

steering (second sequence). The sequence of left-right tests always precedes those performed with right-left steering.

3.2.2 Default Procedure

Fishhook maneuver handwheel angles are calculated with lateral acceleration and

handwheel angle data (δ) collected during a series of six Slowly Increasing Steer tests (a total of three left-steer and three right-steer tests are performed). For each Slowly Increasing Steer test, a linear regression line is fitted to the lateral acceleration data from

0.1 to 0.375 g. Using the slopes of these regression lines, the handwheel angles at 0.3 g are determined for each individual test ($\delta_{0.3 \text{ g}}$). The six handwheel angles are then averaged to produce an overall value ($\delta_{0.3 \text{ g, overall}}$).

$$\delta_{0.3 \text{ g, overall}} = \left(\left| \delta_{0.3 \text{ g, left (1)}} \right| + \left| \delta_{0.3 \text{ g, left (2)}} \right| + \left| \delta_{0.3 \text{ g, left (3)}} \right| + \delta_{0.3 \text{ g, right (1)}} + \delta_{0.3 \text{ g, right (2)}} + \delta_{0.3 \text{ g, right (3)}} \right) / 6$$

The Fishhook maneuver steering angles are calculated by multiplying $\delta_{0.3 \text{ g, overall}}$ by a steering scalar (SS). The default steering scalar is 6.5.

$$\delta_{\text{Fishhook (Default)}} = 6.5 \times \delta_{0.3 \text{ g, overall}}$$

3.2.2.1 Maneuver Entrance Speed

For the sake of driver safety, and as a final step in the tire scrub-in procedure, each Default Procedure sequence begins with a Maneuver Entrance Speed (MES) equal to 35 mph. The MES is measured at the initiation of the first steering ramp, and is increased until a termination condition is satisfied. The order of MES for a sequence is, in mph: 35, 40, 45, 47.5, 50. For each test run, the actual MES must be within 1 mph of the target MES.

Note: NHTSA's experience with the Fishhook maneuver indicates that an incremental increase in MES of 5 mph, up to 45 mph, minimizes tire wear without compromising test driver safety. However, when a MES greater than 45 mph is used, the severity of the responses produced with some vehicles can increase substantially from that observed at lesser entrance speeds. This is especially true if a vehicle has a propensity to oscillate in roll, and/or is able to produce two-wheel lift slightly less than NHTSA's threshold criterion of two inches. In some of these cases, the driver and/or experimenter may not be comfortable with a final 5 mph upwards increment in MES, and might, for the sake of driver safety, deviate from a test procedure that requires it. Generally speaking, such a deviation typically involves the experimenter's use of a more gradual 2.5 mph increase in MES.

To promote driver safety while also eliminating inconsistencies in the way NHTSA's Fishhook maneuvers are performed, the test procedure requires a MES increment equal to 2.5 mph be used above 45 mph if a test performed at 45 mph does not produce two-wheel lift, regardless of the vehicle being evaluated.

3.2.2.2 Outrigger Contact

If either safety outrigger contacts the pavement without two-wheel lift during a Fishhook maneuver test run, the affected outrigger is raised 0.75 inches and the test is repeated at the same MES. If both safety outriggers contact the pavement without two-wheel lift, both outriggers are raised 0.75 inches and the test is repeated at the same MES.

3.2.2.3 Termination and Conclusion Conditions

A test sequence is terminated if the MES capable of producing two-wheel lift is observed and the MES is 45 mph or lower.

If two-wheel lift is observed during a left-right sequence at 45 mph or lower, the [entire] series is terminated. If no two-wheel lift is observed during a left-right sequence, right-left tests are performed. If two-wheel lift is observed during a right-left sequence performed with a MES of 45 mph or lower, the test series is terminated.

If the MES capable of producing two-wheel lift during a left-right or right-left sequence is 47.5 mph or higher, a new set of tires is installed on the vehicle and the procedure described in Section 3.2.3.1 is implemented.

A test series is terminated if rim-to-pavement contact or tire debanding is observed during any test performed with either test sequence.

A test series is deemed complete if both test sequences within a given series have been performed at the maximum maneuver entrance speed without two-wheel lift, rim-to-pavement contact, tire debanding, or outrigger-to-pavement contact. If the Default Procedure is completed without encountering a termination condition, Supplemental Procedure Part 2, described in Section 3.2.3.2, is implemented.

The flowchart presented in Figure I.11 describes the sequence of events for the Default Test Series.

3.2.3 Supplemental Procedures

Note: If the results of the Default Test Series require the implementation of the Supplemental Procedure Part 1, neither Supplemental Procedure Part 2 nor Part 3 is used.

Note: Depending on the response of test vehicles to elements of the Fishhook maneuver protocol, Supplemental Procedure, Parts 1, 2, and 3 may require a change in the steering scalar. The steering machine used by NHTSA has the capability for making such changes in vehicles during test sessions via selection of a pre-programmed steering schedule and the adjustment of overall steering angles.

3.2.3.1 Supplemental Procedure Part 1

Following the tire scrub-in procedure outlined in Section 4.6, tests are performed with handwheel angles equal to $\delta_{\text{Fishhook (Default)}}$, as explained in Section 3.2.2. The steering combination (*i.e.*, either left-right or right-left) that produced two-wheel lift in the Default Test Series is used. The first test is to be performed at a MES of 35 mph. This test is performed to ensure any mold sheen remaining from the tire break-in procedure has been removed from the tires. The second test is to be performed at the MES at which two-wheel lift had been previously observed (*i.e.*, with the previous tire set). If two-wheel

lift is produced during the test performed with handwheel angles equal to $\delta_{\text{Fishhook (Default)}}$, the tip-up will be reported in the vehicle's NCAP Rollover Resistance Rating and the test series is deemed complete. If two-wheel lift is not produced and the MES is 47.5 mph, the MES is increased to 50 mph. If two-wheel lift is produced during the test performed with MES equal to 50 mph, the tip-up will be reported in the vehicle's NCAP Rollover Resistance Rating and the test series is deemed complete.

If two-wheel lift is *not* produced at 50 mph with handwheel angles equal to $\delta_{\text{Fishhook (Default)}}$, tests are performed with steering angles calculated by multiplying $\delta_{0.3 \text{ g, overall}}$ by a steering scalar of 5.5.

$$\delta_{\text{Fishhook (Supplemental)}} = 5.5 \times \delta_{0.3 \text{ g, overall}}$$

After the application of the reduced scalar, a test is to be performed, using the same steering combination (*i.e.*, either left-right or right-left), at the MES at which two-wheel lift had been observed in the Default Test Series. If two-wheel lift is produced during the test performed with handwheel angles equal to $\delta_{\text{Fishhook (Supplemental)}}$, the tip-up will be reported in the vehicle's NCAP Rollover Resistance Rating and the test series is deemed complete. If two-wheel lift is not produced and the MES is 47.5 mph, the MES is increased to 50 mph. If two-wheel lift is produced during the test performed with MES equal to 50 mph, the tip-up will be reported in the vehicle's NCAP Rollover Resistance Rating and the test series is deemed complete. If two-wheel lift is *not* produced at 50 mph, the test series is deemed complete and no tip-up will be reported in the vehicle's NCAP Rollover Resistance Rating.

A test series is terminated if rim-to-pavement contact or tire debanding is observed during any Supplemental Procedure Part 1 test. The flowchart presented in Figure I.12 describes the sequence of events for the Supplemental Procedure Part 1.

3.2.3.2 Supplemental Procedure Part 2

If two-wheel lift is not produced during tests performed with the Default Procedure, the steering scalar is reduced from 6.5 to 5.5. Using the same tires used for tests performed with the Default Test Series, tests are performed with steering angles calculated by multiplying $\delta_{0.3 \text{ g, overall}}$ by a steering scalar of 5.5.

$$\delta_{\text{Fishhook (Supplemental)}} = 5.5 \times \delta_{0.3 \text{ g, overall}}$$

For the sake of driver safety, the first test of the left-right sequence with the reduced steering scalar applied is to be performed at a MES of 45 mph. If this test does not