

GTR-Tyres Industry Preliminary Information Sheet

TOPIC: Tyre Endurance/Low Pressure Test

BACKGROUND:

Most national or regional regulatory tests for tyre endurance either follow the US FMVSS 109 test procedure or make certain modifications to inflation pressure, load and/or speed requirements from 109. As a result of the Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act, passed by the United States Congress in November 2000, tyre standards published in Title 49 Code of Federal Regulations Part 571 were revised and updated. This update included a new endurance/low pressure test for passenger tyres which is contained in the new FMVSS 139 tyre test standard. The revised endurance test increases speed from 80 kph (50 mph) on the test roadwheel to 120 kph (75 mph), and adds a low pressure extension to the test to simulate operation with a TPMS system with a minimum activation pressure (MAP) of 140 kPa (20 psi).

The purposes of the 139 endurance/low pressure tests are to simulate severe highway conditions. As a result, the 139 laboratory endurance testing conditions includes: test speed of 120 kph, load up to 100 percent of maximum sidewall, inflation pressure 75% and 58% of maximum, and ambient temperature of 32 to 38°C. In the US, laboratory based performance testing of tyres routinely uses 1.7-metre diameter roadwheels. However, the curved surface of the roadwheel alters tyre behavior and increases heat generation from that observed on a highway or flat surface. Such changes result from:

- smaller contact area for the same load resulting in higher contact pressure,
- higher deflection and more localized bending of the tread region, and
- higher cyclic stress-strain amplitudes as the tyre rotates through the contact area.

These three changes, combined with the absence of cooling airflow, present in highway driving but not in laboratory roadwheel test conditions, results in significantly higher tyre internal temperatures, which can lead to parasitic removal conditions, such as tread chunking, which are not prevalent in the field. For these reasons, winter tyres (with mountain-snowflake designation) are tested at a lower speed (110 kph) and deep tread tyres equal to and greater than 18/32 inch are excluded from this standard.

As a result of the conditions cited above, a scientifically based severity adjustment for evaluating tyre endurance performance assessments on a 1.7 metre roadwheel, may be required. Such an adjustment would more accurately reflect actual tyre performance under customer usage conditions on the highway (flat surface).

On the next page is a table showing the major differences between FMVSS 109 and 139.

ENDURANCE / LOW PRESSURE MAJOR DIFFERENCES		
	FMVSS 109	FMVSS 139
Endurance		
Ambient (°C)	38 ± 3	32 to 38
Inflation (kPa) % Max.		
Passenger	75	75
Light Truck	---	75
Load Schedule % Max.		
Passenger	85/90/100	85/90/100
LT, Load Range C, D	---	85/90/100
LT, Load Range E	---	85/90/100
Time Schedule (Hrs)		
Passenger	4/6/24	4/6/24
Light Truck	---	4/6/24
Speed (kph)		
LT, LR C, D	80	120
LT, LR E	---	120
Low Pressure		
Same conditions as above except:		
Inflation (kPa) (%Max.)	---	58
Load (% Max.)	---	100
Time (Min)	---	90
Speed (kph)	---	120

CURRENT REGULATIONS:

Most nations or regions that require this test use the US FMVSS 109 procedure, although some have introduced variations, as noted on the last page below.

A new US endurance test was introduced in 2003 as part of US FMVSS 139. A low pressure test, to immediately follow the endurance test, is also part of the 139 protocol.

The traditional 109 endurance test remains but is now applicable only to

- bias ply tyres,
- special tyres (ST) for trailers,
- tyres for use on farm implements (FI) in agricultural service with intermittent highway use,
- tyres with rim diameters of 8 inches and below, and
- all T-type temporary use spare tyres (covering both bias and radial constructions).

Below is a review of the US standard 109 endurance test.

S5.4 Tyre endurance.

S5.4.1 Preparation of tyre.

S5.4.1.1 Mount a new tyre on a test rim and inflate it to the applicable pressure specified in Table II.

TABLE II—TEST INFLATION PRESSURES
[Maximum permissible inflation pressure to be used for the following test]

Test type	Tires other than CT tires										CT tires			
	psi				kPa						kPa			
	32	36	40	60	240	280	300	340	350	290	300	350	390	
Physical dimensions, bead unseating, tire strength, and tire endurance	24	28	32	52	180	220	180	220	180	230	270	230	270	
High speed performance	30	34	38	58	220	260	220	260	220	270	310	270	310	

S5.4.1.2 Condition the tyre assembly to $38^{\circ} \pm 3^{\circ} \text{ C}$ ($100^{\circ} \pm 5^{\circ} \text{ F}$) for at least three hours.

S5.4.1.3 Readjust tyre pressure to that specified in S5.4.1.1 immediately before testing.

S5.4.2 Test procedure.

S5.4.2.1 Mount the tyre and wheel assembly on a test axle and press it against a flat-faced steel test wheel 1708 mm (67.23 inches) in diameter and at least as wide as the section width of the tyre to be tested or an approved equivalent test wheel, with the applicable test load specified in the table in S5.4.2.3 for the tyre's size designation, type and maximum permissible inflation pressure.

S5.4.2.2 During the test, the air surrounding the test area shall be $38^{\circ} \pm 3^{\circ} \text{ C}$ ($100^{\circ} \pm 5^{\circ} \text{ F}$)

S5.4.2.3 Conduct the test at 80 kilometers per hour (km/h)(50 miles per hour) in accordance with the following schedule without pressure adjustment or other interruptions: The loads for the following periods are the specified percentage of the maximum load rating marked on the tyre sidewall:

	Percent
4 hours	85
6 hours	90
24 hours	100

S5.4.2.4 immediately after running the tyre the required time, measure its inflation pressure. Allow the tyre to cool for one hour. Then deflate the tyre, remove it from the test rim, and inspect it for the conditions specified in S4.2.2.5 (a).

Below is a review of the US standard 139 endurance/low pressure tests.

USA - FMVSS 139 for new pneumatic radial tyres for light vehicles (motor vehicles –other than motorcycles and low speed vehicles) that have a gross vehicle weight rating (GVWR) of 10,000 pounds (4,536 Kg) or less. (Note: winter tyres, with mountain snowflake designation, are tested at 110 kph, and tyres with tread depth equal to or greater than 18/23 are excluded from this test.)

S6.3.1 Test Conditions and Procedures

S6.3.1.1 Preparation of Tyre.

S6.3.1.1.1 Mount the tyre on a test rim and inflate it to the pressure specified for the tyre in the following table:

Tyre Application	Test Pressure (kPa)
Passenger Car Tyres	
Standard load	180
Extra load	220
Light Truck Tyres	
Load Range C	260
Load Range D	340
Load Range E	410
Light Truck Tyres with a nominal cross section 295 mm (11.5 inches)	
Load Range C	190
Load Range D	260
Load Range E	340

S6.3.1.1.2 Condition the assembly at 32 to 38° C for not less than three hours,

S6.3.1.1.3 Readjust the pressure to the value specified in S6.3.1.1.1 immediately before testing.

S6.3.1.2.1 Mount the assembly on a test axle and press it against the outer face of a smooth wheel having a diameter of 1.70 m +/- 1%.

S6.3.1.2.2 During the test, the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tyre, is maintained at not less than 32° C or more than 38° C.

S6.3.1.2.3 Conduct the test, without interruptions, at the test speed of not less than 120 km/h with loads and test periods not less than those shown in the following table. For snow tyres, conduct the test at not less than 110 km/h.

Test period	Duration (hours)	Load as a percentage of tire maximum load rating
1	4	85%
2	6	90
3	24	100

S6.3.1.2.4 Throughout the test, the inflation pressure is not corrected and the test loads are maintained at the value corresponding to each test period, as shown in the table in S6.3.1.2.3

S6.3.1.2.5 Allow the tyre to cool for between 15 minutes and 25 minutes after running the tyre for the time specified in the table in S6.3.1.2.3, measure its inflation pressure. Inspect the tyre externally on the test rim for the conditions specified in S6.3.2(a).

S6.3.2 Performance requirements. When the tyre is tested in accordance with S6.3.1:

(a) There shall be no visual evidence of tread, sidewall, ply, cord, belt or bead separation, chunking, open splices, cracking or broken cords.

(b) The tyre pressure, when measured at any time between 15 minutes and 25 minutes after the end of the test, shall not be less than 95% of the initial pressure specified in S6.3.1. 1. 1.

S6.4 Low Inflation Pressure Performance

S6.4.1 Test conditions and procedures.

S6.4.1.1 Preparation of tyre.

S6.4.1.1.1 This test is conducted following completion of the tyre endurance test using the same tyre and rim assembly tested in accordance with S6.3 with the tyre deflated to the following appropriate pressure:

Tyre Application	Test Pressure (kPa)
Passenger Car Tyres	
Standard load	140
Extra load	160
Light Truck Tyres	
Load Range C	200
Load Range D	260
Load Range E	320
Light Truck Tyres with a nominal cross section 295 mm (11.5 inches)	
Load Range C	150
Load Range D	200
Load Range E	260

S6.4.1.1.2 Condition the assembly at 32 to 38° C for not less than 2 hours.

S6.4.1.1.3 Before or after mounting the assembly on a test axle, readjust the tyre pressure to that specified in S6.4.1.1.1

S6.4.1.2 Test procedure.

S6.4.1.2.1 The test is conducted for ninety minutes at the end of the test specified in S6.3, continuous and uninterrupted, at a speed of 120 km/h (75 mph). For snow tyres, conduct the test at not less than 110 km/h.

S6.4.1.2.2 Press the assembly against the outer face of a test drum with a diameter of 1.70 m + 1%.

S6.4.1.2.3 Apply to the test axle a load equal to 100% of the tyre's maximum load carrying capacity.

S6.4.1.2.4 Throughout the test, the inflation pressure is not corrected and the test load is maintained at the initial level.

S6.4.1.2.5 During the test, the ambient temperature, at a distance of not less than 150 mm and not more than 1 m from the tyre, is maintained at not less than 32° C or more than 38° C.

S6.4.1.2.6 Allow the tyre to cool for between 15 minutes and 25 minutes. Measure its inflation pressure. Then, deflate the tyre, remove it from the test rim, and inspect it for the conditions specified in S6.4.2 (a).

S6.4.2 Performance requirements. When the tyre is tested in accordance with S6.4.1:

(a) There shall be no visual evidence of tread, sidewall, ply, cord, innerliner, belt or bead separation, chunking, open splices, cracking, or broken cords, and

(b) The tyre pressure, when measured at any time between 15 minutes and 25 minutes after the end of the test, shall not be less than 95% of the initial pressure specified in S6.4.1.1.1.

Tyre Endurance Test Grouping

