IMPLICATIONS OF ISTEA SPECIAL VEHICLES

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INTRODUCTION

Section 1073 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) is concerned with "Roadside Barriers and Safety Appurtenances" *(1)*. This section reads as follows. "(a) INITIATION OF RULEMAKING PROCEEDINGS. Not later than 30 days after the date of enactment of this Act, the Secretary shall initiate a rulemaking proceeding to revise the guidelines and establish standards for installation of roadside barriers and other safety appurtenances, including longitudinal barriers, end terminals and crash cushions. Such rulemaking shall reflect state-of-the-art designs, testing, and evaluation criteria contained in the National Cooperative Highway Research Program Report No. 230, relating to approval standards which provide an enhanced level of crashworthy performance to accommodate vans, mini-vans, pickup trucks, and 4-wheel drive vehicles. b) FINAL RULE.-Not later than 1 year after the date of the enactment of this Act, the Secretary shall complete the rulemaking proceedings initiated under subsection (a), and issue a final rule regarding the implementation of revised guidelines and standards for acceptable roadside barriers and other safety appurtenances, including longitudinal barriers, end terminals, and crash cushions. Such revised guidelines and standards shall accommodate vans, mini-vans, pickup trucks, and 4-wheel drive vehicles and shall be applicable to the refurbishment and replacement of existing roadside barriers and safety appurtenances as well as to the installation of new roadside barriers and safety appurtenances."

This section of the ISTEA made it clear that roadside barriers and other safety appurtenances had to be able to accommodate what the motor vehicle manufacturers refer to as the "light truck" class of vehicles. When this law was written in 1991, about 25 percent of the vehicle fleet consisted of light trucks *(2)*. Projections from vehicle sales data indicate that these light trucks could be as much as 1/3 of the vehicle fleet in the near future *(2)*.

NCHRP Report 230 contains multiple service levels and recommends tests for these levels in a supplementary matrix *(3)*. However, it does not call for tests with the light truck vehicles listed in the ISTEA. The standard strength test in *NCHRP Report 230* is with a 4,500-lb car impacting at 60 mi/h and 25 degrees.

Until recently, the 1989 AASHTO Guide Specification for Bridge Rails was the only recognized document that recommended crash testing with ISTEA vehicles *(4)*. A crash test with a 5,400-lb pickup truck at 45 mi/h is used to define the strength of a bridge rail for Performance Level One (PL-1). A 5,400-lb pickup truck is also recommended for testing bridge rails to the two higher performance levels.

On July 16, 1993, the Federal Highway Administration (FHWA) published a Final Rule in the Federal Register in which it adopted *NCHRP Report 350 (5)*. This Final Rule amended the "guides and references" section in 23 CFR part 625 by listing *NCHRP Report 350* for guidance in determining the acceptability of roadside barriers and other safety appurtenances for use on National Highway System (NHS) projects *(6,7)*.

The Final Rule pointed out that *NCHRP Report 350* had been developed under an NCHRP project as a replacement for *NCHRP Report 230*. It went on to say that,"The replacement, *Report 350* "Recommended Procedures for the Safety Performance Evaluation of Highway Features," 1993 addresses testing and evaluating appurtenances with pickup trucks and with smaller and larger vehicles. The FHWA believes that following the testing and evaluation guidance contained in *NCHRP Report 350*, along with appropriate roadside features selection procedures, will result in highway design and upgrade practices that will safely accommodate the vehicles cited in the ISTEA" *(5)*.

THE SURROGATE VEHICLE

The issue has been raised as to how well the 3/4-ton pickup truck represents the spectrum of vehicles in the light truck category. There is no "generic" pickup truck. Due to various vehicle models and optional features, there is as much variation within each class as there is among the classes of light trucks.

NCHRP Report 350 recommends tests with a 2000P vehicle, which is essentially a 3/4 ton pickup truck ballasted to 4,500-lb. This test vehicle was originally intended to be a replacement for the 4,500-lb car. Cars weighing about 4,500-lb were widely used as test vehicles until downsizing made them scarce. In general, pickup trucks have higher centers of gravity, higher bumpers

and larger wheels than cars. Therefore, some differences in performance are to be expected.

Since pickup trucks have been used as test vehicles for about 4 years, quite a bit is known about their characteristics and behavior. Both full-size cars and pickup trucks have vaulted after impacting guardrail/curb combinations. Tests of NJ-shape concrete median barriers have shown that the exit trajectories of pickups are different from those of cars. Crash tests of bridge rails have shown that the frame of a pickup truck can twist and flex between the cab and the truck bed. This flexing of the frame makes the pickup truck behave more like an articulated vehicle than a rigid mass. Consequently, the peak impact force is a little lower for a pickup truck than for a car of the same weight. The front wheels of pickup trucks have flown off after impacts with rigid, vertical walls. When a pickup truck impacted an aesthetic guardrail made of logs, the sloping end of its bumper impacted the curved rail face and lifted the vehicle. A G4(1s) W-beam on strong post guardrail with a 1194-ft horizontal radius smoothly redirected a 5,400-lb pickup truck on level terrain. However, the pickup truck rolled over after impacting this guardrail at the top of a superelevated section of roadway. Overall, the available test data seems to indicate that pickup trucks are more critical test vehicles than full-size sedans.

Very few crash tests have been conducted with other ISTEA vehicles, i.e. vans, mini-vans and 4-wheel drive vehicles. Therefore, not much is known about their behavior and characteristics when interacting with safety hardware and other safety features. Vehicle handling studies suggest that these light truck vehicles have a greater potential for rollovers. However in 60 mi/h tests on a embankment with a 3 to 1 slope, a pickup truck and a van were steered remotely down the slope and back onto the roadway. A 1,800-lb car rolled over at the bottom of the slope in a test conducted when the soil was softer. Test results are highly sensitive to test variables that may be even more important than the differences in vehicle characteristics.

It should be kept in mind that the problem of a surrogate vehicle is broader than simply deciding what test vehicle should be selected to represent the light truck class of vehicles. The test conditions, i.e. the test weight of the vehicle, the impact speed and the impact angle are probably at least as important as the model or class of vehicle selected. For example, a test of a traffic barrier with a 3/4-ton pickup truck impacting at 5 mi/h and 3 degrees would not be a discerning test. *NCHRP Report 350* recognizes that more than one test and more than one test vehicle are necessary to represent the range of behavior and characteristics found in passenger cars and the light truck class of vehicles. Consequently, tests are recommended with two sizes of small cars as well as pickup trucks. There are inconsistencies between the test conditions for the pickup truck tests in *NCHRP Report 350* and the AASHTO Guide Specification for Bridge Railings that will have to be reconciled.

The FHWA has expressed willingness to change the test vehicles and test conditions if this becomes necessary. The Notice of Proposed Rulemaking, which was published in February, 1993, stated, "Should the previously cited FHWA and NCHRP studies to examine the performance characteristics of ISTEA vehicles and the compatibility with them show that the 3/4-ton pickup truck, recommended as a test vehicle in *Report 350*, is not suitable or sufficient as a test vehicle to represent the light truck segment of the vehicle fleet, the FHWA will look for another test vehicle or an additional test vehicle or vehicles" *(2)*.

CUSTOM VEHICLES

It is a common practice for vehicle manufacturers, vehicle owners or custom shops to make significant modifications to pickup trucks, vans and the other vehicles in the light truck class. In some cases, these modifications result in vehicles with very large wheels, special extended suspensions and high centers of gravity. The stability of these vehicles can be greatly diminished by such design features. The FHWA has found that, "It is not economically feasible to design safety features to accommodate vehicles of this type" *(2)*.

IMPLICATIONS FOR HARDWARE DESIGNERS

There is enough variability within the light truck class that efforts to fine tune existing designs for these vehicles may not be fully successful. For example, the construction tolerances on guardrail height (27-in, plus or minus 3-in) could be tightened. However, a more economical approach may be to use a higher-performance guardrail system for new construction, such as the Modified Thrie Beam Guardrail. This 34-in high thrie beam guardrail is an operational system that can even redirect heavy vehicles such as a 32,000-lb bus at 60 mi/h and 15 degrees. New warrants and selection procedures are needed so that designers can make cost-effective decisions. Warrants for the multiple test levels in *NCHRP Report 350* are currently being developed under NCHRP Project 22-9,"Improved Procedures for Cost-Effectiveness Analysis of Roadside Safety Features."

During the rulemaking action, a manufacturer expressed doubts that Truck Mounted Attenuators (TMAs) can be made to pass the off-center head-on and off-center angle tests in *NCHRP Report 350 (5)*. Since these tests are considered optional until the state-of-the-art indicates otherwise, the FHWA has stated that it will not consider it essential that the acceptance criteria be met for tests nos. 2-52, 2-53 and 3-52 and 3-53. However, it is recommended that these tests still be run for reference and comparison purposes *(5)*.

IMPACT ON HIGHWAY AGENCIES

The Final Rule stated that,"...the FHWA anticipates that approximately five years after adoption of this rule that all installations of traffic barriers and other roadside safety features on NHS projects will be only those that have been judged to meet the testing and evaluation criteria in Report No. 350." *(5)* There will be no massive retrofit program. Therefore, "the potential economic impact on highway agencies will be minimal." *(5)*

ADDITIONAL RESEARCH

Obviously, additional research will be needed to obtain more information about the behavior and characteristics of the light truck class of vehicles. Some of this research can be performed under a $450,000 research study entitled, "Assessment of Motor Vehicle Characteristics" that FHWA has programmed for FY'94. A companion $500,000 study entitled,"Roadside Safety Hardware Testing" will test and evaluate various roadside safety features in accordance with *NCHRP Report 350*. This study has been structured so that interested States can contribute funds to have their hardware designs tested. It is expected that NCHRP Project No. 22-11, "Evaluation of Current Roadside Barriers and Other Safety Appurtenances to Accommodate Vans, Mini-Vans, Pickup Trucks and 4-Wheel Drive Vehicles" will look at accident data and crash test results to help identify any safety problems associated with the various types of light trucks. This NCHRP project will probably also address the issue of the appropriateness of the 3/4-ton vehicle as a surrogate for the light truck class of vehicles.

SUMMARY AND CONCLUSION

Warrants and guidelines for selecting and designing roadside safety features and appropriate test conditions may be more important than selecting the "perfect" test vehicle in improving safety for the light truck class of vehicles.

REFERENCES

1. Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Public Law 102-240-December 18, 1991.
2. Notice of Proposed Rulemaking, Design Standards for Highways, Requirements for Roadside Barriers and Safety Appurtenances, FHWA Docket No. 92-8, Notice No. 2, Federal Register, Vol. 58, February 3, 1993, pp 6914-6992.
3. Michie, J.D.,"Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances, Transportation Research Board, National Research Council, Washington, D.C., 20418, NCHRP Report No. 230, March, 1981.
4. Guide Specifications for Bridge Railings 1989, American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, N.W., Suite 225, Washington, D.C. 20001, 1989.
5. Final Rule, Design Standards for Highways, Requirements for Roadside Barriers and Safety Appurtenances, FHWA Docket No. 92-8, Notice No. 3, Federal Register, Vol. 58, No. 135, July 16, 1993, pp 38293-38298.
6. Ross, Hayes, E., et al.,"Recommended Procedures for the Safety Evaluation of Highway Features", Transportation Research Board, National Research Council, NCHRP Report No. 350, 1993.
7. Code of Federal Regulations (CFR), Highways 23, Part 625 Design Standards for Highways, U.S. Government Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, D.C., 20402-9328, Revised April 1, 1993.