axle shall also be tested in accordance with the torque wheel procedure in S7.4.

(h) Any determination of noncompliance for failing adhesion utilization requirements shall be based on torque wheel test results.

S7.2.2 Vehicle conditions.

(a) Vehicle load: GVWR and LLVW.

(b) Transmission position: In neutral. S7.2.3 Test conditions and

procedures.

(a) IBT: \geq 50 °C. (122 °F), \leq 100 °C, (212 °F).

(b) Test speed: 65 km/h (40.4 mph) for a braking ratio ≤ 0.50 ; 100 km/h (62.1 mph) for a braking ratio > 0.50.

(c) Pedal force:

(1) Pedal force is applied and controlled by the vehicle driver or by a mechanical brake pedal actuator.

(2) Pedal force is increased at a linear rate such that the first axle lockup occurs no less than one-half (0.5) second and no more than one and one-half (1.5) seconds after the initial application of the pedal.

(3) The pedal is released when the second axle locks, or when the pedal force reaches 1000 N (225 lbs), or 0.1 seconds after first axle lockup, whichever occurs first.

(d) Wheel lockup: Only wheel lockups above a vehicle speed of 15 km/ h (9.3 mph) are considered in determining the results of this test.

(e) Test surfaces: This test is conducted, for each loading condition, on two different test surfaces that will result in a braking ratio of between 0.15 and 0.80, inclusive. NHTSA reserves the right to choose the test surfaces to be used based on adhesion utilization curves or any other method of determining "worst case" conditions.

(f) The data recording equipment shall have a minimum sampling rate of 40 Hz.

(g) Data to be recorded. The following information must be automatically recorded in phase continuously throughout each test run such that values of the variables can be cross referenced in real time.

(1) Vehicle speed.

(2) Brake pedal force.

(3) Angular velocity at each wheel.

(4) Actual instantaneous vehicle deceleration or the deceleration calculated by differentiation of the vehicle speed.

(h) Speed channel filtration. For analog instrumentation, the speed channel shall be filtered by using a lowpass filter having a cut-off frequency of less than one fourth the sampling rate.

(i) Test procedure. For each test surface, three runs meeting the pedal force application and time for wheel lockup requirements shall be made. Up to a total of six runs will be allowed to obtain three valid runs. Only the first three valid runs obtained shall be used for data analysis purposes.

S7.2.4. Performance requirements.

(a) In order to pass this test a vehicle shall be capable of meeting the test requirements on all test surfaces that will result in a braking ratio of between 0.15 and 0.80, inclusive.

(b) If all three valid runs on each surface result in the front axle locking before or simultaneously with the rear axle, or the front axle locks up with only one or no wheels locking on the rear axle, the torque wheel procedure need not be run, and the vehicle is considered to meet the adhesion utilization requirements of this Standard. This performance requirement shall be met for all vehicle braking ratios between 0.15 and 0.80.

(c) If any one of the three valid runs on any surface results in the rear axle locking before the front axle or the rear axle locks up with only one or no wheels locking on the front axle the torque wheel procedure shall be performed. This performance requirement shall be met for all vehicle braking ratios between 0.15 and 0.80.

(d) If any one of the three valid runs on any surface results in neither axle locking (*i.e.*, only one or no wheels locked on each axle) before a pedal force of 1000 N (225 lbs) is reached, the vehicle shall be tested to the torque wheel procedure.

(e) If the conditions listed in paragraph (c) or (d) of this section occur, vehicle compliance shall be determined from the results of a torque wheel test performed in accordance with S7.4.

S7.3. ABS performance. [Reserved.] S7.4. Adhesion utilization (Torque Wheel Method).

S7.4.1. *General information.* This test is for vehicles without any ABS. The purpose of the test is to determine the adhesion utilization of a vehicle.

S7.4.2. Vehicle conditions.

(a) Vehicle load: GVWR and LLVW.

(b) Transmission position: In neutral.

(c) Tires: For this test, a separate set of tires, identical to those used for all other tests under Section 7.0, may be used.

S7.4.3. *Test conditions and procedures.*

(a) IBT: \geq 50°C (122°F), \leq 100 °C (212°F).

(b) Test speeds: 100 km/h (62.1 mph), and 50 km/h (31.1 mph).

(c) Pedal force: Pedal force is increased at a linear rate between 100 and 150 N/sec (22.5 and 33.7 lbs/sec) for the 100 km/h test speed, or between 100 and 200 N/sec (22.5 and 45.0 lbs/sec) for the 50 km/h test speed, until the first axle locks or until a pedal force of 1 kN (225 lbs) is reached, whichever occurs first.

(d) Cooling: Between brake applications, the vehicle is driven at speeds up to 100 km/h (62.1 mph) until the IBT specified in S7.4.3(a) is reached.

(e) Number of runs: With the vehicle at GVWR, run five stops from a speed of 100 km/h (62.1 mph) and five stops from a speed of 50 km/h (31.1 mph), while alternating between the two test speeds after each stop. With the vehicle at LLVW, repeat the five stops at each test speed while alternating between the two test speeds.

(f) Test surface: PFC of at least 0.9. (g) Data to be recorded. The following information must be automatically recorded in phase continuously throughout each test run such that values of the variables can be cross referenced in real time:

(1) Vehicle speed.

- (2) Brake pedal force.
- (3) Angular velocity at each wheel.

(4) Brake torque at each wheel.

(5) Hydraulic brake line pressure in each brake circuit. Hydraulically proportioned circuits shall be fitted with transducers on at least one front wheel and one rear wheel downstream of the operative proportioning or pressure limiting valve(s).

(6) Vehicle deceleration.

(h) Sample rate: All data acquisition and recording equipment shall support a minimum sample rate of 40 Hz on all channels.

(i) Determination of front versus rear brake pressure. Determine the front versus rear brake pressure relationship over the entire range of line pressures. Unless the vehicle has a variable brake proportioning system, this determination is made by static test. If the vehicle has a variable brake proportioning system, dynamic tests are run with the vehicle both empty and loaded. 15 snubs from 50 km/h (31.1 mph) are made for each of the two load conditions, using the same initial conditions specified in this section.

S7.4.4. Data reduction.

(a) The data from each brake application under S7.4.3 is filtered using a five-point, on-center moving average for each data channel.

(b) For each brake application under S7.4.3 determine the slope (brake factor) and pressure axis intercept (brake holdoff pressure) of the linear least squares equation best describing the measured torque output at each braked wheel as a function of measured line pressure applied at the same wheel. Only torque output values obtained from data collected when the vehicle deceleration