possibility is extremely remote. If a manufacturer were to design a vehicle to exhibit slight rear bias, production and test variability would create too great a risk that the vehicle would not comply with either the wheel lock sequence test or the torque wheel test. Rather, the 10% allowance is meant to allow cars to be designed with brake balance that is still front-biased, but closer to ideal than could be achieved if the manufacturer had to worry about a failure of the torque wheel test due to test variability. Also, for a vehicle to exhibit a tendency to spin out, it must experience a condition where the rear wheels are locked and the front wheels are not. Any vehicle falling in the 10% ''window'' would be so close to ideally balanced that the point of wheel lockup would be essentially simultaneous for both axles, and a condition of rear axle lockup without front axle lockup would be almost impossible to maintain.

*b. Wheel Lock Sequence Test.* NHTSA explained its tentative determination in the SNPRM (Notice 5) that the wheel lock sequence test would identify those vehicles that are heavily front biased. Such vehicles have good stability characteristics because their front brakes always lock first during braking, regardless of test surface. Accordingly, a heavily front biased vehicle would not need to be subject to the torque wheel test, since it would be considered to have inherently good stability characteristics. Under the proposal, a vehicle would need to meet the wheel lock sequence test requirements on all test surfaces that would result in a braking ratio of between 0.15 and 0.80, inclusive, at each of two vehicle loading conditions: GVWR and LLVW.[5] The wheel lock sequence test would require a brake application at a linear, increasing rate such that lockup of the first axle is achieved between 0.5 and 1.0 second.

GRRF agreed to the proposed wheel lock sequence test and planned to add it to R13 and R13H. Ford and Chrysler stated that there were insufficient data to establish whether the wheel lock sequence test could be consistently repeated. Ford believed that there is potential for discrepancies between manufacturer testing and NHTSA testing.

NHTSA believes that Ford and Chrysler are incorrect in their assessment of the wheel lock sequence test. The agency notes that the available test data indicate that the wheel lock sequence test is objective and can be consistently repeated.[6] As explained above, the wheel lock sequence test is the first part of the adhesion utilization test procedure, and evaluates whether there is sufficient front axle bias to ensure stability in a lock up situation. If a car has insufficient front axle bias to consistently meet the wheel lock sequence test, it does not automatically fail to comply with FMVSS No. 135. Rather, it would be tested under the torque wheel method. If the vehicle passes the torque wheel test, the wheel lock sequence test results are irrelevant.

NHTSA expects that 90 to 95 percent of cars will pass the wheel lock sequence test, meaning only 5 to 10 percent of the cars will have to be tested with the torque wheel method. This will reduce potential testing expenses by a greater amount than the agency could have foreseen at the time it published the 1991 SNPRM.[7]

Ford requested that the agency specify a braking ratio of 0.15 to 0.70 instead of the proposed ratio of 0.15 to 0.80. It believed that this change would help avoid degradation and flat spotting of tires, since under its recommended ratios only wet surfaces would be required.

NHTSA has determined that it would be inappropriate to lower the upper limit in the braking ratios. If Ford's recommendation were adopted, there would be no assurance of stability on typical dry road surfaces. Therefore, the agency has decided to require the wheel lock sequence test be performed at any ratio between 0.15 to 0.80.

More generally, NHTSA has considered whether the range of possible test surfaces for the wheel lock sequence test raises practicability concerns. The agency notes that a manufacturer will not need to test a vehicle on every possible surface but could instead make predictions based on testing at several points and brake design characteristics. Moreover, instead of using the wheel lock sequence test to screen out vehicles, a manufacturer could conduct only the torque wheel tests, which do not involve a wide range of test surfaces, if a manufacturer doubted that its vehicle could pass the wheel lock sequence test on all applicable test surfaces. Given the availability of the torque wheel test, NHTSA believes that there are no practicability concerns presented by the wide range of test surfaces in the wheel lock sequence test.

Bendix requested that NHTSA clarify whether the definition of wheel lock in S7.2.1(f) is applicable to all testing situations or just those in S7.2. After reviewing this comment, NHTSA has modified the description of wheel lock in S7.2.1(f) to clarify that it only applies for purposes of the adhesion utilization test.

MVMA and Ford noted that the proposed wheel lock sequence test permits wheel lockups of ''less than 0.1 second;'' however, the balance of the SNPRM permits lockup ''for not longer than 0.1 second.'' The agency has decided to standardize this factor so all references to wheel lockup will read -'' ≤ 0.1 second.''

MVMA, Chrysler, Ford, Toyota, and the Japanese Automobile Manufacturers Association (JAMA) commented that it would be difficult to comply with the proposed test condition for lockup to be achieved between 0.5 and 1.0 seconds after initial brake application. Several commenters suggested an upper limit of 1.5 seconds, which they believed would still preclude spike stops. Ford suggested that the requirement specify no maximum time, provided the vehicle's speed was greater than 15 kilometers per second (km/s) at the time lock up occurred.

After reviewing the available information including agency testing, NHTSA has determined that it is appropriate to raise the ceiling to 1.5 seconds. The agency has decided not to remove the ceiling altogether, given the need to have a specification that is independent of the actual pedal force rate since the pedal force rate required to achieve lock up within a specified time will vary among vehicles.

Suzuki, Toyota, and JAMA recommended that S7.2.3(c)(3) be amended to allow braking force to be terminated 0.1 seconds after the first axle locks or when the front axle locks. Suzuki stated that there is no need to require continued braking beyond the first axle lock, since the test is designed to determine which axle locks first. Toyota and JAMA stated that if the rear axle locks first, then the pedal must be immediately released to prevent accidents.

After reviewing the comments, NHTSA has decided to modify S7.2.3(c)(3) to state the following: ''The pedal is released when the second axle

[5] This is defined in Section S4 as the unloaded vehicle weight plus the weight of a mass of 180 kg, including driver and instrumentation.

[6] ''Harmonization of Braking Regulations, Report Number 7, Testing to Evaluate Wheel Lock Sequence and Torque Transducer Procedures,'' DOT HS 807611, February 1990.

[7] When the 1991 SNPRM was published, the percentage of cars that may have been required to be torque wheel tested was already small, given that the agency expected that 95 percent of all cars would pass the wheel lock sequence test. Thus, only five percent of all cars were expected to be torque wheel tested. As a result of the increased use of antilock brake systems that do not need to be torque wheel tested, the agency anticipates that in model year 1999, the number of cars that might need torque wheel testing will be less than one percent.