Partial STURAA Test

ORION V

40' Heavy Duty Bus

from

Bus Industries of America

Test Completion Date
July 1990

PTI-BT-R9003

The Pennsylvania Transportation Institute

Research Building B
The Pennsylvania State University
University Park, PA 16802

(814) 865-1891

Bus Testing and Research Center

6th Avenue and 45th Street
Altoona, PA 16603

(814) 949-7944
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</tbody>
</table>
EXECUTIVE SUMMARY

This was a partial STURAA test which was conducted on an Orion V bus with a Cummins engine. The first part was conducted in November and December 1989. For ABTC, this was an opportunity to practice some of the tests and to work the bugs out. For the manufacturer, it was an opportunity to observe the tests and the performance of the prototype in the tests prior to submitting the first full test. The first complete test was done during the first quarter of 1990 on a unit with a Detroit engine. In order to have test results available on those tests which would be affected by the drive train, the bus with a Cummins engine was tested again during June and July of 1990 for performance, fuel economy, and noise. All of the tests done on the Orion V with a Cummins engine are combined in this report.

In the tests conducted, the bus performed well with no significant deficiencies. The bus was driven on the durability course, but not long enough to develop any breakdowns. The distortion test was performed with only minor leaks at windows observed. The shakedown test was performed with about one-third of an inch deflection and no observable permanent deformation. Jacking and hoisting tests were successfully performed. These results are consistent with the results on the unit with a Detroit engine.

An acceleration curve was plotted and gradeability calculated from it. The top speed was 56 mph. The fuel economy was measured on central business district, arterial, and commuter driving cycles. Individual results were 3.70, 5.06, and 7.78 miles per gallon respectively. Overall average was 4.78 miles per gallon. These numbers are all somewhat higher than the same model with the Detroit engine.

In the interior noise test, penetration of 80 dB(A) white noise from the exterior ranged from 52.1 to 54.6 dB(A). During acceleration, interior noise ranged from 60.2 dB(A) at the driver's seat to 66.0 dB(A) at the rear seats.

In the exterior noise test, the noise generated by the bus under various driving conditions is measured. No unusual observations were made.
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)
$\text{dB(A)}$ - 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)
GVWR - gross vehicle weight rating (curb weight plus gross vehicle load)
MECH - bus mechanic
mpg - miles per gallon
mph - miles per hour
NBM - new bus models
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)
TD - test driver
TECH - test technician
TM - track manager
TP - test personnel
UMTA - Urban Mass Transportation Administration
TEST BUS CHECK-IN

I. OBJECTIVE

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

II. TEST DESCRIPTION

The test consists of assigning a NBM 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

Not all the tests were performed, but the results of the tests that were performed are presented in this partial report.

The engine dolly was returned with the bus. The spare parts delivered with this bus were retained to be available for use with the test on Bus No. 30040.

The bus submitted for this testing was an Orion V with a Cummins LT10 engine and Voith D863 transmission. It had a 54" rear door without a wheelchair lift.
**VEHICLE DATA FORM**

**Bus Number** 30025  
**Arrival date** October 27, 1989  
**Bus manufacturer** Ontario Bus Industries, Inc.  
**Model number** Orion V  
**Vehicle identification number (VIN)** 2B1569E79K5030025  
**Date** 11-3-89  
**Personnel:** TECH: Dennis Fishburn  

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>nominal</th>
<th>40' over body 478&quot;; over bumpers 488.5&quot;</th>
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<tr>
<td>Width (in)</td>
<td>nominal</td>
<td>102&quot;</td>
</tr>
<tr>
<td>Height (in)</td>
<td>nominal</td>
<td>119&quot;</td>
</tr>
<tr>
<td>Wheel base (in)</td>
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<td>280&quot;</td>
</tr>
<tr>
<td>Front overhang (in)</td>
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<td>91&quot;</td>
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<tr>
<td>Front approach angle (deg)</td>
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<td>10°</td>
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<td>Rear overhang (in)</td>
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<td>118&quot;</td>
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<tr>
<td>Rear approach angle (deg)</td>
<td></td>
<td>9°</td>
</tr>
<tr>
<td>Road clearance (in)</td>
<td></td>
<td>9.2&quot; walking beam at rear; 9.0&quot; tie rod at front</td>
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</table>

**Body structure type**

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<thead>
<tr>
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<th>welded X</th>
<th>riveted</th>
<th>other</th>
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</thead>
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<tr>
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<td>Fiberglass &amp; zinc coated steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>floor material</td>
<td>Wood, rubber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>roof material</td>
<td>Aluminum</td>
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<tr>
<td>Seat type</td>
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<td>other</td>
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<tr>
<td>No. of seated passengers</td>
<td>47 (including driver)</td>
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<tr>
<td>Standing room (sq. ft.)</td>
<td>64.5 sq ft</td>
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<tr>
<td>Windows</td>
<td>fixed</td>
<td>moveable X</td>
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<tr>
<td>material</td>
<td>Safety glass</td>
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<td><strong>Bus Number</strong></td>
<td>30025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of doors</strong></td>
<td>2</td>
<td></td>
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</tr>
<tr>
<td><strong>manufacturer/model no.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>location</strong></td>
<td>Front &amp; rear</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>dimensions</strong></td>
<td>24&quot; x 84&quot; - (2) Rear; 30&quot; x 84&quot; - (1) Front</td>
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</tr>
<tr>
<td><strong>Lift(s)</strong></td>
<td>number of lifts 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>type</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
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<tr>
<td><strong>Engine type</strong></td>
<td>Diesel L10 Cummins 240 HP</td>
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<td>Cummins/LTA 10-B 34604388</td>
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<td><strong>Fuel injector type</strong></td>
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</tr>
<tr>
<td><strong>size</strong></td>
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<td><strong>Fuel type</strong></td>
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<td></td>
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<td><strong>Fuel pump(s) type</strong></td>
<td>Supply</td>
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<tr>
<td><strong>Fuel system</strong></td>
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<td></td>
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<tr>
<td><strong>tank capacity (gal)</strong></td>
<td>125 US Gallons</td>
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<tr>
<td><strong>Generator</strong></td>
<td>Delco Remy 50DN 1117799 85D28</td>
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<tr>
<td><strong>output at normal idle</strong></td>
<td>amps 200 volts 24</td>
<td></td>
<td></td>
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<tr>
<td><strong>maximum rating</strong></td>
<td>amps 270 volts 24</td>
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**VEHICLE DATA FORM (page 3)**

**Bus Number**: 30025

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<thead>
<tr>
<th><strong>Starter type</strong></th>
<th>electrical</th>
<th>air</th>
<th>X</th>
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<td><strong>manufacturer/model no.</strong></td>
<td>Ingersoll-Rand/55350GF03R31-02H</td>
<td>WPD17005</td>
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<tr>
<td><strong>Heating system type</strong></td>
<td>Underfloor Heater</td>
<td>Front Heater &amp; Defroster</td>
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<tr>
<td><strong>capacity (btu/hr)</strong></td>
<td>120,000</td>
<td>73,000</td>
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<tr>
<td><strong>Air conditioning</strong></td>
<td>A/C Thermo King T2M9 for use with R-12</td>
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<td></td>
</tr>
<tr>
<td><strong>location</strong></td>
<td>Rear</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>capacity (btu/hr)</strong></td>
<td>82,000 BTU/hr</td>
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<tr>
<td><strong>compressor man./mod. #</strong></td>
<td>Thermo King 0794740481/X426 0594019151</td>
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<tr>
<td><strong>Air compressor</strong></td>
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<tr>
<td><strong>manufacturer/model no.</strong></td>
<td>Bendix Westinghouse/TU FLO 700</td>
<td>1B1689F</td>
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<tr>
<td><strong>capacity</strong></td>
<td>15.5 at 1250 RPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transmission type</strong></td>
<td>Voith D863</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>manufacturer/model no.</strong></td>
<td>Voith/A4.518</td>
<td>18</td>
<td>8.5 BAR</td>
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<tr>
<td><strong>control type</strong></td>
<td>Electric</td>
<td></td>
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<tr>
<td><strong>integral retarder</strong></td>
<td>Yes</td>
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<td></td>
</tr>
<tr>
<td><strong>converter torque multiplication</strong></td>
<td>Rev 1st 2nd 3rd 4th</td>
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<tr>
<td></td>
<td>5.27 5.05 1.43 1 1</td>
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<td><strong>Retarder type</strong></td>
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<td><strong>Brake type(s)</strong></td>
<td>Maxibrake 36/75</td>
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<tr>
<td><strong>manufacturer/model no.</strong></td>
<td>Aeroquip</td>
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<table>
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<th>Number of axles</th>
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<tr>
<td>Drive axle location(s)</td>
<td>Rear</td>
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<td><strong>Axle 1 (front) type</strong></td>
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<tr>
<td>manufacturer/model no.</td>
<td>Rockwell/17101 WX</td>
</tr>
<tr>
<td>axle ratio (if driven)</td>
<td></td>
</tr>
<tr>
<td>suspension type</td>
<td>air [X] springs ____ torsion ____ other ____</td>
</tr>
<tr>
<td><strong>Axle 2 type/location</strong></td>
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<td>manufacturer/model no.</td>
<td>Rockwell/61143 WX NKA 89047015</td>
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<td>axle ratio (if driven)</td>
<td>4.56</td>
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<td>suspension type</td>
<td>air [X] springs ____ torsion ____ other ____</td>
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<td><strong>Axle 3 type/location</strong></td>
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<tr>
<td>manufacturer/model no.</td>
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</tr>
<tr>
<td>axle ratio (if driven)</td>
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</tr>
<tr>
<td>suspension type</td>
<td>air ____ springs ____ torsion ____ other ____</td>
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<tr>
<td><strong>Axle 4 type/location</strong></td>
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<tr>
<td>manufacturer/model no.</td>
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</tr>
<tr>
<td>axle ratio (if driven)</td>
<td></td>
</tr>
<tr>
<td>suspension type</td>
<td>air ____ springs ____ torsion ____ other ____</td>
</tr>
<tr>
<td><strong>Axle 5 type/location</strong></td>
<td></td>
</tr>
<tr>
<td>manufacturer/model no.</td>
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</tr>
<tr>
<td>axle ratio (if driven)</td>
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<tr>
<td>suspension type</td>
<td>air ____ springs ____ torsion ____ other ____</td>
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</tbody>
</table>
VEHICLE DATA FORM (page 5)

Bus Number 30025

| Other axles |  |
|-------------|
| Tire type   | Bias Mileage XT "G" Rating |
| manufacturer | Goodyear |
| size        | 12.5 x 22.5 |

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<tr>
<th>Weights</th>
<th>Front axle</th>
<th>Rear axle</th>
<th>Total</th>
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<tr>
<td>curb</td>
<td>8.573 lb</td>
<td>17.307 lb</td>
<td>25.880 lb</td>
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<tr>
<td>seated</td>
<td>11.424 lb</td>
<td>21.356 lb</td>
<td>32.780 lb</td>
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<td>gross</td>
<td>14.499 lb</td>
<td>25.040 lb</td>
<td>39.539 lb</td>
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<th>Spare parts kit</th>
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<th>Description</th>
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<td>0107150777</td>
<td>Alternator Belt</td>
<td>1</td>
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<tr>
<td>0110212404</td>
<td>Relay</td>
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<tr>
<td>0110010404</td>
<td>67 Bulb</td>
<td>6</td>
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<tr>
<td>BS-5050119</td>
<td>305 Bulb</td>
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<tr>
<td>0010085184</td>
<td>2 AMP Breaker</td>
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<td>0210085024</td>
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<td>0210085004</td>
<td>12 AMP Breaker</td>
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<td>0210085054</td>
<td>15 AMP Breaker</td>
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<td>0210085104</td>
<td>C/B 20 AMP</td>
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<tr>
<td>0210085114</td>
<td>25 AMP Breaker</td>
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<td>30 AMP Breaker</td>
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<td>Trans Filter</td>
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<td>How Often Used</td>
<td>Usefulness</td>
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<td>----------------</td>
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<tr>
<td>NPN</td>
<td>Tow Bar</td>
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<td>NPN</td>
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<tr>
<td>NPN</td>
<td>Video Tapes (8)</td>
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Manufacturer's recommended service | Included X | Not Included
Manufacturer's repair manual | Included X | Not Included
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<th>Subsystem</th>
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<tbody>
<tr>
<td>Heating and</td>
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<tr>
<td>Ventilation</td>
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<td>Body &amp; Sheet Metal</td>
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<td>Satisfactory</td>
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<td>Frame</td>
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<td>Satisfactory</td>
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<td>Steering</td>
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<td>Suspension</td>
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<td>Axles-rear</td>
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<tr>
<td>Brakes</td>
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<tr>
<td>Tires/Wheels</td>
<td>X</td>
<td>Spare tire flat</td>
</tr>
<tr>
<td>Exhaust</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Fuel System</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Power Plant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Lift System</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 are checked, and where accessibility is restricted the subsystem is noted along with the reason for the restriction.

1.1-III. DISCUSSION

A detailed accessibility inspection was not performed during this test. In those areas where accessibility was observed, it was found to be satisfactory.
## ACCESSIBILITY DATA SHEET

<table>
<thead>
<tr>
<th>Component</th>
<th>Checked</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air conditioning, heating, ventilation</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>2. Body and sheet metal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Steering</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>5. Suspension</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>6. Axles-front</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>7. Axles-rear</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>8. Brakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Transmission</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>10. Clutch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Drive shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Power take off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Cranking system</td>
<td>X</td>
<td>Satisfactory</td>
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<tr>
<td>14. Lighting system</td>
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<tr>
<td>15. Charging system</td>
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</tr>
<tr>
<td>16. Air intake system</td>
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<tr>
<td>17. Instruments</td>
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<tr>
<td>18. Tires/wheels</td>
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<td>Satisfactory</td>
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<td>19. Cooling system</td>
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<td>20. Exhaust system</td>
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<td>21. Fuel system</td>
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<td></td>
</tr>
<tr>
<td>22. Power plant</td>
<td>X</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>23. Accessories-general</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Lift systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Radio equipment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. SAFETY - A DOUBLE-LANE CHANGE
(Obstacle Avoidance Test)

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 speeds until the test is unsafe or a speed of 45 mph is reached. The lane change course will be set up using pylons to mark off two 12-ft center to center lanes with two 100-ft lane change areas 100 ft apart. The bus will begin in one lane, change to the other lane in a 100-ft span, travel 100 ft, and return to the original lane in another 100-ft span. This procedure will be repeated, starting once in the right-and then in the left-hand lane.

3-III. DISCUSSION

The double lane change maneuver was performed satisfactorily up to 45 miles per hour. There were no problems with handling or stability during the test.
SAFETY DATA FORM - 3

Safety Test: Double Lane Change

Bus Number _______30025_______  Date _______11-21-89_____

Personnel: TP _______Dave Klinikowski_______
TD _______Bill Jones_______

Maximum safe speed for double-lane change to the left _______ mph

Maximum safe speed for double-lane change to the right _______ mph

Tested speed for safe double-lane change to the left _______45_______ mph

Tested speed for safe double-lane change to the right _______45_______ mph

Comments:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Test completed _______David Klinikowski_______  _______11-21-89_____
(test technician signature)  (date)
Orion V in Double-Lane Change
4. PERFORMANCE - AN ACCELERATION, GRADEABILITY, AND TOP SPEED TEST

4-I. TEST OBJECTIVE

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

4-II. TEST DESCRIPTION

In this test, the bus will be operated at SLW on a smooth, straight and level roadway. The bus will be accelerated at full throttle from standstill to a maximum speed that the operator feels is safe. Using a noncontacting speed sensor, the time required to reach various speeds and the maximum safe speed will be recorded. Gradeability capabilities will be calculated from the test data. Acceleration capabilities will be reported as the time needed to reach various speeds.

4-III. DISCUSSION

The time to accelerate to speed up to 50 mph was measured and the acceleration curve was plotted. Gradeability is calculated from this curve. Top speed was 56 mph.
PERFORMANCE DATA FORM - 4

Acceleration, Gradeability, Top Speed

Bus Number 30025
Date 07-09-90

Personnel: TECH Stephen McConnell

TP

TD Bill Jones

Environment data: Temperature 80° F Wind direction SW
Humidity 68 % Wind speed 5 mph

Table 1. Time to speed data. (sec)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Counter Clockwise Run 1</th>
<th>Clockwise Run 4</th>
<th>Counter Clockwise Run 2</th>
<th>Clockwise Run 5</th>
<th>Counter Clockwise Run 3</th>
<th>Clockwise Run 6</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mph</td>
<td>5.71</td>
<td>5.12</td>
<td>5.53</td>
<td>5.33</td>
<td>5.12</td>
<td>5.21</td>
<td>5.39</td>
</tr>
<tr>
<td>30 mph</td>
<td>17.82</td>
<td>15.45</td>
<td>17.14</td>
<td>16.41</td>
<td>15.45</td>
<td>15.93</td>
<td>16.68</td>
</tr>
<tr>
<td>50 mph</td>
<td>-</td>
<td>40.19</td>
<td>-</td>
<td>41.63</td>
<td>-</td>
<td>40.91</td>
<td></td>
</tr>
</tbody>
</table>

"safe" or "geared" safe safe safe safe safe safe

Top speed on level roadway 56 mph

Gradeability calculation example

A = slope of speed vs. time plot at 44 mph = 1.13 ft/sec^2

Slope = sin^{-1} [ A / (32.2 ft/sec^2) ] = 2.01 degrees

Maximum percent grade = tan [ Slope ] = 3.50 percent

Test completed

(test technician signature) 9 July 1990 (date)
### Velocity vs Time

![Graph showing velocity vs time with data points for different speeds and slopes.]

<table>
<thead>
<tr>
<th>Speed mph</th>
<th>Slope ft/s/s</th>
<th>Slope degrees</th>
<th>Maximum Grade %</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>2.95</td>
<td>5.26</td>
<td>9.20</td>
</tr>
<tr>
<td>20</td>
<td>2.47</td>
<td>4.40</td>
<td>7.69</td>
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<tr>
<td>30</td>
<td>2.02</td>
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<td>44</td>
<td>1.13</td>
<td>2.01</td>
<td>3.50</td>
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</table>
5. STRUCTURAL INTEGRITY

5.1. STRUCTURAL STRENGTH AND DISTORTION TESTS -
STRUCTURAL SHAKEDOWN TEST

5.1-I. TEST OBJECTIVE

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 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
after the last loading sequence.

5.1-III. DISCUSSION

The loading was performed twice. The data are recorded on two test
sheets. There were apparently two errors made on the data recording causing
points 1 and 2 to be meaningless.

The results show settling up to about .1" during the first loading,
deflection up to .341" at the second loading, and additional settling or
permanent deformation up to .005" at the end. These results are consistent
with those obtained on the other test bus of the same model.
Table 5.1-1. Structural Shakedown Data.

Bus Number 30025  Temperature 65° F  Date 12-19-89

Technician Steve McConnell, Ken Defibaugh, Dennis Fishburn, Bob LaMorte

Indicate Approximate Location of Each Reference Point

Right

Front of Bus

Left

FIRST LOADING

<table>
<thead>
<tr>
<th>Reference Point Number</th>
<th>Original Height (in)</th>
<th>Loaded Height (in)</th>
<th>Deflection (in)</th>
<th>Unloaded Height</th>
<th>Permanent S&amp;L (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>.376</td>
<td>.376</td>
<td>.165</td>
<td>.165</td>
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<tr>
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<td>.278</td>
<td>.100</td>
<td>.100</td>
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<tr>
<td>3</td>
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<td>.076</td>
<td>.076</td>
<td>.052</td>
<td>.052</td>
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<tr>
<td>4</td>
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<td>.020</td>
<td>.009</td>
<td>.009</td>
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<td>.248</td>
<td>.080</td>
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<tr>
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<td>15</td>
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22
Table 5.1-1. Structural Shakedown Data.

<table>
<thead>
<tr>
<th>Bus Number</th>
<th>Temperature</th>
<th>Date</th>
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<tbody>
<tr>
<td>30025</td>
<td>65° F</td>
<td>12-19-89</td>
</tr>
</tbody>
</table>

Technician: Steve McConnell, Ken Defibaugh, Dennis Fishburn, Bob LaMorte

Indicate Approximate Location of Each Reference Point

![Diagram of bus with reference points]

<table>
<thead>
<tr>
<th>Reference Point Number</th>
<th>Original Height (in)</th>
<th>Loaded Height (in)</th>
<th>Deflection (in)</th>
<th>Unloaded Height</th>
<th>Permanent S&amp;L (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.165</td>
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<td>(.097)</td>
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<tr>
<td>2</td>
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<td>.050</td>
<td>(.050)</td>
</tr>
<tr>
<td>3</td>
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<td>.023</td>
<td>.052</td>
<td>.000</td>
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<td>15</td>
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</tbody>
</table>
5. STRUCTURAL INTEGRITY

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 run with all four wheels level for a control reference, and then eight times with the frame under longitudinal twist as prescribed in the test description. No deficiencies were observed with all wheels level. The only deficiencies observed under stress were minor water leaks at the windows.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

Bus Number 30025 Date 12-5-89

Personnel: TECH: Dennis Fishburn & Bob LaMorte

Temperature 65° F

Wheel Position: Left front ( ) 6 in higher
Right front ( ) than others ( )
Right rear ( ) 6 in lower
Left rear ( ) than others ( )

All wheels level (X ) before (X )
before (X )
after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all
emergency windows are closed but will open and close properly and (3) no windows are
cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal
and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal
(McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.

Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.

Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.

Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.

Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.

Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.

Findings: No deficiencies noted.

11. Steering Mechanism--Verify normal operation.

Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

Bus Number 30025  Date 12-5-89

Personnel: TECH: Dennis Fishburn & Bob LaMorte

Temperature 65° F

Wheel Position: Left front (X) 6 in higher
Right front ( ) than others (X)
Right rear ( ) 6 in lower
Left rear ( ) than others ( )

All wheels level ( ) before ( )
after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/ Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.
   Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.
   Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.
   Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.
   Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.
   Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.
    Findings: 3rd window on right and 3rd window on left leaked

11. Steering Mechanism--Verify normal operation.
    Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

Bus Number: 30025  Date: 12-5-89

Personnel: TECH: Dennis Fishburn & Bob LaMorte

Temperature: 65° F

Wheel Position: Left front ( ) 6 in higher
Right front (X) than others (X)
Right rear ( ) 6 in lower
Left rear ( ) than others ( )

All wheels level ( ) before ( )
after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.
Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.
Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.
Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.
Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.
Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.
Findings: Second and last windows on left leaked

11. Steering Mechanism--Verify normal operation.
Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

Bus Number  30025  Date  12-5-89

Personnel: TECH: Dennis Fishburn & Bob LaMorte

Temperature  65° F

Wheel Position:  Left front ( )  6 in higher
                 Right front ( )  than others (X )
                 Right rear (X )  6 in lower
                 Left rear ( )  than others ( )

     All wheels level ( )  before ( )
                 after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/ Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.

Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.

Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.

Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.

Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.

Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.

Findings: 3rd and rear windows on left side leaked

11. Steering Mechanism--Verify normal operation.

Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

Bus Number 30025 Date 12-5-89
Personnel: TECH: Dennis Fishburn & Bob LaMorte
Temperature 65° F

Wheel Position: Left front ( ) 6 in higher
                Right front ( ) than others (X )
                Right rear ( ) 6 in lower
                Left rear (X ) than others ( )

All wheels level ( ) before ( )
                   after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.

Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.

Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.

Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.

Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.

Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.

Findings: Driver's window and 2nd window from last on left side leaked

11. Steering Mechanism--Verify normal operation.

Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2  
(Note: Ten copies of this data sheet are required)

<table>
<thead>
<tr>
<th>Bus Number</th>
<th>30025</th>
<th>Date</th>
<th>12-5-89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel:</td>
<td>TECH: Dennis Fishburn &amp; Bob LaMorte</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>65° F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wheel Position</th>
<th>( X)</th>
<th>6 in higher than others ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right front</td>
<td>( )</td>
<td>6 in lower than others ( X )</td>
</tr>
<tr>
<td>Right rear</td>
<td>( )</td>
<td></td>
</tr>
<tr>
<td>Left rear</td>
<td>( )</td>
<td></td>
</tr>
</tbody>
</table>

| All wheels level | ( ) | before ( ) after ( ) |

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: **No deficiencies noted.**

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: **No deficiencies noted.**

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: **No deficiencies noted.**

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: **No deficiencies noted.**
5. Engine--Operate the engine in neutral and verify normal operation.

Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.

Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.

Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.

Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.

Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.

Findings: 5th window on right and 2nd, 4th and last windows on left leaked

11. Steering Mechanism--Verify normal operation.

Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

Bus Number 30025 Date 12-5-89

Personnel: TECH: Dennis Fishburn & Bob LaMorte

Temperature 65° F

Wheel Position: Left front ( ) 6 in higher
Right front (X) than others ( )
Right rear ( ) 6 in lower
Left rear ( ) than others (X )

All wheels level ( ) before ( )

after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.

Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.

Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.

Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.

Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.

Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.

Findings: 5th window on right and 2nd and last windows on left leaked

11. Steering Mechanism--Verify normal operation.

Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2
(Note: Ten copies of this data sheet are required)

<table>
<thead>
<tr>
<th>Bus Number</th>
<th>30025</th>
<th>Date</th>
<th>12-5-89</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel:</td>
<td>TECH: Dennis Fishburn &amp; Bob LaMorte</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>65° F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wheel Position:
- Left front ( ) 6 in higher
- Right front ( ) than others ( )
- Right rear (X) 6 in lower
- Left rear ( ) than others (X )

All wheels level ( ) before ( )
after ( )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.

Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.

Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.

Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.

Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.

Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.

Findings: 5th & 6th windows on left and 3rd window on right leaked

11. Steering Mechanism--Verify normal operation.

Findings: No deficiencies noted.
DISTORTION TEST INSPECTION FORM - 5.2  
(Note: Ten copies of this data sheet are required) 

<table>
<thead>
<tr>
<th>Bus Number</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>30025</td>
<td>12-5-89</td>
</tr>
</tbody>
</table>

**Personnel:** TECH: Dennis Fishburn & Bob LaMorte

**Temperature:** 65° F

**Wheel Position:**
- Left front (  ) 6 in higher than others (  )
- Right front (  )
- Right rear (  ) 6 in lower than others (X )
- Left rear ( X )

All wheels level (  ) before (  )

after (  )

1. Windows--Verify that (1) all transom windows open and close properly, (2) all emergency windows are closed but will open and close properly and (3) no windows are cracked or broken.

Findings: No deficiencies noted.

2. Front Doors--Verify that the front doors open and close properly under both normal and emergency control.

Findings: No deficiencies noted.

3. Rear Doors--Verify that the rear doors open and close properly under both normal (McKay gate and operator control) and emergency control.

Findings: No deficiencies noted.

4. Escape Mechanisms/Roof Vents--Verify that the roof vents open and close properly.

Findings: No deficiencies noted.
5. Engine--Operate the engine in neutral and verify normal operation.
   Findings: No deficiencies noted.

6. Handicapped Devices/Special Seating--Place the special seating in the raised and lowered positions, operate all handicapped, and verify proper operation.
   Findings: Not applicable.

7. Undercarriage--To the extent possible, inspect the undercarriage for cracks, gaps, loose hoses and other abnormalities.
   Findings: No deficiencies noted.

8. Service Doors--Verify that all service doors open and close properly.
   Findings: No deficiencies noted.

9. Body--Inspect the interior and exterior body for cracks and gaps.
   Findings: No deficiencies noted.

10. Windows/Body--Inspect the interior for leaks during the water spray tests.
    Findings: 5th, 6th and rear windows on left and 3rd window on right leaked

11. Steering Mechanism--Verify normal operation.
    Findings: No deficiencies noted.
5. STRUCTURAL INTEGRITY

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 coach 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 coach 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 coach.

5.5-III. DISCUSSION

The jack used for this test has a minimum clearance of 8.75". The test was performed with no problems on the jacking points. It was noted that if both tires were flat at the same time on the rear, this jack could not be used, as the clearance is only 6".
JACKING TEST DATA FORM - 5.5

Bus Number  30025  Date  12-15-89
Personnel:  TECH: Dennis Fishburn & Bob LaMorte
Temperature  60° F

Record any permanent deformation or damage to coach as well as any difficulty encountered during jack procedure.

Right Front Clearance measured: __________________________________________
Remarks:  Jack worked with no problems noted

Left Front Clearance measured: __________________________________________
Remarks:  Jack worked with no problems noted

Right Rear Clearance measured: __________________________________________
Remarks:  Jack will not fit under the frame jacking point, and there is no jacking point on the axle with both tires flat; the jack will work with one deflated and one inflated.

Left Rear Clearance measured: __________________________________________
Remarks:  Jack will not fit under jacking point on the frame, and there is no jack position on the axle; can't change outside or inside independent of each other.  Jack will work with one deflated and one inflated tire.
5. STRUCTURAL INTEGRITY

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 an electric post lift. No problems were observed with lifting or stability on jack stands.
HOISTING TEST DATA FORM - 5.6.1

Bus Number __30025__  Date __12-15-89__

est Personnel: __Steve McConnell, Dennis Fishburn, & Bob LaMorte__

Temperature __60° F__

Problems or Comments: __No problems noted with front on jack stands; no problems noted with rear on jack stands. Bus is stable with both front and rear on jack stands.__
5. STRUCTURAL INTEGRITY

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 article is loaded to GVWR and driven on the PSBRTF durability facility for 6,250 mi and on the high speed lane for 1,250 mi. The test article will then be unloaded and driven at curb weight on the PSBRTF durability facility for 6,250 mi and on the high speed lane for 1,250 mi. 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 basis. In addition any unscheduled breakdowns or repairs are recorded on the same log as are any unusual things noted by the driver. Once a week the test article shall be washed down and inspected for any signs of failure.

5.7-III. DISCUSSION

The bus was run on the durability course for a brief period only. The purpose was to be sure that the elements on the course could be successfully cleared by the bus and to determine the maximum speed that a standard heavy duty bus could be expected to run on the course. The bus successfully negotiated individual stress elements at speeds from 5 to 20 mph with an average speed of about 13 mph.
Orion V in 4" x 4' Pothole

Orion V on Staggered Bumps
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 mpg of fuel expended by a vehicle travelling a specified test loop under specified operation 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 SLW using a procedure based on the ATA-MC/SAE Fuel Consumption Test Procedure: Type II-SAE J1321 Oct. 86. 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 renders that method impractical.

The fuel economy test will be conducted on the bus test lane at the PSBRTF. Signs are erected at carefully measured points which delineate the test course. The operation will comprise 4 mi of commuter phase, 4 mi of arterial phase, and 6 mi of CBD phase. An electronic fuel weighing system will indicate the fuel consumption on each of these three phases. The test runs will be repeated until there are three test runs in which the fuel consumption for each 14 mi segment is within 2 percent of each other. This set of three valid runs comprise a valid test.

The test procedure is the ADB cycle with the following three 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. The cycle used in this test program collects these phases together
into the following order: commuter, arterial, CBD with a separate idle fuel consumption (see table 6-1). This phase sequence permits the reporting of mpg for each of these phases separately and will make the data more useful to bus manufacturers and transit proprietors.

2. The operating profile for testing purposes shall consist of simulated transit type service. The duty cycle is described in table 6-1 and figure 6-1. The duty cycle consists of three phases to be repeated in sequence: a central business district (CBD) phase of 2 laps with 7 stops per lap and a top speed of 20 mph, and arterial route phase of 2 laps with 2 stops per lap and a top speed of 40 mph, and a commuter phase of 4 laps with 1 stop and a maximum speed of 40 mph. The bus shall be loaded to SLW and shall average approximately 18 mph while operating on this duty cycle. Operation shall continue regardless of the ambient temperature or weather conditions. The passenger doors shall be opened and closed at each stop during the CBD phase. The braking profile shall be:

16 percent of the stops at 3 ft/s²
50 percent of the stops at 6 ft/s²
26 percent of the stops at 9 ft/s²
8 percent of the stops at 12 ft/s².

These percentages of stops shall be evenly distributed over the three phases of the duty cycle. For scheduling purposes, the average deceleration rate is assumed.

3. The individual ADB cycles remain unaltered except that the length of 1 mile has been changed to be 1 lap on the PSBRTF track, so that separate signs for each lap are not required. One lap is equal to .95 miles. The change is made by adjusting the cruise distance and time.

Several changes were made to the Joint ATA-MC/SAE Fuel Consumption Test Procedure - Type II - SAE J1321 Oct. 81:

A. J1321 requires the use of at least a 16-gal fuel tank. Such a fuel tank when full would weigh about 160 lb. It is judged that a 12-gal tank weighing less than 120 lb will be sufficient for this test and much easier for the driver and observer to handle.

B. J1321 mentions the use of a mechanical scale or a flowmeter system. This test procedure uses a load cell readout combination that allows accuracy of 0.5 percent in weight and permits onboard weighing of the gravimetric tanks at the end of each phase. This modification permits the determination of a fuel economy figure for each phase as well as the overall cycle.
6-III. DISCUSSION

This is a comparative test of fuel economy using #1 Diesel fuel with a volumetric heating value of 126,470 BTU/gal. The driving cycle consists of central business district (CBD), arterial (ART), and commuter (COM) segments 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 126,700 BTU/gal.

An extensive pre-test check is made, including replacing or refreshing all tribology functions. The details of the pre-test check are given on the first five data sheets. The next three data sheets show the test details of each of the three test runs. Finally, the summary data sheet gives the average fuel consumption for each type driving and the overall average. The final averages were: CBD - 3.70 mpg, ART - 5.06 mpg, COM - 7.78 mpg. Overall average was 4.78 mpg. The average fuel consumption at idle was 0.986 gal/hr.
Fuel Economy Inspection Form

Bus Number 30025  MFG Ontario Bus Industries  Date 06-28-90

Personnel: Eugene Stoltz & Ken Defibaugh

Seated Load Weight 32,800 lbs

1. **Fuel System**

<table>
<thead>
<tr>
<th>Item</th>
<th>OK</th>
<th>Date</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) install gravimetric tank system</td>
<td>Yes</td>
<td>07-12-90</td>
<td></td>
</tr>
<tr>
<td>b) replace fuel filter</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>c) check for fuel leaks</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>d) specify fuel type (refer to fuel analysis report) #1 Diesel</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
</tbody>
</table>

Remarks ____________________________________________

2. **Brakes/Tires**

<table>
<thead>
<tr>
<th>Item</th>
<th>OK</th>
<th>Date</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) inspect hoses</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>b) inspect drums/calipers</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>c) inspect linings/pads</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>d) inspect drum/rotors</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>e) inspect cams &amp; diaphragms</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
<tr>
<td>f) relube bearings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) mount test tires</td>
<td>*See Remarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) set inflation pressures (mfg. specs.)</td>
<td>Yes</td>
<td>06-28-90</td>
<td></td>
</tr>
</tbody>
</table>

Remarks Rear tires nearly bald

52
Bus Number 30025  MFG Ontario Bus Industries  Date 06-28-90

3. **Cooling system**
   a) check hoses and connection  Yes 06-28-90
   b) check system for leaks  Yes 06-28-90
   c) check coolant freeze point  Yes 06-28-90

Remarks

---

4. **Electrical Systems**
   a) check battery  Yes 06-28-90
   b) inspect wiring  Yes 06-28-90
   c) inspect terminals  Yes 06-28-90
   d) check lighting  Yes 06-28-90

Remarks

---

5. **Drive System**
   a) remove transmission fluid
   b) replace filter/gasket
   c) check hoses and connections
   d) replace fluid  *See remarks*
   e) check for leaks
   f) check shifting operation

Remarks  Added fluid

---
6. **Lubrication**

   a) drain crankcase  Yes 06-28-90
   b) replace filters  Yes 06-28-90
   c) replace oil  Yes 06-28-90
   d) check for leaks  Yes 06-28-90
   e) check level  Yes 06-28-90
   f) lube all chassis joints
   g) lube universal joints
   h) replace differential lube including axles

*Remarks*  Wheel bearings OK according to manufacturer

7. **Exhaust/Emission System**

   a) check for exhaust leaks  Yes 06-28-90

*Remarks*  

8. **Engine**

   a) replace air filter  Yes 06-28-90
   b) inspect air compressor and air system  Yes 06-28-90
   c) inspect vacuum system, if applicable
   d) check and adjust all drive belts  Yes 06-28-90
   e) check cold start assist
   f) disconnect A/C compressor lead  Yes 07-12-90

*Remarks*  

---

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9. **Steering System**

   a) check power steering hoses and connectors  
      * Yes 06-28-90

   b) service fluid level  
      Yes 06-28-90

   c) check power steering operation  
      Yes 06-28-90

   d) check wheel alignment  
      Yes 06-28-90

**Remarks**  *Steering box leaking*

10. **Ballast bus to seated load weight**  
    Yes 06-28-90

11. **Test Drive**

   a) check brake operation  
      Yes 06-28-90

   b) check transmission operation  
      Yes 06-28-90

   c) check for tires/wheel imbalance
FUEL ECONOMY PRE-TEST INSPECTION FORM

Bus Number 30025  MFG Ontario Bus Industries  Date 06-28-90

Personnel Eugene Stoltz & Ken Defibaugh

PRE WARM-UP

1. Tire Pressure
   A. Steering  115 psi
   B. Drive     100 psi
   C. Less than 50% wear

2. Engine oil level

3. Engine coolant level

4. Belt tension

5. Interior and exterior lights on, evap. fan on

6. Instrumentation working properly, including solenoids and fan timer

7. Fuel lines - no leaks or kinks

8. Body free of dents

9. No puddles or drips on pavement

10. Ballast in position

11. Wind speed, temperature, and track condition within test requirements

12. Safety inspection completed

POST WARM-UP:

1. No extensive smoke from exhaust

Comments: #1.C. Rear tires bald

#9. Transmission filter leak

If OK, Initial:
**Fuel Economy Calculation Procedure**

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 (126,700 BTU/gal for diesel #1); 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.

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

<table>
<thead>
<tr>
<th>phase</th>
<th>miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>1.9097</td>
</tr>
<tr>
<td>ART</td>
<td>1.9097</td>
</tr>
<tr>
<td>COM</td>
<td>3.1893</td>
</tr>
</tbody>
</table>

\[
\text{FE}_{\text{mi/lb}} = \frac{\text{Observed fuel economy}}{\text{miles}} \times \text{lbs of fuel}
\]

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

\[
\text{FE}_{\text{mpg}} = \text{FE}_{\text{mi/lb}} \times G_s \times G_w
\]

where

\( G_s = \) Specific gravity of test fuel at 60°F *(referred to water)*
\( = 0.816 \) for Texaco Diesel #1

\( G_w = \) 8.3373 lbs/gal

3.) Correct to a standard gallon of fuel by multiplying by the volumetric heating value of the diesel test fuel \( H \) and dividing by the volumetric heating value of standard reference fuel \( Q \).

Both heating values must have the same units.

\[
\text{FE}_c = \text{FE}_{\text{mpg}} \times \frac{Q}{H}
\]

where

\( H = \) Volumetric heating value of diesel test fuel [BTU/gal]
\( = 126,470 \) BTU/gal for Texaco Diesel #1

\( Q = \) Volumetric heating value of standard reference fuel
\( = 126,700 \) BTU/gal for all diesel #1

Combining steps 1-3 yields

\[
\rightarrow \text{FE}_c = \frac{\text{miles}}{\text{lbs}} \times (G_s \times G_w) \times \frac{Q}{H}
\]
## FUEL ECONOMY DATA FORM

**BUS NUMBER:** 30025  
**MANUFACTURER:** Ontario Bus Industries  
**DATE:** 07-12-90  
**TD:** Bill Jones  
**TECH:** Stephen McConnell  
**RUN NUMBER:** 1  
**TEMPERATURE:** 64° F  
**RELATIVE HUMIDITY:** 100%  
**WIND SPEED & DIRECTION:** 9 mph E  
**BAROMETRIC PRESSURE:** 30.18

### FUEL PARAMETERS

<table>
<thead>
<tr>
<th>CYCLE TYPE</th>
<th>TIME</th>
<th>RUN NO.</th>
<th>WEIGHT (lb)</th>
<th>TEMPERATURE (°C)</th>
<th>CYCLE TIME</th>
<th>IDLE TIME</th>
<th>FUEL USED 1b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>START</td>
<td>FINISH</td>
<td>START</td>
<td>FINISH</td>
<td>min/s</td>
</tr>
<tr>
<td>CBD</td>
<td>12:06</td>
<td>1.1</td>
<td>110.30</td>
<td>106.64</td>
<td>26.6</td>
<td>29.9</td>
<td>8:33</td>
</tr>
<tr>
<td>ART</td>
<td>12:16</td>
<td>1.1</td>
<td>106.64</td>
<td>104.00</td>
<td>29.9</td>
<td>30.9</td>
<td>4:13</td>
</tr>
<tr>
<td>CBD</td>
<td>12:22</td>
<td>1.2</td>
<td>104.00</td>
<td>100.30</td>
<td>30.9</td>
<td>30.2</td>
<td>8:30</td>
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<tr>
<td>ART</td>
<td>12:32</td>
<td>1.2</td>
<td>100.30</td>
<td>97.70</td>
<td>30.2</td>
<td>30.4</td>
<td>4:13</td>
</tr>
<tr>
<td>CBD</td>
<td>12:37</td>
<td>1.3</td>
<td>97.70</td>
<td>94.04</td>
<td>29.5</td>
<td>32.0</td>
<td>8:33</td>
</tr>
<tr>
<td>COM</td>
<td>12:47</td>
<td>1.4</td>
<td>94.04</td>
<td>90.54</td>
<td>31.7</td>
<td>30.5</td>
<td>5:55</td>
</tr>
</tbody>
</table>

Total Fuel Consumed: 19.76

### COMMENTS:

**Five-Minute Idle Test:***

- Fuel Weight (lb)
  - Start: 90.54
  - End: 90.04
  - Total consumed: .50
- Fuel Temperature
  - Start: 30.5
  - End: 29.6
## FUEL ECONOMY DATA FORM

| BUS NUMBER: | 30025 | MANUFACTURER: Ontario Bus Industries | DATE: | 07-12-90 |
| TD: | Bill Jones | TECH: Stephen McConnell | RUN NUMBER: | 2 |
| TEMPERATURE: | 64°F | RELATIVE HUMIDITY: | 100% | WIND SPEED & DIRECTION: | 9 mph E |
| BAROMETRIC PRESSURE: | 30.18 |

### FUEL PARAMETERS

<table>
<thead>
<tr>
<th>CYCLE TYPE</th>
<th>TIME</th>
<th>RUN NO.</th>
<th>WEIGHT (lb)</th>
<th>TEMPERATURE (°C)</th>
<th>CYCLE TIME min/s</th>
<th>IDLE TIME min/s</th>
<th>FUEL USED lb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>START</td>
<td>FINISH</td>
<td>START</td>
<td>FINISH</td>
<td>START</td>
<td>FINISH</td>
<td></td>
</tr>
<tr>
<td>CBD</td>
<td>1:00</td>
<td>1:09</td>
<td>2.1</td>
<td></td>
<td>90.10</td>
<td>86.60</td>
<td>29.5</td>
</tr>
<tr>
<td>ART</td>
<td>1:10</td>
<td>1:14</td>
<td>2.1</td>
<td></td>
<td>86.60</td>
<td>83.84</td>
<td>30.6</td>
</tr>
<tr>
<td>CBD</td>
<td>1:15</td>
<td>1:24</td>
<td>2.2</td>
<td></td>
<td>83.84</td>
<td>80.24</td>
<td>30.9</td>
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<tr>
<td>ART</td>
<td>1:25</td>
<td>1:29</td>
<td>2.2</td>
<td></td>
<td>80.24</td>
<td>77.64</td>
<td>31.8</td>
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<tr>
<td>CBD</td>
<td>1:31</td>
<td>1:39</td>
<td>2.3</td>
<td></td>
<td>77.64</td>
<td>74.00</td>
<td>32.2</td>
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<tr>
<td>COM</td>
<td>1:40</td>
<td>1:47</td>
<td>2.4</td>
<td></td>
<td>74.00</td>
<td>70.54</td>
<td>33.9</td>
</tr>
</tbody>
</table>

Total Fuel Consumed: 19.56

### COMMENTS:

Five-Minute Idle Test:
- **Fuel Weight (lb)**
  - Start: 70.54
  - End: 70.00
  - Total consumed: .54

- **Fuel Temperature**
  - Start: 34.7
  - End: 32.8
## FUEL ECONOMY DATA FORM

**BUS NUMBER:** 30025  
**MANUFACTURER:** Ontario Bus Industries  
**DATE:** 07-12-90  
**TD:** Bill Jones  
**TECH:** Stephen McConnell  
**RUN NUMBER:** 3  
**TEMPERATURE:** 64° F  
**RELATIVE HUMIDITY:** 100%  
**WIND SPEED & DIRECTION:** 9 mph E  
**BAROMETRIC PRESSURE:** 30.18

<table>
<thead>
<tr>
<th>CYCLE TYPE</th>
<th>TIME</th>
<th>RUN NO.</th>
<th>FUEL PARAMETERS</th>
<th>CYCLE TIME</th>
<th>IDLE TIME</th>
<th>FUEL USED lb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>START</td>
<td>FINISH</td>
<td>WEIGHT (lb)</td>
<td>TEMP (°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBD</td>
<td>2:17</td>
<td>2:26</td>
<td>3.1</td>
<td>111.50</td>
<td>24.9</td>
<td>8:33</td>
</tr>
<tr>
<td>ART</td>
<td>2:27</td>
<td>2:31</td>
<td>3.1</td>
<td>108.04</td>
<td>25.3</td>
<td>4:14</td>
</tr>
<tr>
<td>CBD</td>
<td>2:32</td>
<td>2:41</td>
<td>3.2</td>
<td>105.40</td>
<td>25.3</td>
<td>8:28</td>
</tr>
<tr>
<td>ART</td>
<td>2:42</td>
<td>2:46</td>
<td>3.2</td>
<td>101.80</td>
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<td>4:11</td>
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<tr>
<td>CBD</td>
<td>2:47</td>
<td>2:56</td>
<td>3.3</td>
<td>99.06</td>
<td>26.2</td>
<td>8:26</td>
</tr>
<tr>
<td>COM</td>
<td>2:57</td>
<td>3:03</td>
<td>3.4</td>
<td>95.50</td>
<td>26.9</td>
<td>5:54</td>
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</table>

**Total Fuel Consumed:** 19.54

**COMMENTS:**

**Five-Minute Idle Test:**

<table>
<thead>
<tr>
<th>Fuel Weight (lb) Start:</th>
<th>91.96</th>
</tr>
</thead>
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<tr>
<td>Fuel Weight (lb) End:</td>
<td>91.32</td>
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</table>

<table>
<thead>
<tr>
<th>Fuel Temperature Start:</th>
<th>26.9</th>
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</thead>
<tbody>
<tr>
<td>Fuel Temperature End:</td>
<td>27.5</td>
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</tbody>
</table>

Total consumed: .64
### FUEL ECONOMY SUMMARY DATA

<table>
<thead>
<tr>
<th>CYCLE</th>
<th>TOTAL FUEL LBS</th>
<th>IDLE FUEL LBS</th>
<th>MILES</th>
<th>CORRECTED MPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBD</td>
<td>11.02</td>
<td>.38</td>
<td>5.73</td>
<td>3.67</td>
</tr>
<tr>
<td>ART</td>
<td>5.24</td>
<td>.18</td>
<td>3.82</td>
<td>5.14</td>
</tr>
<tr>
<td>COM</td>
<td>3.50</td>
<td>.23</td>
<td>3.82</td>
<td>7.96</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19.76</td>
<td>.79</td>
<td>13.37</td>
<td>4.80</td>
</tr>
<tr>
<td>IDLE</td>
<td>.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| TEST 2 |                |               |       |               |
| CBD    | 10.74          | .20           | 5.73  | 3.70          |
| ART    | 5.36           | .18           | 3.82  | 5.03          |
| COM    | 3.46           | .12           | 3.82  | 7.80          |
| TOTAL  | 19.56          | .50           | 13.37 | 4.78          |
| IDLE   | .54            |               |       |               |

| TEST 3 |                |               |       |               |
| CBD    | 10.62          | .17           | 5.73  | 3.74          |
| ART    | 5.38           | .17           | 3.82  | 5.00          |
| COM    | 3.54           | .11           | 3.82  | 7.59          |
| TOTAL  | 19.54          | .45           | 13.37 | 4.77          |
| IDLE   | .64            |               |       |               |

### AVERAGE MPG

- CBD: 3.70
- ART: 5.06
- COM: 7.78

**TOTAL: 4.78**

### AVERAGE IDLE CONSUMPTION

- 0.986 gph
- 6.72 lbs/hr
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 PSBRTF.

3. The bus will be operated at various speeds from 0 to 55 mph with and without the air conditioning and accessories on. Any resonant vibration or rattles will be noted. This test will be performed on the test segment between the PSBRTF and the ABTC.

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

The Interior Noise Test (Part 1) was conducted at ABTC. Three speakers are used to generate 80 dB(A) of white noise. Interior readings with the microphone at 60" high ranged from 59.4 to 63.5 dB(A). Ambient temperature was 80° F.

During acceleration, the sound level ranged from 60.2 dB(A) at the driver's seat to 66.0 dB(A) at the rear seats. No resonant vibrations or rattles were noted during the highway driving part of the test.
INTERIOR NOISE TEST DATA FORM - 7.1-1
Heavy-Duty Large Buses, 35 to 40 ft
Test Condition 1: 80 dB(A) Outside Noise

Bus Number ________ 30025 ________ Date ________ 06-28-90 ________

Personnel: Ken Defibaugh & Gene Stoltz

Temperature ________ 80 ________ °F ________ Wind Speed ________ 9 ________ mph

Humidity ________ 51 ________ % ________ Wind Direction ________ WNW ________

Ambient noise level ________ 55 ________ dB(A) ________ outside

Microphone height: 60" above road surface outside (calibration)
45" above floor level inside
with wind screen on inside & outside

Measurement Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Sound Level-dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver’s Seat</td>
<td>53.6</td>
</tr>
<tr>
<td>Front Passenger Seats</td>
<td>52.1</td>
</tr>
<tr>
<td>In Line with Front Speaker</td>
<td>54.4</td>
</tr>
<tr>
<td>In Line with Middle Speaker</td>
<td>53.0</td>
</tr>
<tr>
<td>In Line with Rear Speaker</td>
<td>54.6</td>
</tr>
<tr>
<td>Rear Passenger Seats</td>
<td>52.6</td>
</tr>
</tbody>
</table>

Comments: Sound level meter placed 45" from floor during interior readings:
all readings taken in center aisle.
INTERIOR NOISE TEST DATA FORM - 7.1-2  
Heavy-Duty Large Buses, 35 to 40 ft  
Test Condition 2:  0 to 35 mph Acceleration Test

<table>
<thead>
<tr>
<th>Measurement Location</th>
<th>Sound Level-dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver's Seat</td>
<td>60.2</td>
</tr>
<tr>
<td>Front Passenger Seats</td>
<td>61.1</td>
</tr>
<tr>
<td>Middle Passenger Seats</td>
<td>64.3</td>
</tr>
<tr>
<td>Rear Passenger Seats</td>
<td>66.0</td>
</tr>
</tbody>
</table>

Comments: Sound level meter placed 45" off the floor; all readings taken in center aisle.
INTERIOR NOISE TEST DATA FORM - 7.1-3
Heavy-Duty Large Buses, 35 to 40 ft
Test Condition 3: Resonant Vibration Test

Bus Number ______ 30025 _______ Date ______ 06-28-90 ______

Personnel: Ken Defibaugh & Gene Stoltz

Temperature ______ 80 ______ °F
Humidity ______ 51 ______ %

Comment on the relative magnitude(s) and location(s) of any resonant vibrations or rattles encountered during the test:

No significant vibrations or rattles noted.
7. NOISE

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 SLW in three different conditions using a smooth, straight and level roadway:

1. Accelerating at full throttle at or below 35 mph and just prior to transmission upshift.
2. Accelerating at full throttle from standstill.
3. Stationary, with the engine at high idle and in neutral gear. In addition, the buses will be tested with all accessories operating.

In addition, the buses will be tested with and without the air conditioning operating. The exterior noise characteristics 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. Microphones placed at strategic locations outside the bus will sense the noise levels.

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

This test determines the noise generated by the vehicle at different operating conditions. The test site is the PSBRTF skid pad which is a large, level, paved area with no reflecting surfaces nearby.

With an ambient noise level of 47.6 dB(A), the test result for accelerating from a constant speed was 75.5 dB(A) on the right side and 77.5 dB(A) on the left side. When accelerating from a standstill with the same ambient reading, the result was 74.1 dB(A) on the right side and 75.1 dB(A) on the left side.

With the vehicle stationary and the accessories and air conditioning on, the readings averaged 62.8 dB(A) at low idle, 69.4 dB(A) at high idle, and 78.1 dB(A) at wide open throttle. With the accessories and air conditioning off, the readings averaged slightly lower at all three engine speeds.
EXTERIOR NOISE TEST DATA FORM 7.2-1
Heavy-Duty Large Buses, 35 to 40 ft
Accelerating from Constant Speed

Bus Number: 30025  Date: 07-09-90
Personnel: Stephen J. McConnell, Dennis Fishburn, Bill Jones
Temperature: 82 °F  Wind Speed: 1 mi/h  Wind Direction: SW
Humidity: 68 %  Barometric Pressure: 30.31
Fuel Type: #2 D

Verify that microphone height is 48", windspeed is less than 12 mi/h and ambient temperature is between 30°F and 90°F  Check [x]

Initial Sound Meter Calibration Check [X]  Ambient Noise Level: 47.6 dB(A)

Accelerating from Constant Speed -- Curb (Right) Side
Reading No. 1. 76.0  2. 75.1  3. 74.0  4. 75.1  5. 74.4
            6.      7.      8.      9.      10.    
Average of the two highest readings: 75.5 dB(A)

Accelerating from Constant Speed -- Street (Left) Side
Reading No. 1. 74.6  2. 77.5  3. 76.9  4. 75.2  5. 77.5
            6.      7.      8.      9.      10.    
Average of the two highest readings: 77.5 dB(A)

Final Sound Meter Calibration Check [X]
EXTERIOR NOISE TEST DATA FORM 7.2-2
Heavy-Duty Large Buses, 35 to 40 ft
Accelerating from Standstill

Bus Number: 30025                  Date: 07-09-90
Personnel: Stephen J. McConnell, Dennis Fishburn, Bill Jones
Temperature: 85 °F      Wind Speed: 2 mi/h      Wind Direction: SW
Humidity: 68 %      Barometric Pressure: 30.31
Fuel Type: #2 D

Verify that microphone height is 48", windspeed is less than 12 mi/h and ambient temperature is between 30°F and 90°F   Check [X]

Initial Sound Meter Calibration Check [X]    Ambient Noise Level: 47.6 dB(A)

---

Accelerating from Standstill -- Curb (Right) Side

Reading No. 1. 74.0  2. 74.0  3. 74.2  4. 74.0  5. 74.0
   6. 74  7. 74  8. 74  9. 74  10. 74

Average of the two highest readings: 74.1 dB(A)

---

Accelerating from Standstill -- Street (Left) Side

Reading No. 1. 75.0  2. 74.9  3. 75.2  4. 75.0  5. 74.8
   6. 75  7. 75  8. 75  9. 75  10. 75

Average of the two highest readings: 75.1 dB(A)

---

Final Sound Meter Calibration Check [X]
EXTERIOR NOISE TEST DATA FORM 7.2-3
Heavy-Duty Large Buses, 35 to 40 ft
Stationary

Bus Number: 30025  Date: 07-09-90
Personnel: Stephen J. McConnell, Dennis Fishburn, Bill Jones
Temperature: 85 °F  Wind Speed: 2 mi/h  Wind Direction: SW
Humidity: 68 %  Barometric Pressure: 30.31
Fuel Type: #2 D

Verify that microphone height is 48", windspeed is less than 12 mi/h and ambient temperature is between 30°F and 90°F  Check [X]

Initial Sound Meter Calibration Check [X]  Ambient Noise Level: 47.6 dB(A)

---

**Accessories and Air Conditioning ON**

<table>
<thead>
<tr>
<th>Engine RPM</th>
<th>Curb (Right) dB(A)</th>
<th>Street (Left) dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Idle</td>
<td>76.8</td>
<td>62.0</td>
</tr>
<tr>
<td>High Idle</td>
<td>112.6</td>
<td>67.7</td>
</tr>
<tr>
<td>Wide Open Throttle</td>
<td>234.4</td>
<td>77.8</td>
</tr>
</tbody>
</table>

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**Accessories and Air Conditioning OFF**

<table>
<thead>
<tr>
<th>Engine RPM</th>
<th>Curb (Right) dB(A)</th>
<th>Street (Left) dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Idle</td>
<td>76.8</td>
<td>61.1</td>
</tr>
<tr>
<td>High Idle</td>
<td>112.6</td>
<td>67.1</td>
</tr>
<tr>
<td>Wide Open Throttle</td>
<td>235.6</td>
<td>76.6</td>
</tr>
</tbody>
</table>

---

Final Sound Meter Calibration Check [X]