TECHNOLOGY DIGEST

Timely Technology Transfer

"OVER-THE-ROAD TESTS DEMONSTRATE IMPROVED RIDE QUALITY FOR TRANSPORTATION OF FINISHED AUTOMOBILES BY RAIL"

by Ken Rownd, Curt Urban, Darrell Iler

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Summary

The Association of American Railroads (AAR) recently performed tests in cooperation with TTX Company as part of the Advanced Freight Car Truck Design program. Acceleration performance of conventional multi-level railcars was measured in controlled tests performed at the Transportation Technology Center (TTC) and in tests performed in railroad service. Results indicate that ride quality for transportation of finished automobiles can be improved by using advanced suspension designs. Automakers have identified enhanced vertical ride performance as key for this fleet.

As reported in TD-96-021, controlled tests were performed using bi-level autorack cars equipped with conventional (old technology), premium, and advanced suspensions. Testing demonstrated that improvements to the suspension can achieve the desired vertical ride in a controlled test environment.

This digest summarizes over-the-road performance of three bi-level railcars, equipped with the same three sets of trucks, as tested together in railroad service. Additional support for the over-the-road test was provided by a joint railroad and automotive industry working group called Quality and Maintenance of Today's Equipment.

Suggested Distribution:
- ❑ Equipment/Rolling Stock
- ❑ Research and Development
- ❑ Intermodal
- ❑ Car Department

Association of American Railroads
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INTRODUCTION/CONCLUSIONS

The Association of American Railroads (AAR) recently performed tests in cooperation with TTX Company as part of the Advanced Freight Car Truck design program. Acceleration performance of conventional multi-level railcars was measured in controlled tests performed at the AAR's Transportation Technology Center (TTC) and in tests performed in railroad service. Results indicate that ride quality for transportation of finished automobiles can be improved by using advanced suspension designs. Automakers have identified enhanced vertical ride performance as key for this fleet.

A recommended practice published in 1995 describes ride quality expectations for railcars involved in transportation of finished automobiles. This document describes requirements for controlled testing at TTC and over-the-road testing in railroad service. Exhibit 1 shows bi-level autorack cars in revenue service.

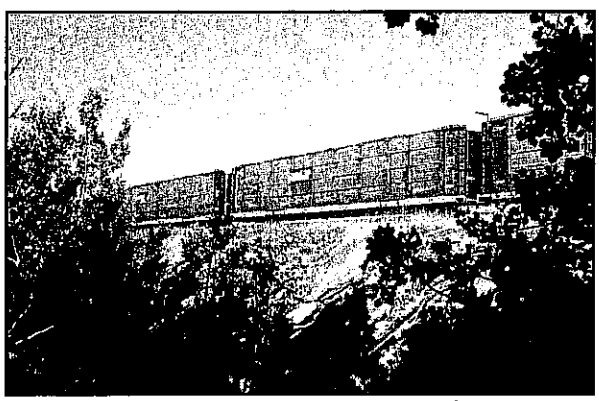

Exhibit 1. Testing Conducted in the Railroad Environment to Document Railcar Deck Acceleration

Using the methods described in the recommended practice, three truck types installed in the same bi-level autorack car were tested at TTC. One design is the old technology truck, now being replaced in autorack service. The second was the premium design replacement truck. The third was a new truck, specially designed to meet newly developed ride quality expectations.

One design met the controlled test requirements, while the other two did not. As a result of the differences measured in the controlled tests, the same trucks were tested, coupled together, in railroad service. The issue is: Will success in controlled tests predict the desired performance in railroad service?

The over-the-road test program demonstrated the following:

- Performance differences between the three truck types measured in controlled tests were confirmed by major differences measured in railroad service.
- The advanced freight car truck met requirements for controlled testing and over-the-road testing.
- The premium truck performed better than the old technology truck but did not meet vertical performance standards in controlled tests or in over-the-road tests.
- The old technology truck did not meet performance requirements in either test scenario.
- For the three truck types tested, improved performance in controlled testing was reflected in a reduction in the number of over-the-road acceleration events as well as a reduction in the magnitude of maximum acceleration.

BACKGROUND

Partnerships between the railroad and automotive industries have been established to identify performance objectives for transporting finished automobiles by rail. These objectives are expressed in terms of acceptable acceleration performance measured in tests described in a recommended practice for railcars used for automobile transportation titled: Ride Quality

Performance Requirements for Motor Vehicle Shipments.

This recommended practice specifies standard test and analysis cases for evaluating ride quality performance. It also prescribes methods for data collection and analysis. Requirements include controlled tests over specially constructed track anomalies, impact tests, and over-the-road tests on selected railroad property. The controlled tests are used to identify weaknesses in design and to promote design development. The over-the-road tests document in-service performance for designs which meet controlled test requirements.

Controlled Test Results

Bi-level autorack testing, on specially constructed tracks at TTC, demonstrated that old technology and premium suspensions do not meet new standards for vertical ride performance. An innovative (advanced) suspension design was successful in meeting this requirement.

Exhibit 2 compares the maximum vertical acceleration for a bi-level autorack car equipped with a premium suspension and the advanced suspension. Testing was conducted on a section of track at TTC which has 10 identical vertical bumps installed on each rail. This track is intended to excite the rigid body modes of pitch and bounce for the railcar. The criterion for success was vertical acceleration of no more than 0.50 g at speeds up to 70 mph. The premium truck exceeded the criterion at speeds above 55 mph.

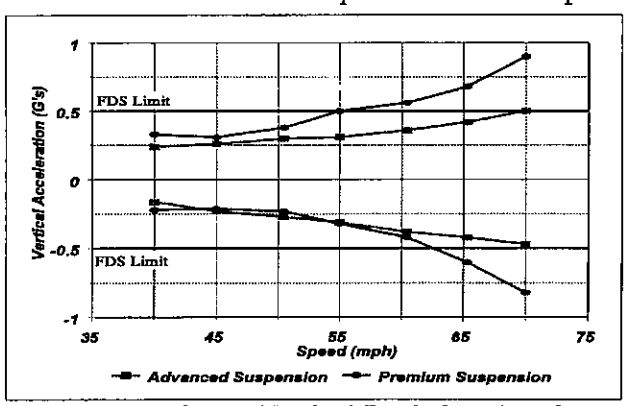

Exhibit 2. Maximum Vertical Deck Acceleration - Pitch and Bounce Premium and Advanced Suspension Tests

Automakers have expressed concern over the vertical ride performance for the premium design.

Exhibit 3 displays the acceleration response of a pickup truck and a sedan, measured during the premium truck test. The maximum automobile acceleration remains constant once a significant railcar deck acceleration has been achieved. This indicates that limiting both the number of vertical acceleration events and the magnitude of the maximum deck acceleration is important.

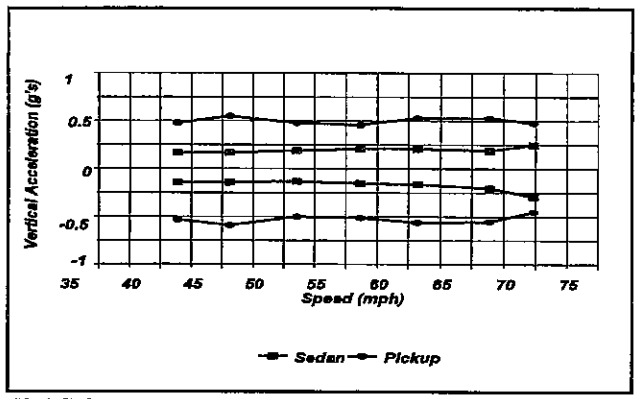

Exhibit 3. Max Vertical Automobile Acceleration - Pitch and Bounce Premium Railcar Suspension Tests

OVER-THE-ROAD RIDE QUALITY TESTING

In addition to controlled test requirements, the recommended practice describes an over-the-road test which measures vertical, lateral, and longitudinal acceleration at each deck. The test route is: Newark, NJ to Chicago, IL, Chicago to Milpitas, CA, and then from Los Angeles, CA to Chicago. Criteria for success are the number of occurrences at a predetermined level for each acceleration. In the vertical plane, one occurrence at 1.0 g or 100 occurrences at 0.50 g per thousand miles would exceed the criteria. In the lateral plane, one occurrence at 0.75 g or 100 occurrences at 0.35 g per thousand miles would exceed the criteria.

Over-the-road data can be dominated by local factors such as train handling, performance of adjacent cars, weather, special track (switches etc.), and train speed. To minimize trip-to-trip variations, the three suspensions were tested, as installed, in three identical autoracks coupled together.

Vertical Performance in Railroad Service

Exhibit 4 lists the average vertical performance for the 5,578-mile trip. The advanced truck met the requirements for all three trip segments. The old technology truck did not meet requirements for any of the three segments. Although the premium truck performed better than the old technology truck, it also did not meet requirements for any of the three segments. These results confirm observations made during the controlled test program.

The vertical performance of the three truck types is shown in Exhibits 5 (upper deck) and 6 (lower deck). The number of vertical events reduced when progressing from old technology to premium to advanced suspension types. Importantly, this trend was true at all levels of acceleration, not just at the highest *g* levels. Automobiles shipped with advanced truck technology will be subjected to fewer acceleration events and will not be subject to high amplitude events.

FOLLOW-UP WORK

Several advanced truck concepts will undergo controlled testing at TTC in 1996. Successful candidates may be tested in railroad service in 1997.

ACKNOWLEDGMENT

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Contact: Ken Rownd at (719) 584-0552 with questions or comments about this document.

Exhibit 4. Over-the-Road Vertical Performance Events > 0.50 g Normalized to 1,000 Miles/ Events > 1.0 g not Normalized

	Upper Deck		Lower Deck	
Truck Type	> 0.50 G	> 1.0 G	> 0.50 G	> 1.0 G
Old Technology	554	117	213	24
Premium	123	7	43	2
Advanced	18	0	2	0

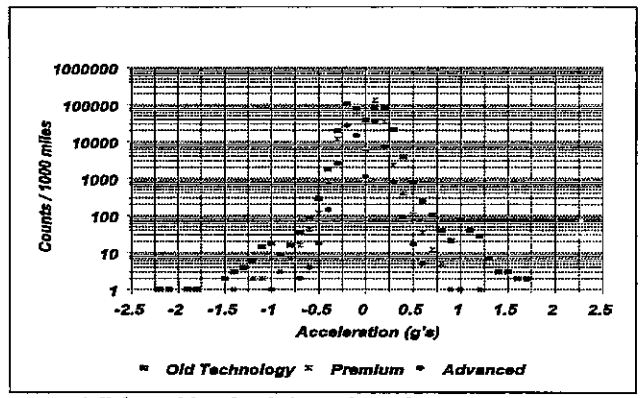

Exhibit 5. Vertical Acceleration Events per Thousand Miles — Upper Deck, Events > 1.0 g not Normalized

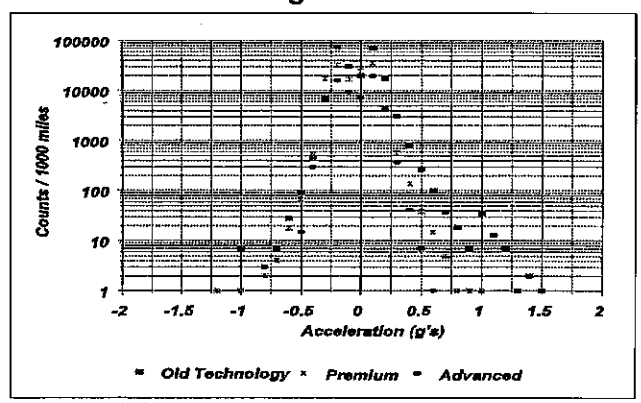

Exhibit 6. Vertical Acceleration Events per Thousand Miles For Lower Deck, Events > 1.0 g not Normalized