

previous research in 1997–8, the agency chose the J-Turn and the Fishhook maneuvers as dynamic rollover tests. They are the limit maneuver tests that NHTSA found to have the highest levels of objectivity, repeatability and discriminatory capability. The document announced that vehicles would be tested in two load conditions using the J-Turn at up to 60 mph and the Fishhook maneuver at up to 50 mph. Both maneuvers would be conducted with an automated steering controller, and the reverse steer of the Fishhook maneuver would be timed to coincide with the maximum roll angle to create an objective “worst case” for all vehicles regardless of differences in resonant roll frequency. Figures 1 and 2 illustrate the open-loop steering wheel motions characterizing these maneuvers. The light load condition would be the weight of the test driver and instruments, approximating a vehicle with a driver and one front seat passenger. The notice announced that the heavy load condition would add additional 175 lb manikins in all rear seat positions.

The National Academy of Sciences recommended that dynamic maneuver tests be used to supplement rather than replace Static Stability Factor in consumer information on rollover resistance. NHTSA proposed two alternatives for consumer information ratings on vehicle rollover resistance that included both dynamic maneuver test results and Static Stability Factor. The first alternative was to include the dynamic test results as vehicle variables along with SSF in a statistical model of rollover risk that would combine their predictive power. This is conceptually similar to the present ratings in which a statistical model is used to distinguish between the effects of vehicle variables and demographic and road use variables recorded for state crash data on a large number of single-vehicle crashes. The National Academy of Sciences recommended using a logistic regression model for this purpose. Such a model would be used to predict the rollover rate in single-vehicle crashes for a vehicle considering both its dynamic maneuver test performance and its Static Stability Factor for an average driver population (as a common basis of comparison).

Under the first alternative, the “star rating” of a vehicle would be based on its rollover rate in single-vehicle crashes predicted by a statistical model. The format would be the same as for the present rollover ratings (for example, one star for a predicted rollover rate in single-vehicle crashes greater than 40 percent and five stars for a predicted

rollover rate less than 10 percent). The present rollover ratings are based on a linear regression model using state crash reports of 241,000 single-vehicle crashes of 100 make/model vehicles. We proposed to replace the current rollover risk model with one that uses the performance of the vehicle in dynamic maneuver tests as well as SSF to predict rollover risk. The performance of a vehicle in dynamic maneuver tests would be simply whether it tipped up or not in each of the four maneuver/load combinations.

In order to compute this logistic model for rollover risk, it is necessary to have the dynamic maneuver test results as well as SSF for a number of vehicles with rollover rates established by state crash reports of single-vehicle crashes. We had the SSF measurements and established rollover rates for the 100 make/model vehicles upon which we based the static rating system but not their dynamic maneuver test results. Thus, we asked for comment on the suitability of a rating method that combines static and dynamic vehicle properties in a single rating and on the validity of logistic regression analysis for the risk model that combines the properties in a way that is predictive of real-world crash experience.

The NPRM notice announced that we were going to perform the dynamic maneuver tests on about 25 of the 100 make/model vehicles for which we had SSF measurements and substantial state crash data. Time and budget constraints would not permit testing all 100 vehicles. With these dynamic maneuver test results and our existing crash and SSF information we would be able to compute the new risk model using a standard statistical package of computer programs (SAS) for logistic regression analysis. This final document presents the dynamic maneuver test results for 24 of the 100 vehicles, chosen to span the SSF range and to represent high production vehicles of each type (passenger car, van, pickup truck and sport utility vehicle (SUV)). An additional SUV with a lower SSF than found among the 100 vehicles was also included. The resulting risk model is presented in this document.

The second alternative we proposed was to have separate ratings for Static Stability Factor and for dynamic maneuver test performance. Dynamic maneuver tests directly represent on-road untripped rollovers. Under this alternative, the dynamic maneuver test performance would be used to rate resistance to untripped rollovers in a qualitative scale. Barring unforeseen results of the dynamic maneuver tests of the 25 vehicle group, the obvious

qualitative scale would be: A for no tip-ups, B for tip-up in one maneuver, C for tip-ups in two maneuvers, D for tip-ups in three maneuvers and E for tip-ups in all four maneuvers/load combinations.

A statistical risk model is not possible for untripped rollover crashes, because they appear to be relatively rare events and they cannot be reliably identified in state crash reports. For this alternative, the current Static Stability Factor based system would be used to rate resistance to tripped rollovers (since we believe most of the rollovers reported in the state crash reports are tripped). Again we asked for comments on the usefulness and validity of the concept in the NPRM notice, but we could not offer examples of actual vehicle ratings because the tests had not yet been conducted.

V. Results of Dynamic Maneuver Tests of 25 Vehicles

This section presents an overview of the test maneuvers and the results for 25 vehicles that were used to develop the logistic regression risk model. A more extensive account of the test program is contained in the Phase VI and VII Report that has been placed in Docket NHTSA–2001–9663. A detailed description of how we will perform the maneuver tests for NCAP ratings is contained in Appendix I.

The NHTSA J-Turn and Fishhook (with roll rate feedback) maneuver tests were performed for 25 vehicles representing four vehicle types including passenger cars, vans, pickup trucks and SUVs. We chose mainly high production vehicles that spanned a wide range of SSF values, using vehicles NHTSA already owned where possible. Except for four 2001 model year vehicles NHTSA purchased new, the vehicle suspensions were rebuilt with new springs and shock absorbers, and other parts as required for all the other vehicles included in the test program.

A. J-Turn Maneuver

The NHTSA J-Turn maneuver represents an avoidance maneuver in which a vehicle is steered away from an obstacle using a single input. The maneuver is similar to the J-Turn used during NHTSA’s 1997–98 rollover research program and is a common maneuver in test programs conducted by vehicle manufacturers and others. Often the J-Turn is conducted with a fixed steering input (handwheel angle) for all test vehicles. In its 1997–98 testing, NHTSA used a fixed handwheel angle of 330 degrees. In the testing that preceded the NPRM notice, we developed an objective method of specifying equivalent handwheel angles