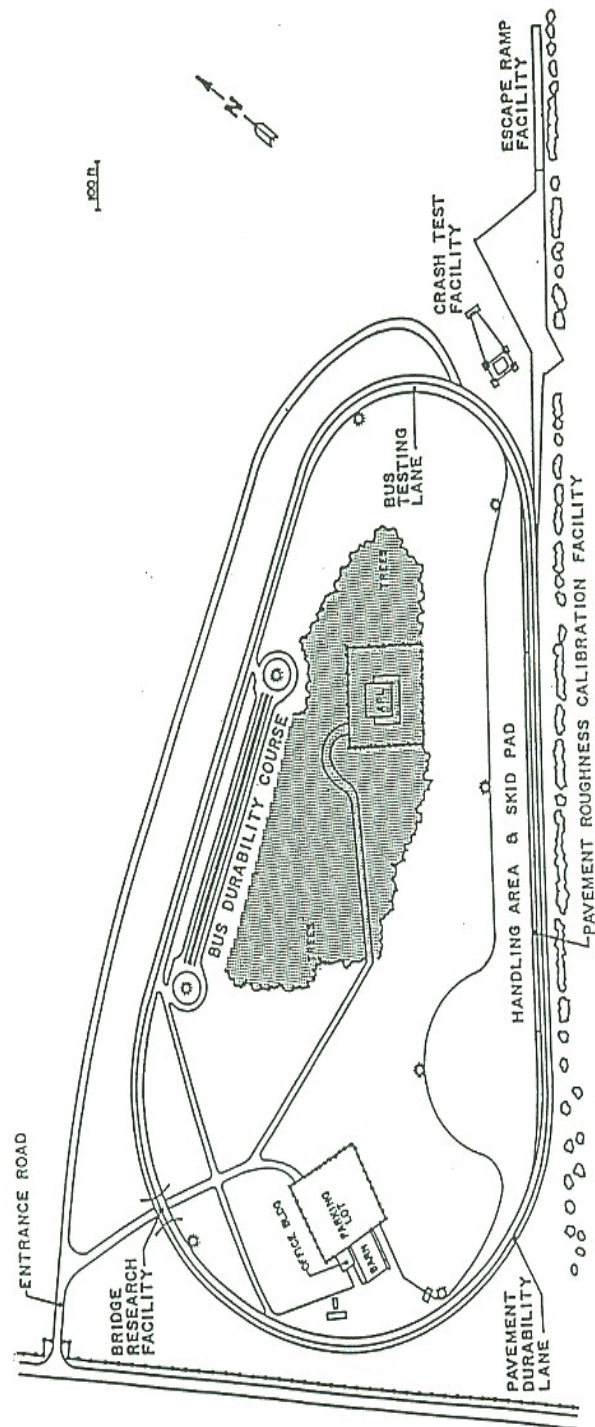
B—Break

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

D—Drive bus as specified by procedure

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

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



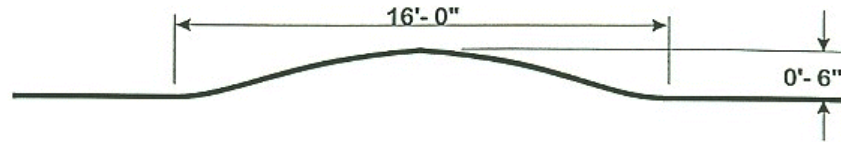
BUS TESTING AND RESEARCH TEST TRACK  
UNIVERSITY PARK, PA



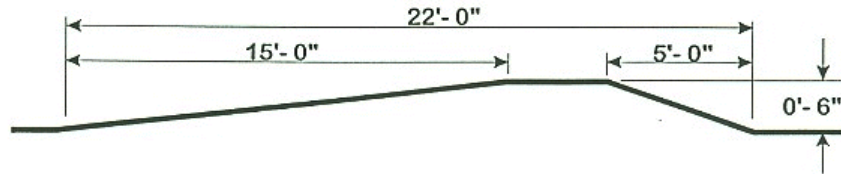


### Plan View

Staggered  
Bumps  
(10 mph)



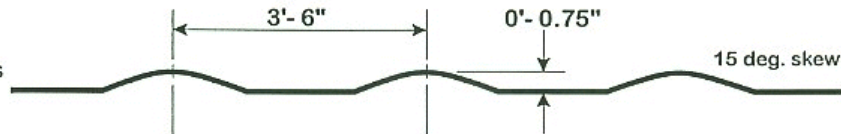
Railroad  
Crossing  
(8 mph)



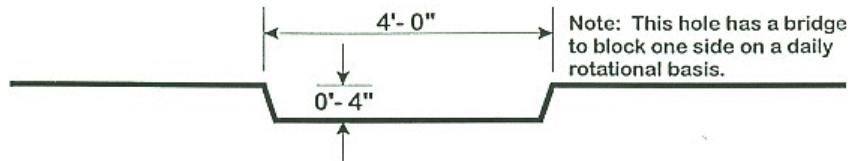
1" Random  
Chuck Holes  
(20 mph)



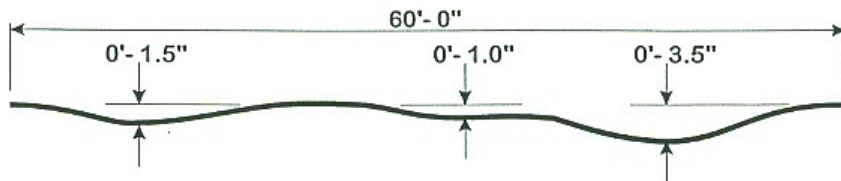
Chatter Bumps  
(20 mph)



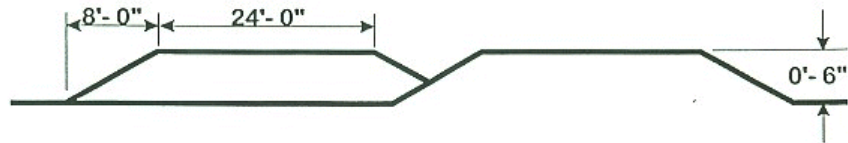
4" Chuck Hole  
(5 mph)



High Crown  
Intersection  
(20 mph)



Frame Twist  
(10 mph)



## Durability Element Profiles

The Pennsylvania Transportation Institute  
Penn State