

Bus Testing

PROGRAM

BRIEF 2

Spring 1993

TECHNICAL ASSISTANCE BRIEF



U.S. Department
of Transportation

**Federal Transit
Administration**

Office of Technical
Assistance and Safety

■ The Center

The Bus Testing Program of the Federal Transit Administration was established in response to the requirements of the Surface Transportation and Uniform Relocation Assistance Act (STURAA) of 1987. Under the program, testing is required on all new model buses before they can be purchased with federal funds. The testing mandated by STURAA and the vehicle categories included were expanded by the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991.

Changes in the law concerning the types of vehicles that must be tested are described in this Technical Brief on page 2. Testing is performed at the Altoona Bus Testing Center (ABTC) in Altoona, PA. Additional test facilities are located at the Bus Research and Testing Facilities of the Pennsylvania Transportation Institute, at Penn State University.

Seven tests are currently performed on the buses: safety, structural integrity and durability, reliability, performance, maintainability, noise, and fuel economy. These are not pass-or-fail tests; the data from all the tests are compiled into a test report that is made available to the manufacturer to provide information during the procurement process. Descriptions of the individual tests may be found in Technical Brief 1.

The Center currently handles up to eight buses at one time. Testing has been completed on 30 buses and testing is in progress on other vehicles. Over the course of testing thus far, Center staff identified more than 535 malfunctions, resulting in more than 55 probable design changes.

Expansion of Mandated Testing

The Intermodal Surface Transportation Efficiency Act (ISTEA), signed into law by President Bush in December 1991, requires adaptation of the existing facilities and procedures to accommodate testing of alternative fueled buses and to add brake performance and emissions testing. The facilities will accommodate the testing and repair of vehicles using the following fuels: gasoline, diesel, compressed natural gas (CNG), liquefied natural gas (LNG), methanol/ethanol, propane, and battery-powered electric. Modifications will provide for the storage and dispensing of the above fuels as well as the installation of all required safety equipment.

New test procedures and equipment

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Expansion of Mandated Testing

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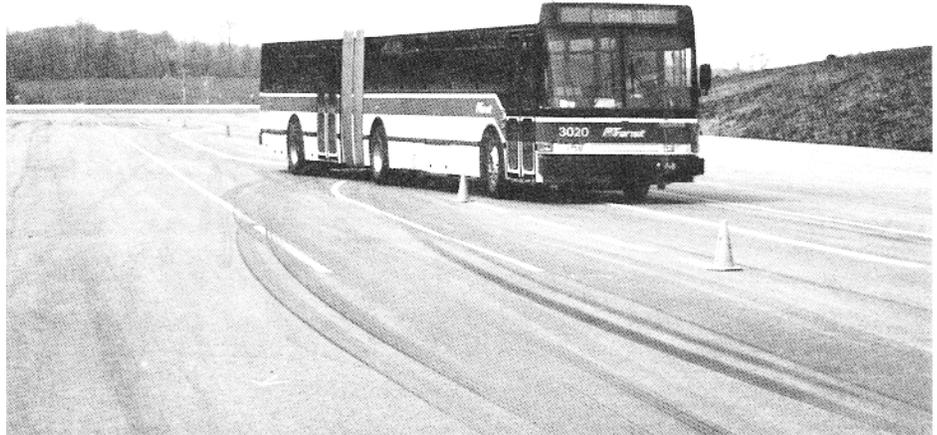
will allow the testing required for alternative-fueled vehicles. Specifically, new fuel economy test rigs will withstand the corrosive effects of methanol and ethanol; additional systems will measure the consumption of LNG, CNG, and electrical power. Procedures will also address safety considerations for handling, dispensing, and testing with alternative fuels.

Additional Tests to Be Performed

The expansion of testing will add two new tests to the seven currently operational test areas. These are brake and emissions testing. Brake testing will be performed using a Brake Slope and Brake Soak Facility located at the Bus Research and Testing Facility. The Brake Slope consists of concrete ramps at 20 and 30 percent grades adjacent to the existing test track. The Brake Slope will be used to determine the effectiveness of a test vehicle's parking brake. The Brake Soak facility consists of a 6-in-deep, water filled trough capable of thoroughly wetting the vehicle's brake linings. Additional brake tests include stopping distance and fade tests. Compliance testing in accordance with FMVSS 121 and J05 can also be provided to the bus manufacturer.

Facilities for emissions testing at the Center include an emissions test chamber, sampling and control equipment, a full-scale chassis dynamometer, and an analytical laboratory. Emissions testing will be performed under controlled labora-

(continues on page 6)



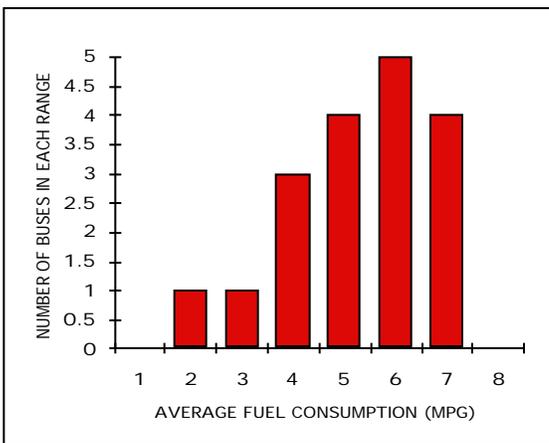
Comprehensive testing is performed on the test track and in the vehicle test bays at the Altoona Bus Testing Center.

ABTC Management

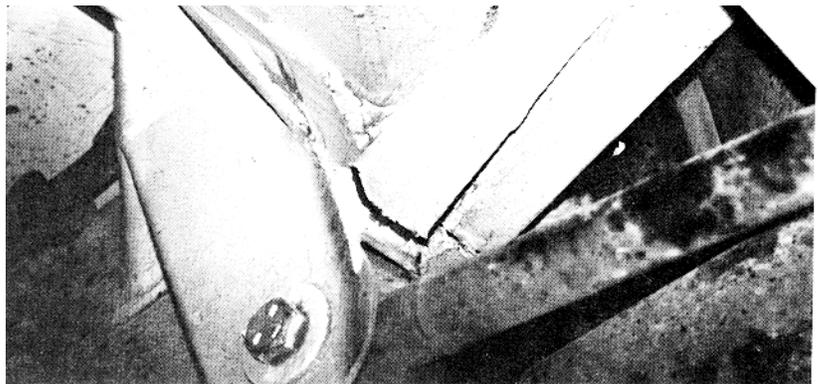
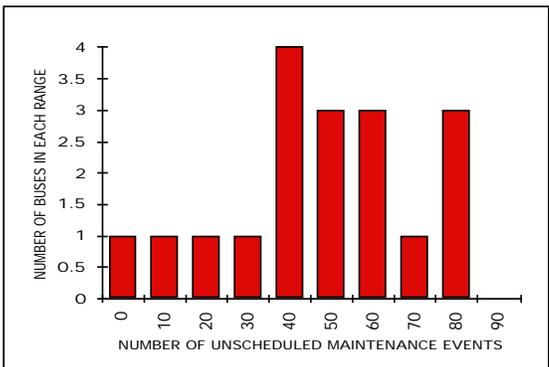
The Bus Research and Testing Program is directed by Dr. Bohdan T. Kulakowski, Professor of Mechanical Engineering and Director of the Pennsylvania Transportation Institute. Dr. Kulakowski and Dr. Amine E. Lehtihet, Associate Professor of Industrial and Management Systems Engineering, Penn State University, direct operations at the Center.

Test Results: Benefits for Maker, Buyer and Passenger

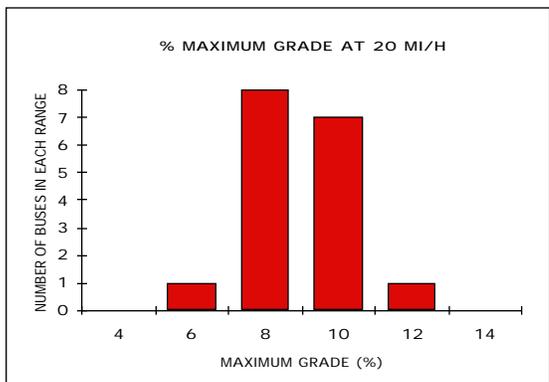
The variability observed in compiled cumulative test results obtained at the Center indicates that FTA-mandated bus testing provides an important service to our customers. Test reports, for example, can prompt transit agencies and bus manufacturers to work together in a constructive relationship, and testing so far has revealed serious problems that have been corrected prior to full-scale production. Test reports also provide valuable information (reliability, noise, fuel consumption, etc.) that can be used by transit agencies contemplating the acquisition of buses with Federal funds to assist in the selection process, the determination of specifications for testing, and the development of quality control checks for monitoring of bus construction. Finally, the knowledge that a bus has gone through a stringent accelerated testing program designed to reveal any potentially serious flaws provides an additional level of confidence.



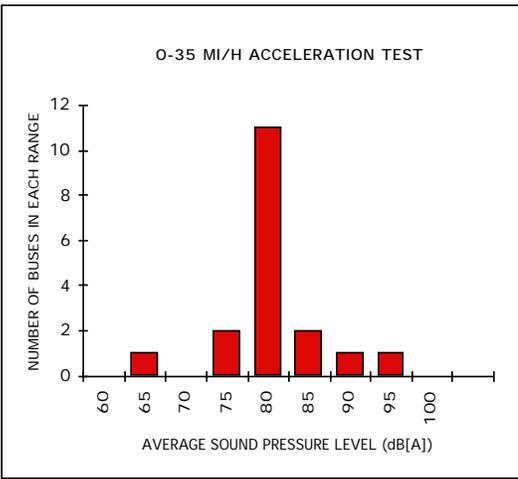
Illustrates the average fuel economy for buses tested using diesel, gasoline, and methanol



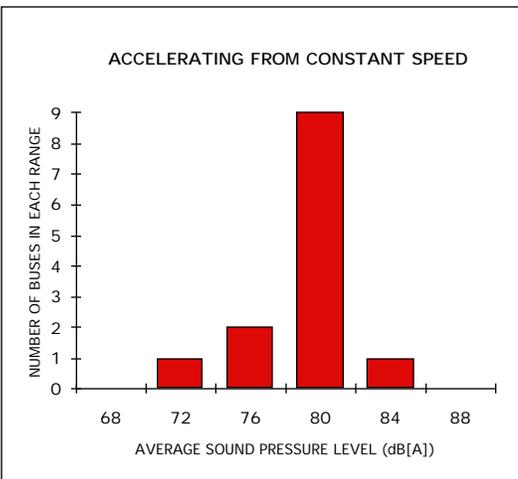
Illustrates the number of unscheduled maintenance events requiring design modification, part



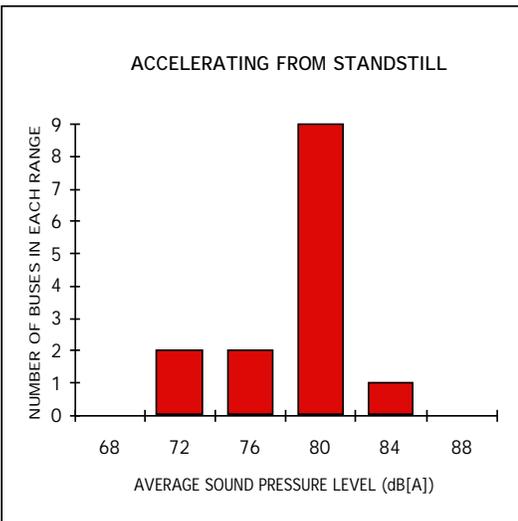
Illustrates the maximum grade the bus can climb while maintaining a constant speed of 20



Illustrates the average value of the highest interior noise level measurements obtained while accelerating from 0 to 35 mi/h.

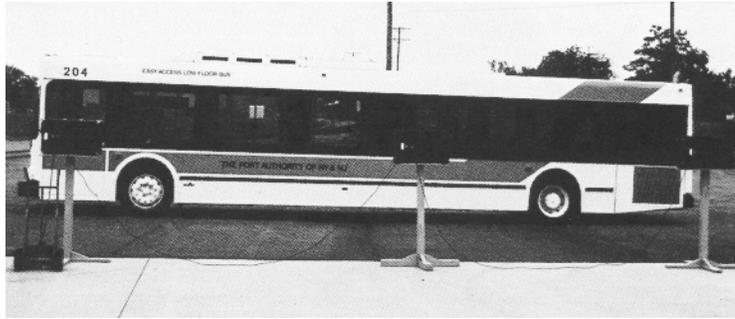


Illustrates the average value of the highest exterior noise level measurements obtained while accelerating from a constant speed..



Illustrates the average value of the highest exterior noise level measurements obtained while accelerating from a standstill.

Test Results (continued from page 3)



Malfunctions in First 18 Buses Tested

Malfunction Type	Number of Malfunctions
HVAC	27
Articulation	12
Interior/Body	129
Frame /Chassis	40
Brake	3
Drivetrain /Engine	95
Electrical	47
Exhaust	18
Steering	12
Suspension	128
Wheelchair Lift	24
Total	535

* Malfunctions are defined as unscheduled maintenance requiring part modification, replacement or repetitive adjustment.

Number of Buses Tested in Each Category

12 - year buses	12
10 - year buses	4
7 - year buses	2

Changes in the Law

□ **ISTEA's Impact on STURRA**

The ISTEA amended Section 317 of STURRA in two significant ways: it requires additional tests to be performed for emissions and vehicle braking, and it specifically adds alternative fuel buses to those required to be tested. ISTEA authorizes the FTA to pay 80 percent of the costs of bus testing.

□ **New Interim Rule**

FTA's interim final rule of 8/23/89 covered only heavy duty large buses, heavy duty small buses, and purpose-built medium duty buses. The second interim final rule of 7/28/92 expands these categories by including all medium duty buses, including those that are body-on-chassis type designs.

□ **New Vehicle Categories**

Specifically, two categories of small vehicles have been added by the interim rule of 7/28/92.

- Vehicles with a minimum service life of 5 years or 150,000 miles—usually light duty mid-sized buses that are approximately 25 to 35 feet in length.
- Vehicles with a minimum service life of 4 years or 100,000 miles—usually light duty small buses, cut-aways, or modified vans approximately 16 to 28 feet in length.

This rule completes the categories FTA has intended to cover under the bus testing procedures. Unmodified, mass-produced vans are not included in this regulation.

□ **Request for Comments**

FTA requests comments, particularly as to whether changes to a mass produced van by the original manufacturer should require the van to be tested; or whether the annual production rate of 20,000 applied to "mass produced van or chassis" should be increased or decreased.

□ **Partial Testing**

Full testing is explicitly required only when a new bus model has not been tested previously at the Altoona Bus Research & Testing Center. For a bus model that's been previously tested but is being produced with a major change, partial testing procedures apply and only those tests that may produce significantly different data must be performed. If a vehicle chassis has been tested at the Altoona facility, and is now used on a new untested model, partial testing applies.

□ **Revised Descriptions of Existing Categories**

Descriptions of the existing categories of vehicles were revised to be consistent with the form used for the two new categories. For example, the first category of heavy duty buses now is applied to vehicles with a "minimum service life of 12 years or 500,000 miles typified by heavy duty large buses, as well as articulated buses."

□ **Definition Changes**

The definition of "major change in components" has been expanded to account for a vehicle built on a mass-produced chassis. For these vehicles, a major change in components is limited to "a change in the vehicle's chassis from one major design to another." This refers to a change in frame structure, material, or configuration, or a change in chassis suspension type. For other vehicles, the definition reads as before, in the 10/9/90 interim final rule, to include "a change in a vehicle's engine, axle, transmission, suspension or steering components."

□ **Maintenance and Repair**

Experience has shown that while prohibiting manufacturer provision of maintenance or repair is a sound approach, situations occur in which it may be more effective and efficient for the manufacturer to perform this work. Under the revised rule, the manufacturer may be required to provide maintenance or repairs when the Altoona facility determines that the manufacturer is the best party to do so. The determination is made by the operator of the facility, who may supervise the work to be performed.

□ **Effective for New Vehicle Types**

The effective date for inclusion of the new vehicle types cited in the 7/28/92 interim final rule has been postponed by FTA to provide additional time for the FTA to determine what, if any, changes need to be made to the rule. For this reason, the effective date has been postponed from August 27, 1992 to February 10, 1993.

□ **Final Rule to be Published**

The FTA plans to publish its final rule on bus testing in the future. That rule will address all issues raised by comments addressed to the three interim final rules that the FTA has published. A final regulatory evaluation will be prepared before the final rule is issued.

Expansion of Mandated Testing (continued from page 2)

tions, using a chassis dynamometer to simulate a defined operating duty cycle. This cycle will consist of a modified Advanced Design Bus operating cycle. Sampling equipment will be used to extract gas and particulate samples for analysis. Analysis instrumentation will be used to detect and measure the levels of CO, CO₂, NO_x, HC, and aldehydes. The instrumentation will measure total unburned hydrocarbons as well as non-methane hydrocarbons. The units of measurement for each of these constituents will be grams per mile (gm/mi). These units can be readily used by transit operators for making relative comparisons between buses.

Emissions testing for Environment Protection Agency (EPA) compliance certification is typically conducted on a new engine in a test cell. While standardized procedures and test cycles have been developed by the EPA for this type of compliance testing, no standardized test procedures or cycles exist for testing an in vehicle engine on a chassis dynamometer. The chassis dynamometer test will be performed on a engine after the bus has accumulated several thousand miles of operation, thus providing a more realistic indication of the level of emissions that can be expected in actual transit service. Detailed test procedures will standardize testing for each bus category, including alternative fueled vehicles, to be tested. This testing will provide a relative comparison of the levels of emissions produced for each bus.

Agency Perspectives: Centre Area Transit Authority

The Centre Area Transportation Authority (CATA) is in the process of acquiring a number of lift-equipped, advance design buses (ADB's) in the next year. This bus procurement will be the Authority's first such new bus purchase in a decade. As such, CATA is keenly interested in test information and maintenance data about any and all vehicle models which may be submitted by bus manufacturers for purchase consideration.

As a public service provider, the reliability and operating performance of a vehicle is critically important to the Authority's mission.

I found the test information and vehicle maintenance data to be thorough, comprehensive, and well-documented. The testing data were well presented and objective. The Executive Summary detailed relevant testing objectives and any meaningful findings. I believe the Summary format could be improved by specifying separate test categories (i.e., maintainability, reliability, safety, performance, etc.) and highlighting any significant findings or discussion items. The current paragraph-by-paragraph narrative contains all the appropriate

information, but its presentation format is cumbersome and could be enhanced.

Based on my review of this test report, I will make sure to secure all other such test reports of vehicles which CATA may consider for purchase. As more and more vehicle models are tested, a census of test information / data will become available, enabling transit vehicle consumers to conduct comparison analyses. I look forward to this opportunity. It will assist me as a Transit Manager in making a more informed purchasing decision.

I want to thank you for your assistance in this endeavor. I very much enjoyed the test data report and am committed to making such vehicle reviews a regular part of CATA's management decision-making.

Kevin C. Abbey,
General Manager
Centre Area Transportation Authority
State College, PA

The Altoona Bus Testing Center appreciates Mr. Abbey's comments. The Center is currently working to enhance the usability and format of its bus testing reports

How do I Schedule a Bus for Testing ?

Call Mr. David Klinikowski, program manager, to request copies of the current contract, a fee schedule, and a procedure summary. For record keeping purposes, please make your request in writing as well. If you have any contract questions, direct them to Mr. Klinikowski. Send two copies of the signed contract back to Mr. Klinikowski's office, at which time the bus will be added to the test schedule. The paperwork will then be processed at Penn State and a signed copy of the contract will be sent back to the manufacturer.

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■ New On-Line Bus Testing Service

An on-line service for accessing bus testing information will be available in the spring of 1993. Information to be provided includes a summary of tests that are performed, a listing of buses that have been tested and their configurations, the contract for testing, and other testing related information. The on-line service can be accessed at (814)863-8755. For more information about the service, call (814) 863-1898.

■ Test Reports

All of the data collected from the various tests have been compiled into a report that contains the test findings and, if the manufacturer requests, recommendations for possible design changes or improvements. Reports can be ordered from ABTC for \$12.00 each, plus shipping. Call (814) 863-1898 for additional information.

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