

**PARTIAL**  
**STURAA TEST**  
**7 YEAR**  
**200,000 MILE BUS**  
**from**  
**CABLE CAR CONCEPTS**  
**MODEL 208" WB MAXI DIESEL FUELED TROLLEY**

**MAY 2003**  
**PTI-BT-R0306-P**



**The Pennsylvania Transportation Institute**

201 Research Office Building (814) 865-1891  
The Pennsylvania State University  
University Park, PA 16802

**Bus Testing and Research Center**

6th Avenue and 45th Street (814) 949-7944  
Altoona, PA 16602

# TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY .....	3
ABBREVIATIONS .....	5
BUS CHECK-IN .....	6
1. MAINTAINABILITY	
1.2    SERVICING, PREVENTATIVE MAINTENANCE, AND REPAIR AND MAINTENANCE DURING TESTING .....	20
2. RELIABILITY - DOCUMENTATION OF BREAKDOWN AND REPAIR TIMES DURING TESTING .....	29
5. STRUCTURAL INTEGRITY	
5.7    STRUCTURAL DURABILITY TEST .....	68

## EXECUTIVE SUMMARY

Cable Car Concepts submitted a model 208" WB Maxi Trolley, diesel-powered 31 seat (including the driver) 32-foot trolley, for a partial STURAA test in the 7 yr/200,000 mile category. The Federal Transit Administration determined that the following tests would be performed; 1.2 Servicing, Preventive Maintenance, and Repair and Maintenance During Testing, 2. Reliability and 5.7 Structural Durability Test. The odometer reading at the time of delivery was 326 miles. Testing started on February 4, 2003 and was completed on April 25, 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 February 10, 2003 and was completed on April 23, 2003.

The interior of the bus is configured with seating for 31 passengers including the driver. Free floor space will accommodate 24 standing passengers resulting in a potential load of 55 persons. At 150 lbs per person, this load results in a measured gross vehicle weight of 23,360 lbs. The first segment of the Structural Durability Test was performed with the bus loaded to a GVW of 23,360 lbs. The middle segment was performed at a seated load weight of 20,010 lbs and the final segment was performed at a curb weight of 15,450 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.

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. Also the problems also are listed by class as defined in Section 2. The test bus encountered no Class 1 or Class 2 failures. Of the twelve reported failures, six were Class 3 and six were Class 4.

## ABBREVIATIONS

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

# TEST BUS CHECK-IN

## I. OBJECTIVE

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

## II. TEST DESCRIPTION

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

## III. DISCUSSION

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

The test bus consists of a Cable Car Concepts, model 208" WB Maxi Diesel Fueled Trolley, built on a Freightliner model MB-55 chassis. The trolley has a front door, rear of the front axle, and a dedicated handicap access door equipped with a Braun Corp. model L915FIB platform lift, located to the rear of the rear axle. Power is provided by a diesel-fueled, Cummins Motors model ISB 205 engine coupled to an Allison 2400 Series transmission.

The measured curb weight is 6,550 lbs for the front axle and 8,900 lbs for the rear axle. These combined weights provide a total measured curb weight of 15,450 lbs. There are 31 seats including the driver and room for 24 standing passengers bringing the total passenger capacity to 55. Gross load is  $150 \text{ lb} \times 55 = 8,250 \text{ lbs}$ . At full capacity, the measured gross vehicle weight is 23,360 lbs.

## VEHICLE DATA FORM

Bus Number: 0306	Arrival Date: 2-4-03
Bus Manufacturer: Cable Car Concepts	Vehicle Identification Number (VIN): 4UZAACBVX1CJ15034
Model Number: 208" WB Maxi	Date: 2-4-03
Personnel: S.C. & T.S.	

WEIGHT:

Individual Wheel Reactions:

Weights (lb)	Front Axle		Middle Axle		Rear Axle	
	Right	Left	Right	Left	Right	Left
CW	3,370	3,180	N/A	N/A	4,540	4,360
SLW	3,470	3,600	N/A	N/A	6,400	6,540
GVW	3,910	3,970	N/A	N/A	7,520	7,960

Total Weight Details:

Weight (lb)	CW	SLW	GVW	GAWR
Front Axle	6,550	7,070	7,880	8,000
Middle Axle	N/A	N/A	N/A	N/A
Rear Axle	8,900	12,940	15,480	17,500
Total	15,450	20,010	23,360	GVWR: 25,000

Dimensions:

Length (ft/in)	32 / 9.0
Width (in)	100.0
Height (in)	126.5
Front Overhang (in)	52.0
Rear Overhang (in)	132.5
Wheel Base (in)	208.5
Wheel Track (in)	Front: 85.0
	Rear: 72.5

Bus Number: 0306	Date: 2-4-03
------------------	--------------

**CLEARANCES:**

Lowest Point Outside Front Axle	Location: Radiator frame Clearance(in): 13.6
Lowest Point Outside Rear Axle	Location: Fuel tank Clearance(in): 11.3
Lowest Point between Axles	Location: Step well Clearance(in): 10.6
Ground Clearance at the center (in)	10.6
Front Approach Angle (deg)	17.4
Rear Approach Angle (deg)	7.6
Ramp Clearance Angle (deg)	5.8
Aisle Width (in)	20.5
Inside Standing Height at Center Aisle (in)	79.5

**BODY DETAILS:**

Body Structural Type	Integral		
Frame Material	Steel		
Body Material	Aluminum & fiberglass		
Floor Material	Plywood		
Roof Material	Fiberglass		
Windows Type	<input type="checkbox"/> Fixed	<input checked="" type="checkbox"/> Movable	
Window Mfg./Model No.	KTG / AS# M2 DOT620		
Number of Doors	1 Front	1 Rear	
Mfr. / Model No.	Bode / 3433		
Dimension of Each Door (in)	Front – 44.3 x 87.3	Rear – 44.5 x 70.5 (handicap entrance)	
Passenger Seat Type	<input type="checkbox"/> Cantilever	<input checked="" type="checkbox"/> Pedestal	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Great American Trolley Co. / N/A		
Driver Seat Type	<input checked="" type="checkbox"/> Air	<input type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Bostrom / 910SC		
Number of Seats (including Driver)	31		

Bus Number: 0306	Date: 2-4-03
------------------	--------------

BODY DETAILS (Contd..)

Free Floor Space ( ft <sup>2</sup> )	36.0				
Height of Each Step at Normal Position (in)	Front	1. <u>12.2</u>	2. <u>7.3</u>	3. <u>7.3</u>	4. <u>7.7</u>
	Middle	1. <u>N/A</u>	2. <u>N/A</u>	3. <u>N/A</u>	4. <u>N/A</u>
	Rear	1. <u>N/A</u>	2. <u>N/A</u>	3. <u>N/A</u>	4. <u>N/A</u>
Step Elevation Change - Kneeling (in)	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.	Cummins Motors / ISB 205			
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)	60 gals.			
Fuel Induction Type	<input checked="" type="checkbox"/> Injected		<input type="checkbox"/> Carburetion	
Fuel Injector Mfr. / Model No.	Cummins Motors / ISB 205			
Carburetor Mfr. / Model No.	N/A			
Fuel Pump Mfr. / Model No.	Cummins Motors / ISB 205			
Alternator (Generator) Mfr. / Model No.	Leece-Neville / A0014884JB			
Maximum Rated Output (Volts / Amps)	14 / 230			
Air Compressor Mfr. / Model No.	Holset / 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.	Delco-Remy / TM82 Series			



Bus Number: 0306	Date: 2-4-03
------------------	--------------

TRANSMISSION

Transmission Type	<input type="checkbox"/> Manual	<input checked="" type="checkbox"/> Automatic	
Mfr. / Model No.	Allison Transmission / 2400 Series		
Control Type	<input checked="" type="checkbox"/> Mechanical	<input type="checkbox"/> Electrical	<input type="checkbox"/> Other
Torque Converter Mfr. / Model No.	Allison Transmission / 2400 Series		
Integral Retarder Mfr. / Model No.	N/A		

SUSPENSION

Number of Axles	2		
Front Axle Type	<input type="checkbox"/> Independent	<input checked="" type="checkbox"/> Beam Axle	
Mfr. / Model No.	Meritor / MFS121015N2		
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.	Gabriel / T1108SA		
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 / RS17145NFNN212		
Axle Ratio (if driven)	4.11		
Suspension Type	<input checked="" type="checkbox"/> Air	<input type="checkbox"/> Spring	<input type="checkbox"/> Other (explain)
No. of Shock Absorbers	2		
Mfr. / Model No.	Gabriel / T1011243A		

Bus Number: 0306	Date: 2-4-03
------------------	--------------

**WHEELS & TIRES**

Front	Wheel Mfr./ Model No.	Accuride / 6.75 x 19.5
	Tire Mfr./ Model No.	Michelin XZE / 245/70R 19.5
Rear	Wheel Mfr./ Model No.	Accuride / 6.75 x 19.5
	Tire Mfr./ Model No.	Michelin XZE / 245/70R 19.5

**BRAKES**

Front Axle Brakes Type	<input checked="" type="checkbox"/> Cam	<input type="checkbox"/> Disc	<input type="checkbox"/> Other (explain)
Mfr. / Model No.	Meritor / Q-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	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)	33,000		
Mfr. / Model No.	ACC Climate / 20014A		
Air Conditioner	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	
Location	Center roof & dash		
Capacity (Btu/hr)	110,000		
A/C Compressor Mfr. / Model No.	ACME / N/A		

**STEERING**

Steering Gear Box Type	Hydraulic gear
Mfr. / Model No.	TRW / TAS-55
Steering Wheel Diameter	18.0
Number of turns (lock to lock)	4.0

Bus Number: 0306	Date: 2-4-03
------------------	--------------

OTHERS

Wheel Chair Ramps	Location: N/A	Type: N/A
Wheel Chair Lifts	Location: Right rear	Type: Electric/hydraulic platform
Mfr. / Model No.	The Braun Corp. / L915FIB	
Emergency Exit	Location: Window Door	Number: 5 1

CAPACITIES

Fuel Tank Capacity (units)	60 gals.
Engine Crankcase Capacity (gallons)	4.75
Transmission Capacity (gallons)	3
Differential Capacity (gallons)	4.5
Cooling System Capacity (quarts)	2.4 (engine only)
Power Steering Fluid Capacity (gallons)	1

**VEHICLE DATA FORM**

Bus Number: 0360	Date: 2-4-03
------------------	--------------

**List all spare parts, tools and manuals delivered with the bus.**

Part Number	Description	Qty.
245/70R 19.5	Mounted tires	5
1024DT	Battery	2
ECO Series HS0119188D	Air cleaner	1
WIX 57182	Oil filter	1
WIX 33585	Fuel filter	1

## COMPONENT/SUBSYSTEM INSPECTION FORM

Bus Number: 0306	Date: 2-4-03
------------------	--------------

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	✓	Interior walls not complete.
Batteries	✓	

## CHECK - IN



**CABLE CAR CONCEPT'S  
MODEL 208" WB MAXI DIESEL FUELED TROLLEY**



## **CHECK - IN CONT.**



**CABLE CAR CONCEPT'S  
MODEL 208" WB MAXI DIESEL FUELED TROLLEY  
EQUIPPED WITH A BRAUN CORPORATION,  
MODEL L915FIB PLATFORM 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 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.

(Page 1 of 1)  
 SCHEDULED MAINTENANCE  
 Cable Car 0306

DATE	TEST MILES	SERVICE	ACTIVITY	DOWN TIME	HOURS
02-21-03	1,637	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
02-26-03	1,780	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
03-05-03	2,518	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
03-13-03	4,213	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
03-26-03	5,671	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
04-07-03	6,217	P.M. / Inspection	Linkage, tie rods, universals/u-joints all lubed; all fluids checked.	4.00	4.00
04-23-03	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

## 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 six Class 3 failures, four involved the suspension system, and the two occurred with the body frame & doors. These, and the remaining six Class 4 failures are available for review in the Unscheduled Maintenance List, located in Section 5.7 Structural Durability.

(Page 1 of 2)  
**RELIABILITY DATA FORMS**

Bus Number: 0306	Date: 04/23/03
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		260			0.50	0.50
		529			1.00	1.00
		688			0.50	0.50
		4,267			1.50	1.50
	6,101				2.00	2.00
Heat / A/C	1,635/1,780				1.00	1.00
	4,786				1.00	1.00
	6,027/6,217				5.00	5.00
Body Frame / Doors		4,786			2.00	2.00
		5,927			8.00	8.00
Electrical	260				0.50	0.50
	4,267				1.00	1.00

## 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 2,500 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 February 10, 2003 and was conducted until April 23, 2003. The first 3,000 miles were performed at a GVW of 23,360 lbs. and completed on March 5, 2003. The next 2,500 mile SLW segment was performed at 20,010 lbs and completed on March 13, 2003, and the final 3,000 mile segment was performed at a CW of 15,450 lbs and completed on April 23, 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.

**CABLE CAR - TEST BUS #0306**  
**MILEAGE DRIVEN/RECORDED FROM DRIVERS' LOGS**

DATE	TOTAL DURABILITY TRACK	TOTAL OTHER MILES	TOTAL
02/10/03 TO 02/16/03	559.00	280.00	839.00
02/17/03 TO 02/23/03	846.00	42.00	888.00
02/24/03 TO 03/02/03	168.00	110.00	278.00
03/03/03 TO 03/09/03	822.00	634.00	1456.00
03/10/03 TO 03/16/03	622.00	184.00	806.00
03/17/03 TO 03/23/03	773.00	88.00	861.00
03/24/03 TO 03/30/03	555.00	244.00	799.00
03/31/03 TO 04/06/03	180.00	60.00	240.00
04/07/03 TO 04/13/03	0.00	50.00	50.00
04/14/03 TO 04/20/03	337.00	164.00	501.00
04/21/03 TO 04/27/03	138.00	645.00	783.00
TOTAL	5000.00	2501.00	7501.00

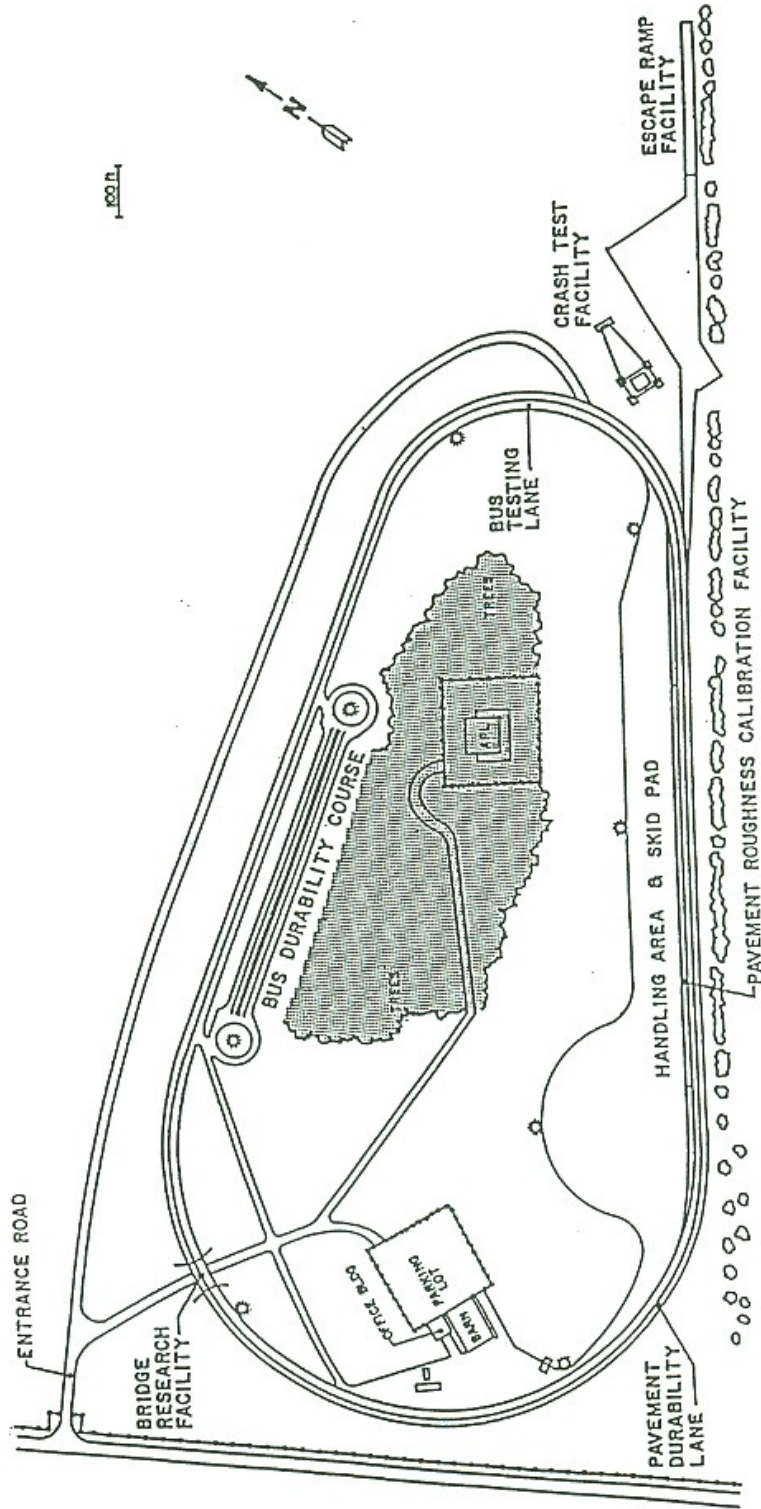


Table 4. Driving Schedule for Bus Operation on the Durability Test Track.

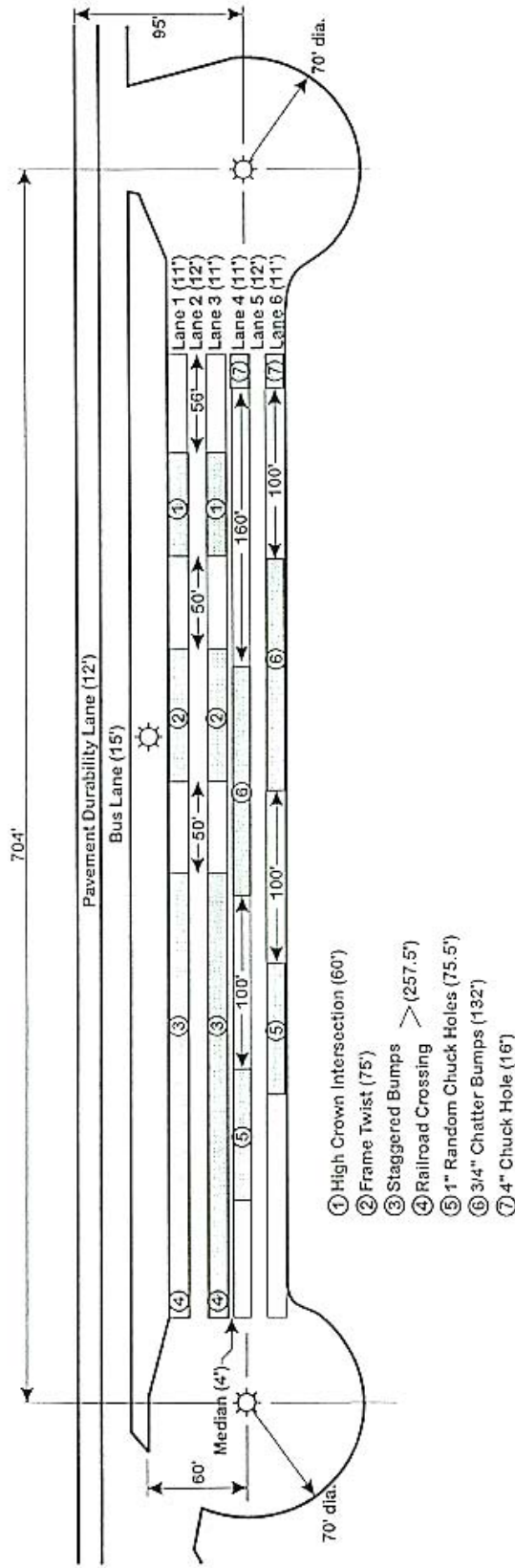
STANDARD OPERATING SCHEDULE			
Monday through Friday			
	HOUR	ACTION	
Shift 1	midnight	D	
	1:40 am	C	
	1:50 am	B	
	2:00 am	D	
	3:35 am	C	
	3:45 am	B	
	4:05 am	D	
	5:40 am	C	
	5:50 am	B	
	6:00 am	D	
	7:40 am	C	
	7:50 am	F	
	Shift 2	8:00 am	D
		9:40 am	C
9:50 am		B	
10:00 am		D	
11:35 am		C	
11:45 am	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

B—Break  
 C—Cycle all systems five times, visual inspection, driver's log entries  
 D—Drive bus as specified by procedure  
 F—Fuel bus, complete driver's log shift entries

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



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

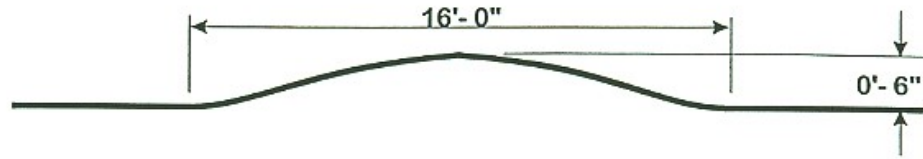


Plan View

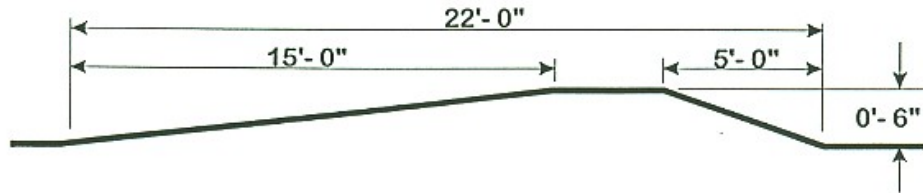
# Vehicle Durability Test Track

The Pennsylvania Transportation Institute  
Penn State

Staggered  
Bumps  
(10 mph)



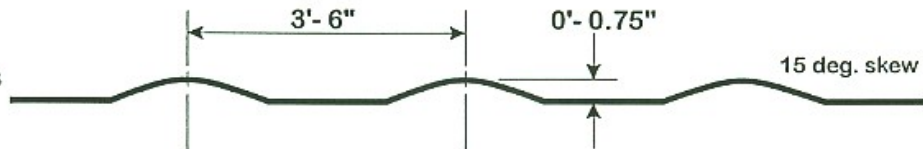
Railroad  
Crossing  
(8 mph)



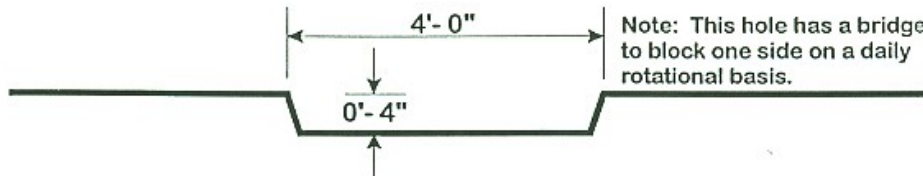
1" Random  
Chuck Holes  
(20 mph)



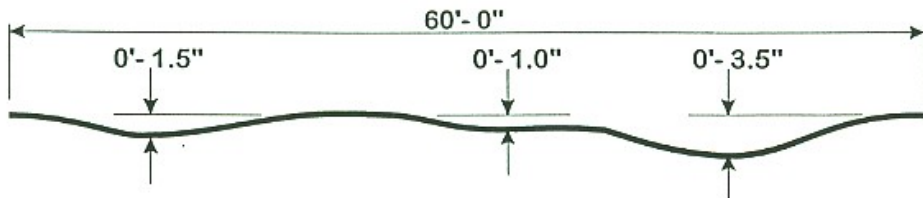
Chatter Bumps  
(20 mph)



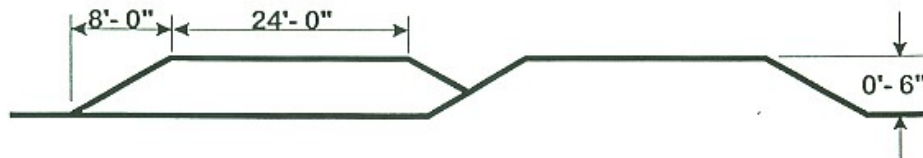
4" Chuck Hole  
(5 mph)



High Crown  
Intersection  
(20 mph)



Frame Twist  
(10 mph)



## Durability Element Profiles

The Pennsylvania Transportation Institute  
Penn State

(Page 1 of 2)  
 UNSCHEDULED MAINTENANCE  
 Cable Car 0306

<b>DATE</b>	<b>TEST MILES</b>	<b>SERVICE</b>	<b>ACTIVITY</b>	<b>DOWN TIME</b>	<b>HOURS</b>
02-12-03	260	The dash lights are inoperative.	5 amp fuse is missing from the fuse panel—5 amp fuse installed.	0.50	0.50
02-12-03	260	Inspect for a noise in the front suspension.	Loose front sway bar link bracket bolts torqued.	0.50	0.50
02-13-03	529	The front sway bar link bracket bolts are loose.	Torqued bolts on the front sway bar link bracket.	1.00	1.00
02-14-03	688	The front sway bar link bracket bolts are loose.	Nylok nuts installed on front sway bar link bracket bolts.	0.50	0.50
02-21-03	1,635	No heat in the rear of the bus.	The fan motor in the rear floor heater came loose and broke the fan blades. Broken fan blades removed. Parts ordered.	0.50	0.50
02-27-03	1,780	New fan blades that were ordered on 02/21/03 arrived.	Installed new fan blades in rear floor heater.	0.50	0.50
03-17-03	4,267	The end brackets on the cross member located between the rear spring hangers are broken.	Both end brackets replaced.	1.50	1.50

(Page 2 of 2)  
 UNSCHEDULED MAINTENANCE  
 Cable Car 0306

<b>DATE</b>	<b>TEST MILES</b>	<b>SERVICE</b>	<b>ACTIVITY</b>	<b>DOWN TIME</b>	<b>HOURS</b>
03-20-03	4,786	The rear heater blower motor has broken loose damaging the fan blades.	Rear heater blower motor and fan removed.	1.00	1.00
03-20-03	4,786	The left door panel, lower pivot pin is missing.	Lower pivot pin replaced.	2.00	2.00
04-02-03	5,927	The roof frame around the A/C unit has cracked.	Welded and repaired cracks in roof frame.	8.00	8.00
04-03-03	6,027	Test driver noticed smoke coming from the engine compartment. The upper A/C compressor clutch has seized.	Power to both compressors disconnected. Notified warranty dealer.	0.50	0.50
04-04-03	6,101	Both front lower sway bar bushings are worn.	Both front lower sway bar bushings replaced.	2.00	2.00
04-09-03	6,217	The upper A/C compressor clutch has seized (reported on 04/04/03).	Warranty dealer (Thermo King) replaced compressor.	4.50	4.50

## UNSCHEDULED MAINTENANCE



**REAR BLOWER MOTOR AND FAN  
(1,635 TEST MILES)**



**BROKEN REAR SPRING HANGER  
CROSS MEMBER END BRACKETS  
(4,267 TEST MILES)**

**UNSCHEDULED MAINTENANCE CONT.**



**CRACKED ROOF FRAME AROUND THE A/C UNIT  
(5,927 TEST MILES)**





## UNSCHEDULED AMINTANANCE CONT.



**FAILED A/C COMPRESSOR CLUTCH  
(6,217 TEST MILES)**