

the 15 tires failed to complete the test, representing a failure rate of 7 percent. The one failure was a "Q" speed-rated snow tire that completed the 40-hour duration but failed the post-inspection because of chunking.

For the 5 LT tires tested, 3 of the 5 completed the endurance tests at the proposed parameters, representing a 40 percent failure rate. When the load and ambient temperature were reduced to 85/90/100 percent and 38° C, respectively, all 5 LT tires completed the test without any failures.

The agency also conducted low pressure testing at Smithers Scientific to evaluate Alternative 2 of the proposed low pressure test on the performance of 13 tires (10 P-metric and 3 LT).¹⁹ The proposed 40-hour endurance test was performed on the tires before they were run to the low pressure test. The low pressure test parameters included an inflation pressure of 140 kPa, a speed of 140, 150, 160 km/h, a duration of 90 minutes (30 minutes at each test speed), a 67 percent load. The same tests were performed using 3 LT tires, but at inflation values of 260/340/410 kPa for load ranges C/D/E, respectively. These inflation pressure values represent the lowest inflation pressure provided by tire industry standardizing bodies for a tire load limit.

One of the P-metric tires failed to complete the endurance test and, therefore, was not tested to the low pressure test. The 12 remaining tires tested completed the 90-minute low inflation test without failure.

2. Rubber Manufacturer's Association (RMA) Design of Experiment (DOE) and Confirmation Testing

Members of the RMA developed a response surface model Design of Experiment (DOE) to assess tire temperatures versus test conditions (inflation pressure, load, and speed), surface type (standard test wheel of 1.7-m diameter versus a flat surface), and ambient temperature. An additional follow-up confirmation round of testing, which contained a broader range of tire types and sizes, was also conducted by RMA.²⁰

¹⁹ The agency did not re-test any tires to Alternative 1 of the low pressure endurance performance test since earlier testing (in Spring 2001) of 24 tires that completed a more stringent endurance test (50 hours and loads of 100/110/115 percent indicated no failures).

²⁰ An additional follow-up confirmation round of testing, containing a broader range of tire types and sizes, was conducted to validate the results of the DOE. RMA ran a matrix of passenger and light truck tires on high speed (increasing speed in 10 km/h steps to failure) and endurance (increasing load in 10% steps to failure). Seven high-volume, representative tire sizes of various brands were

RMA tested P-metric and LT tires to a matrix of high speed and endurance tests. Seven (4 P-metric and 3 LT) tire sizes of various brands were included in the test protocol. P-metric tires included P235/75R15 for all season, P215/70R15 for standard load "broad line," P265/75R16 for all terrain, and P215/70R15 for snow. For LT tires, the sizes were LT245/75R16 LRE for all-terrain/all-traction, LT 235/85R16 LRE for all season, and 31 x 10.5 R 15 LRC for mud. A total of 145 tires were tested.

The parameters RMA used for its high speed testing for P-metric tires were identical to the agency's, except for the ambient temperature. For LT tires, RMA's test parameters were 10 km/h lower than the agency's proposal for speed (130, 140, 150 km/h), and higher for inflation pressures at 330 and 520 kPa for load ranges C and E tires, respectively. All 42 P-metric tires tested to RMA's proposal completed the 160 km/h step without any failures. Of the 32 LT tires tested, 1 tire failed to complete the 150-km/h step, representing a 3 percent failure rate, and 2 LT tires failed to complete the 160 km/h speed step, a 6 percent failure rate.

For its endurance test parameters for P-metric tires, RMA utilized an ambient temperature at 38° C, a load at 85/90/100 percent of the maximum load rating, the same test speed proposed in the NPRM (120 km/h) and duration at 34 hours. For LT tires, RMA's testing included the same parameters as those for P-metric tires except it utilized a lower test speed of 110 km/h and higher inflation pressures at 285 and 445 kPa for load ranges C and E tires, respectively. For the 30 P-metric tires tested to RMA's endurance test, 2 failed to complete the 100 percent load step (5 percent failure rate). For LT tires, 2 of 32 tires tested failed to complete the 100 percent load step (6 percent failure rate).

The outline of RMA's DOE test matrix, including specific test conditions applied by tire type, as well as a full set of DOE tables, charts, graphs, and data are included as DOE Attachment II to RMA's comments (Docket No. 2000-8011-64).

According to RMA, tires included in the test matrix were selected to cover the appropriate range of technical parameters and to ensure representative

included in the test protocol (4 passenger and 3 light truck). Each tire size was tested for high speed and endurance; a total of 145 tires were tested. Passenger tire sizes tested included: P235/75R15 for economy all-season; P215/70R15 for standard load "broad-line"; P265/75R16 for all-terrain; and, P215/70R15 for snow. The light truck sizes tested included: LT245/75R16 LRE for all-terrain/all-traction; LT235/85R16 LRE for all-season; and, 31 x 10.5 R15 LRC for mud.

high volume in the marketplace. The three "popular" tire sizes chosen by RMA were: (1) P205/65R15, (2) P235/75R15, and (3) LT245/75R16 LRC/LRE. Most of the tires tested by RMA, particularly those used for the confirmation testing, were at the lower end of the speed rating scale, *e.g.* "Q" through "S" and included snow tires, which represent a small percent of sales of replacement tires in the U.S. A brief summary of RMA's DOE conclusions and recommendations are briefly discussed below. RMA's recommendations and comments on the NPRM proposals are summarized in the following section of this document.

In summary, the RMA concluded from the DOE and confirmation test results that:

(1) Speed is the most dominant test parameter. Larger temperature increases are observed when speed is increased compared to changing inflation pressure or load, particularly on a test wheel. According to the DOE, at 80 km/h the average tire temperature is 2° C higher on a 1.7 m test wheel than a flat surface, at 160 km/h the curved surface is 25° C higher.

(2) Passenger car and light truck tires require different test conditions on a test wheel, particularly for speed, to achieve comparable levels of severity. The effect of this curved surface of the 1.7 m test wheel is to increase the tire deflection compared to a flat surface. In addition, the combination of the curvature of the tire and reverse curvature of the test wheel results in the footprint of the tire being altered. The footprint shape is altered in a non-representative manner when compared to a flat surface. This altered deflection and footprint area result in substantially higher stresses. This is demonstrated by the higher tire temperatures on a curved versus flat surface.

(3) The effect of the test wheel curvature increases substantially with speed. Standing waves, which lead to early tire failure, occur at speeds 10 to 20 km/h lower on a curved surface compared to flat. To have a realistic test that can be related to real-world conditions, it is important to properly adjust test conditions on a curved surface to as closely as possible match those of a flat surface.

3. Ford Motor Company (Ford) Tire Aging Analysis

In June 2002, Ford presented its analysis on the effectiveness of the aging protocols proposed by NHTSA for FMVSS No. 139. Ford's presentation was comprised of evaluated results obtained from tire investigations and data analysis from experiments based on