

**HEAVY-DUTY ARTICULATED 500,000-MILE BUS
WITH A MINIMUM SERVICE LIFE OF
12 YEARS**

5. STRUCTURAL INTEGRITY

**5.3 STRUCTURAL STRENGTH AND DISTORTION TESTS –
STATIC TOWING TEST**

APRIL 2006

ABBREVIATIONS

ABTC	- Altoona Bus Test Center
A/C	- air conditioner
ADB	- advance design bus
CBD	- central business district
CI	- compression ignition
CNG	- compressed natural gas
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)
FTA	- Federal Transit Administration
GAWR	- gross axle weight rating
GL	- gross 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
hr	- hour
LNG	- liquefied natural gas
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
SCF	- standard cubic feet
SCFM	- standard cubic feet per minute
SCH	- test scheduler
SEC	- secretary
SI	- spark ignition
SLW	- seated load weight (curb weight plus 150 lb for every designed passenger seating position and for the driver)
TD	- test driver
TM	- track manager
TP	- test personnel

5.3-I. TEST OBJECTIVE

The objective of this test is to determine the strength characteristics of the bus towing fixtures during static loading conditions.

5.3-II. TEST DESCRIPTION

Using a load-distributing yoke, a hydraulic cylinder is used to apply a static tension load equal to 1.2 times the bus curb weight. The load will be applied to both the front and rear (if applicable) towing fixtures at an angle of 20 degrees with the longitudinal axis of the bus. The first test will be a 20 degree pull upward from the longitudinal axis of the bus, and then a 20 degree downward pull from the longitudinal axis of the bus. The bus will then be positioned to one side at an angle of 20 degrees from the longitudinal axis and then to the other. Any deformation or damage to the tow eyes or adjoining structure will be recorded. The bolts that connect the tow eyes and adjoining brackets must be torqued after each test, to the manufactures specification to check for any failure.

5.3-III. TEST ARTICLE

The test article is a heavy-duty transit bus with a minimum service life of 12 years or 500,000 mi.

5.3-IV. TEST EQUIPMENT/FACILITIES/PERSONNEL

This test will be performed on the structural strength test surface at the Test Track. The following test equipment and personnel are required for this test:

1. Static loading fixture
2. Manufacturer provided towing sling
3. Tension measuring load cell apparatus
4. Axle anchoring fixture
5. Test personnel (TP)

5.3-V. TEST DATA

The test data consist of the completed Static Data Test Towing Form. Upon completion of this test, data shall be forwarded to the ABTC manager.

5.3-VI. TEST PREPARATION AND PROCEDURES

Detailed test preparation and procedures are listed in procedure 5.3-1. This section also includes Static Towing Test Data Form - 5.3.

DETAILED TEST PROCEDURES		TITLE: 5. Structural Integrity
Procedure 5.3-1		NOMENCLATURE: 5.3 Structural Strength and Distortion Tests - Static Towing Test
OPER STEP	ACTION BY	TEST PREPARATION
1	TP	Record the bus number, date, temperature, and personnel on the data sheet. Retrieve the Work Order Form for this test.
2	TP	Position bus at the proper angle on the structural strength test surface at the ABTC. Consult with NBM manufacturer to determine proper method for anchoring bus. WARNING: Make sure bus is properly secured to prevent movement during testing.
3	TP	Attach manufacturer supplies load equalizing towing sling, per manufacturer instructions, to front towing fixtures.
4	TP	Photograph bus in position for tests, also take a close-up photograph of towing sling as attached.
5	TP	Zero the digital readout of the load cell conditioner and check calibration value; adjust if necessary. WARNING: Inspect the condition of all cables and towing hardware. Repair or replace any damaged equipment before proceeding with test.

DETAILED TEST PROCEDURES

TITLE: 5. Structural Integrity

Procedure 5.3-1

**NOMENCLATURE: 5.3 Structural Strength
and Distortion Tests - Static Towing Test**

OPER STEP	ACTION BY	TEST PROCEDURE
1	TP	WARNING: Stay clear of cable and loading apparatus during test. Failure of loaded mechanism may cause serious personal injury. Position the bus such that the cable makes angle of 20 degrees upward from the horizontal plane.
2	TP	Inspect towing sling, axle anchoring apparatus, tension measuring device, and tow cable. Ensure that they are secure and properly installed.
3	TP	Using the loading apparatus, <u>slowly</u> apply a load equal to 1.2 times the curb weight of the bus and release. Photograph the procedure (side view).
4	TP	Visually inspect the towing sling, tow eyes, and adjoining structure for damage or permanent deformation. Torque all bolts on tow eyes and adjoining brackets to manufacturer's specifications. Record any deformation, bolt failure, or any structural change that may occur and photograph any damage. NOTE: If damage or deformation occurs, terminate test immediately and record observation. If rear towing fixtures are to be tested, then proceed with rear tow test.
5	TP	Reposition the bus such that the cable makes an angle of 20 degrees downward from the horizontal plane.
6	TP	Repeat steps 2 through 4.
7	TP	Reposition the bus such that the cable makes an angle of 20 degrees to the left from the vertical plane.
8	TP	Repeat steps 2 through 4.
9	TP	Reposition the bus such that the cable makes an angle of 20 degrees to the right from the vertical.
10	TP	Repeat steps 2 through 4.
11	TP	Repeat steps 2 through 10 for rear towing fixture when applicable.
12	TP	Complete Static Towing Test Data Form and record observations. File completed data form and work order.

REVISIONS

All revisions to this test must be identified on this page. Briefly describe each revision in the space provided below.

Revision	Description	Date	Approval
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STATIC TOWING TEST DATA FORM

Bus Number:	Date:
Personnel:	Temperature (•F):

Inspect right front tow eye and adjoining structure.
Comments:
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments:
Inspect left front tow eye and adjoining structure.
Comments:
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments:
Inspect right rear tow eye and adjoining structure.
Comments:
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments:
Inspect left rear tow eye and adjoining structure.
Comments:
Check the torque of all bolts attaching tow eye and surrounding structure.
Comments:
General comments of any other structure deformation or failure: