

U.S. TEST AND EVALUATION PROCEDURES

OVERVIEW

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National Cooperative Highway Research Program

Development of Updated Procedures for the Safety Performance Evaluation of Highway Features

The National Cooperative Highway Research Program (NCHRP) was initiated in 1962 as a means for the states to address common research needs. One of the very first research projects initiated was an effort that led to Highway Research Circular 482, which recommended specific vehicular masses, impact speeds, and approach angles as the basis for full-scale crash testing to validate the performance of roadside safety features. This one-page circular reflected the knowledge of safety performance evaluation when it was published in 1962.

In 1973 NCHRP initiated Project 22-2, Traffic Barrier Performance and Design. The Southwest Research Institute was selected to undertake this project, with Mr. Maurice Bronstad and Mr. Jarvis Michie heading the research team. This project investigated issues related to safety performance evaluation and developed an expanded set of procedures, recognizing that there was not a sufficient understanding of safety performance to develop procedures for all aspects and roadside features. Their efforts led to the publication of NCHRP Report 153, *Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances*, which recommended a set of testing procedures to promote greater uniformity. This report was 19 pages in length.

Report 153 quickly was found to have some limitations, and in 1976 Transportation Research Board (TRB) Committee on Roadside Safety Features (A2A04) accepted the responsibility to monitor the needs for the updating of these procedures. They initiated an effort in 1978 that led to TRB Research Circular 191, which recommended some minor changes in procedures and provided the basis for broadening the scope of the testing procedures themselves.

In 1978, recognizing that something better was again needed, the NCHRP initiated Project 22-2(4), *Procedures for Testing Highway Appurtenances*, to consolidate Report 153 and Research Circular 191 into a single document and incorporate the things that had been learned over that era. Since there had been a considerable amount of crash testing during the 1970s, there was a new wealth of both experience and understanding of safety performance of roadside features

that was incorporated into the procedures. The procedures were described in a report authored by Jarvis Michie, which became the venerable NCHRP Report 230, *Recommended Procedures for the Safety Performance Evaluation of Highway Safety Appurtenances*. This report was 42 pages in length, more than doubling the length of the previous report, indicating greater detail and breadth in the procedures.

NCHRP Report 230 was the only document that was specifically referenced (other than U.S. laws) in the 300-page legislation for the Intermodal Surface Transportation Efficiency Act (ISTEA), which was enacted into law by Congress in 1991. ISTEA set the stage for further investigations in this country to validate the safety performance of barriers and other safety features relative to vans, minivans, pickup trucks, and four-wheel-drive vehicles. This "light truck" of truck class of vehicles has grown to represent about one-quarter of the current fleet of vehicles in use in this country.

Again in 1988, recognizing that things had changed over time, the American Association of State Highway and Transportation Officials (AASHTO) authorized NCHRP Project 22-7, Update of Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances. In 1989 NCHRP initiated a contract with the Texas Transportation Institute to undertake Project 22-7. The research team was headed by principal investigators Dr. Hayes Ross and Jarvis Michie, who were charged with taking a critical look at existing crash testing procedures and developing an appropriate update.

It was a long and arduous process that Dr. Ross and Mr. Michie undertook to develop the update. It started with the project panel identifying those issues that were considered critical to the update. Dr. Ross and his research team investigated these issues and generated white papers on the subjects. Ultimately, eight white papers were produced, covering the topics of future characteristics of the vehicle fleet, form of the test matrices, feasibility of using surrogate testing and simulation modeling, in-service evaluation procedures, the instrumentation of test articles, the purpose of the document, and conversions to standard international (SI) units of measurement.

The panel reviewed each of these white papers and met in mid-1990 to review the issues and the recommendations that the research team had made. After detailed discussions, the panel reached consensus on both the research approach and content of the update. The panel's consensus was reflected in a first

draft of the report that was produced in late 1990. The panel again took a very close look at all aspects of the proposed update to the procedures for safety performance evaluation in the context of the many new features and concepts that had emerged both in the United States and abroad.

After a thorough review of the first draft, the panel convened for a second time with the research team to go over each issue and establish a consensus to set the foundation for a second draft report. The second draft report was issued in the early 1991. It was initially reviewed by the project panel to ascertain that an effective set of safety performance evaluation procedures was evolving. The second draft report was then sent out for further review by about 100 additional individuals, including about 30 foreign representatives.

The comments of these reviewers were compiled in their entirety and transmitted to the research team. The set of returned comments, when typed single-spaced, were 75 pages long and represented more text than there was in the second draft of the report. Dr. Ross and Mr. Michie waded through all the comments and responded to all the major criticisms that were made. They then recommended a series of revisions to the procedures and met with the panel to weigh the validity of and the need for these revisions.

In early 1992 the third draft of the report was produced. After another panel review, final revisions were made, technical editing was completed, and the revised document — NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features* — became available from TRB in March 1993. It was a long and arduous process that involved a lot of individuals. There were a lot of comments reviewed and pros and cons debated, and the various perspectives — manufacturers', state DOTs', and federal agencies' — were considered in the process of producing this consensus document.

Dr. Ross and Mr. Michie worked hard with the project panel to produce a viable set safety evaluation procedures that cover a broad range of roadside features and provide a basis for tailoring performance to roadway and traffic conditions. The project panel that served on a voluntary basis reviewed all materials, met on numerous occasions, and hammered out an updated set of procedures for the United States. The panel, under the guidance of Chairman Roger Stoughton, included Mr. James Bryden, Dr. Charles Dougan, Mr. Dennis Hanson, Mr. James Hatton, Mr. Walter Jestings, Mr. James Roberts, Mr. Florio Taminini, Mr. Tom Turbell, Mr. Harry Taylor, and the late Dr. Edward Post. In addition, Mr. Marty Hargrave and Mr. Leonard Meczowski from the Federal Highway Administration were very instrumental in the review of the document.

UPDATE TO NCHRP REPORT 230

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National Cooperative Highway Research Program (NCHRP) Project 22-7 developed an update to NCHRP Report 230. The project was a team effort. Input was provided by a large number of people in various disciplines, not only nationally but internationally. The document, published as NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*, is a consensus document. The NCHRP advisory panel, chaired by Roger Stoughton of the California Department of Transportation, and staffed by Kenneth Opiela, NCHRP senior project officer, provided comments and reviewed the drafts.

The project, which began in June 1989 and was completed in August 1992, was conducted at the Texas Transportation Institute. Jarvis Michie of Dynatech Engineering Inc. was a consultant/subcontractor on the project. Jarvis was a key member of the research team because he wrote Report 230 and guidelines that preceded Report 230.

One major change incorporated in Report 350 includes the adoption of the International System of Units (SI). To the extent possible, a "hard conversion" procedure was used, in which English units are converted to the equivalent SI unit and then rounded. By so doing, it increased the requirements of some tests and it diminished the requirements of others, but in all cases the changes were not major. For example, a 60 mph test speed, which has been a standard value for high-speed tests, converts to 96.6 km/h. The decision was made to round to 100 km/h, which is 62.1 mph.

The critical test speed for many breakaway features is at the lower end of the spectrum rather than the high end. The test speed on the low end has been 20 mph. In Report 350 the speed was set at 35 km/h, or 21.7 mph. It was initially decided to round to 30 km/h, which is 18.6 mph. However, those who design and use breakaway hardware stated that such a conversion would create an unnecessarily conservative test requirement since the 20 mph requirements of Report 230 were believed to be very conservative. Not only are these features required to break away at low speeds, they also are required to do this for vehicles at the low end of the weight spectrum. Furthermore, the acceptable vehicular velocity change (and hence occupant risk measures) for breakaway features is much lower than for other features such as crash cushions, end treatments, and so on.