GTR-Tyres Industry Preliminary Information Sheet

TOPIC: Plunger Energy (Tyre Strength)

BACKGROUND:

This test was implemented as a regulation for bias ply tyres. The current US DOT test procedure is the basis for most world-wide plunger energy test procedures. The procedure specifies a rounded plunger to be forced into the center area of the tread of an inflated tyre, measuring the energy required to either penetrate the carcass or contact the rim surface (commonly referred to as a "bottom out").

The tyre industry does not believe that this type of test is applicable to radial ply tyres. In the course of the Government-Industry effort on global harmonization known as GTS 2000 (work conducted from 1997-2000), participating members were in general agreement that plunger energy would not be required for radial ply tyres. The plunger energy test would continue to be required for bias ply tyres.

Although the industry believes that this test is not appropriate for today's radial ply tyres, it is difficult to prove this premise. In any region where such a test is required by regulation (USA, Australia, and India for example) one cannot argue that this test adds any value, because all tyres must comply with the requirement to be used or sold within the region. The regions would not be able to estimate how the test requirement adds value, as they would not have data on tyres that do not comply with this test requirement. Similarly, the expressed concern that a preponderance of unimproved roads is justification for a plunger energy test requirement may not be a valid argument. Unimproved roads can be found in regions that both do and do not have a plunger energy regulation.

Additionally, the current test procedures which specify a plunger penetration rate of 2" per minute is not at all representative of actual tyre impacts and envelopment. The current family of plunger energy tests is not applicable. During the early efforts by NHTSA to upgrade FMVSS 109, the Agency considered several alternatives to the current (static) test. Specifically, a wheel durability pendulum impact test was considered as being more representative to the real world impact situation. This real world, dynamic (although not rotating) test did not show promise as offering any additional value to a tyre regulation.

Conversely, we may be able to gain insight as to the validity of this type of test in those regions where the test is not required by regulation. Such regions would be those that use only ECE Reg 30. The industry should consider issuing a request to Regulating bodies in such regions as to their historical experience with plunger energy related issues. If such regions have no known issues of carcass penetrations for radial ply tyres (through the tread area), this may suggest that adding this test requirement to the GTR may not add any value for radial ply tyres.

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.

In the US, the plunger energy test requirement applies to all passenger and light truck tyres, including radial and bias constructions. Test specifics such as plunger diameter and required energy value vary with tyre size-type. The rate of penetration of the plunger is 2 inches per minute. Some regions consider that a “bottom-out’ test result is considered to meet regulatory requirements.

Below is a review of the US standard.

USA - FMVSS 109 for passenger car tyres

S4.2.2.4 Tyre Strength – Each tyre shall meet the requirements for minimum breaking energy specified in the Table I below, when tested as follows:

S5.3 Tyre Strength

S5.3.1 Preparation of tyre

S5.3.1.1 Mount the tyre on a test rim and inflate it to the applicable pressure specified in Table II.

S5.3.1.2 Condition it at room temperature for at least 3 hours; and readjust its pressure to that specified in S5.3.1.1

S5.3.2 Test Procedure

S5.3.2.1 Force a 19 mm diameter cylindrical steel plunger with a hemispherical end perpendicularly into the tread rib as near to the centerline as possible, avoiding penetration into the tread rib as near to the centerline as possible, at the rate of 50 mm per minute.

S5.3.2.2 Record the force and penetration at five test points equally spaced around the circumference of the tyre. If the tyre fails to break before the plunger is stopped by reaching the rim, record the force and penetration as the rim is reached and use these values in S5.3.2.3

S5.3.2.3 Compute the breaking energy for each test point by means of one of the two following formulas: W=Energy, in joules; F=Force, Newtons; and P=Penetration, mm; or W=[(FxP)/2] Where W=Energy, inch-pounds; F=Force, pounds; and P=Penetration, inches.

S5.3.2.4 Determine the breaking energy value for the tyre by computing the average of the five values obtained in accordance with S5.3.2.3.

TABLE I-A—FOR BIAS PLY TIRES WITH DESIGNATED SECTION WIDTH OF 152 MM (6 INCHES) AND ABOVE

Cord material	32 psi	36 psi	40 psi	240 kPa	280 kPa	300 kPa	340 kPa
Rayon:							
(in-lbs)	1,650	2,574	3,300	1,650	3,300	1,650	3,300
(joules)	186	291	373	186	373	186	373
Nylon or polyester:							
(in-lbs)	2,600	3,900	5,200	2,600	5,200	2,600	5,200
(joules)	294	441	588	294	588	294	588

TABLE I-B—FOR BIAS PLY TIRES WITH DESIGNATED SECTION WIDTH BELOW 152 MM (6 INCHES)

Cord material	32 psi	36 psi	40 psi	240 kPa	280 kPa	300 kPa	340 kPA
Rayon:							
(in-lbs)	1,000	1,875	2,500	1,000	2,500	1,000	2,500
(joules)	113	212	282	113	282	113	282
Nylon or polyester:							
(in-lbs)	1,950	2,925	3,900	1,950	3,900	1,950	3,900
(joules)	220	330	441	220	441	220	441

TABLE I-C—FOR RADIAL PLY TIRES

Size designation	Maximum permissible inflation											
	Tires other than CT tires								CT tires			
	psi			kPa					kPa			
	32	36	40	240	280	300	340	350	290	330	350	390
Below 160 mm:												
(in-lbs)	1,950	2,925	3,900	1,950	3,900	1,950	3,900	1,950	1,950	3,900	1,950	3,900
(joules)	220	330	441	220	441	220	441	220	220	441	220	441
160 mm or above:												
(in-lbs)	2,600	3,900	5,200	2,600	5,200	2,600	5,200	2,600	2,600	5,200	2,600	5,200
(joules)	294	441	588	294	588	294	588	294	294	588	294	588

TABLE I-D—FOR TIRES WITH 420 KPA (60 PSI) MAXIMUM PERMISSIBLE INFLATION PRESSURE AND MAXIMUM LOAD RATING 399 KG (880 LB) AND ABOVE

Cord material	Inch-pounds joules (J)
Rayon	1,650 inch pounds 186 joules (J).
Nylon or Polyester	2,600 inch pounds 294 joules (J).

TABLE I-E—FOR TIRES WITH 420 KPA (60 PSI) MAXIMUM PERMISSIBLE INFLATION PRESSURE AND MAXIMUM LOAD RATING BELOW 399 KG (880 LB)

Cord material	Inch-pounds joules (J)
Rayon	1,000 inch pounds 113 joules (J).

TABLE I-E—FOR TIRES WITH 420 KPA (60 PSI) MAXIMUM PERMISSIBLE INFLATION PRESSURE AND MAXIMUM LOAD RATING BELOW 399 KG (880 LB)—Continued

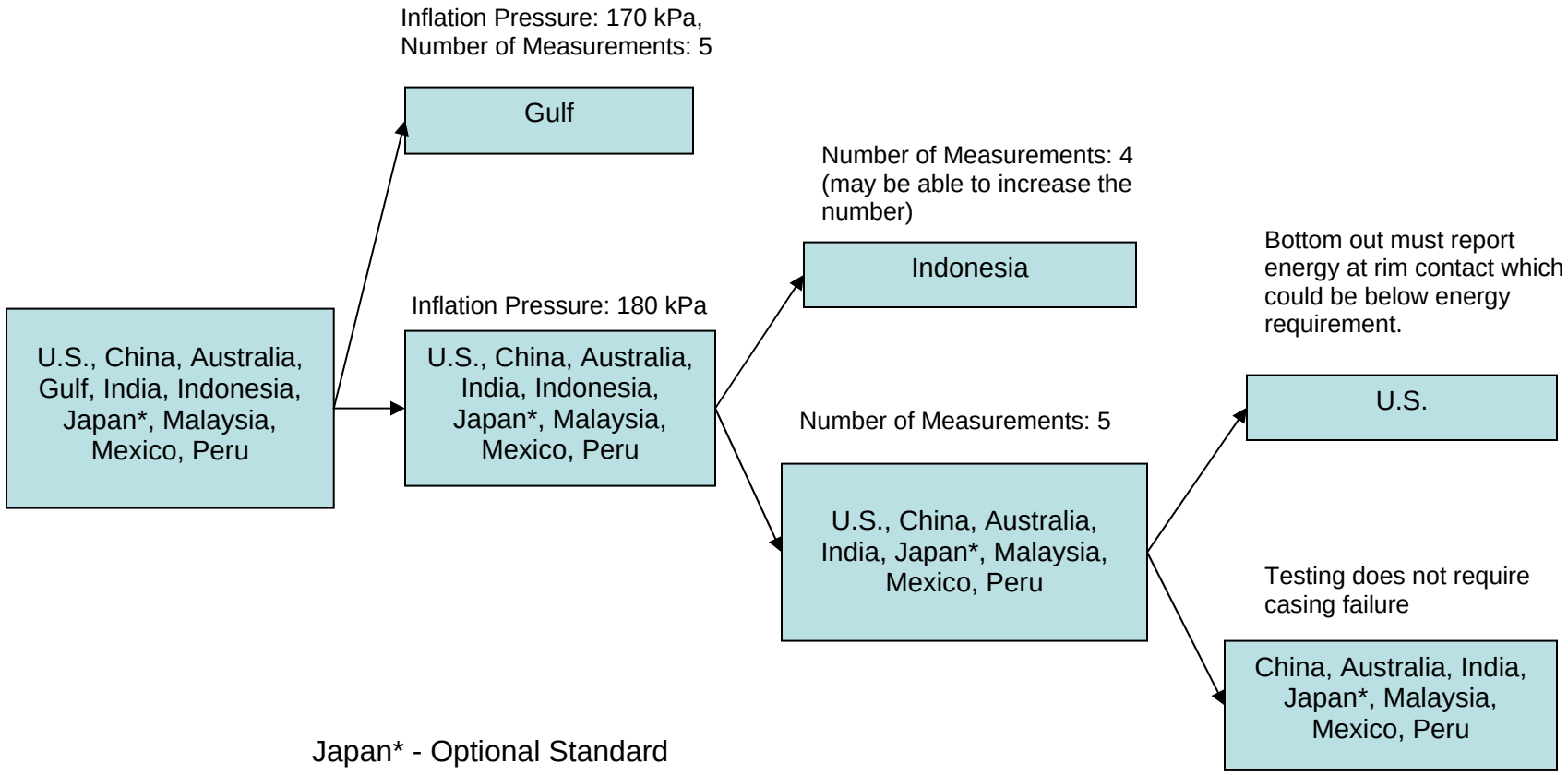
Cord material	Inch-pounds joules (J)
Nylon or Polyester	1,950 inch pounds 220 joules (J).

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

Tyre Strength Procedure Grouping for mandatory and optional testing, with notable variations in inflation pressure, number of measurements, and end of test requirements



Japan* - Optional Standard