SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J1015 | REV. MAR91

Issued 1974-03
Revised 1991-03-14

Superseding J1015 DEC83

Submitted for recognition as an American National Standard

(R) TON KILOMETER PER HOUR TEST PROCEDURE

1. SCOPE:

This SAE Standard establishes the Ton Kilometer Per Hour Test Procedure for off-the-road tires. This document is applicable to only those tires used on earthmoving machines as defined in SAE J1057 JUN81, and certain machines referenced in SAE J1116 JUN86.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1057 JUN81 Identification Terminology of Earthmoving Machines
SAE J1098 MAR91 Ton Mile Per Hour Application Practice
SAE J1116 JUN81 Categories of Off-Road, Self-Propelled Work Machines

2.1.2 Tire & Rim Association Publications: Available from The Tire & Rim Association Inc., 175 Montrose West Avenue, Suite 150, Copley, OH 44321.

Tire & Rim Association Yearbook

3. APPLICATION:

The Ton Kilometer Per Hour (TKPH) rating is one of several factors for evaluating the performance capability of off-the-road tires. The TKPH rating is a measure of work per unit time, and as such is intended to supplement information published by tire industry standards associations and manufacturers.

Printed in U.S.A.
90-1202 GM

3.1 The TKPH test was developed using Tire & Rim Association (TRA) standards (Section 3, Off-the-Road, TRA Yearbook) and reference is made to these specifications throughout this procedure.

3.2 The test procedure is also applicable to tire and rim developments approved by the tire and rim manufacturers, although not published in the TRA Yearbook (see Section 8).

3.3 This test procedure does not define how the TKPH rating is applied in evaluating specific applications to machines or their performance. (Refer to SAE Standard J1098 MAR91 for application practice.)

4. FACILITIES:

4.1 Test Machines:

The tires are to be mounted on a suitable machine with a rim as specified in the TRA Yearbook. The test tires should be singles located on a drive (nonsteered) or trail axle. Care must be exercised to eliminate any camber or toe-in of the wheels to prevent nonuniform loading (see 3.2).

4.2 Test Course:

The test course shall be any dry, flat, highly compacted material, or paved road, laid out in a closed loop configuration. The course length and arrangement should be such that tire loading will not be significantly affected by weight transfer due to turns and super-elevations. The intent is to operate the tire with a known constant load. Provision for a turnaround should be made to reverse the direction of travel. TKPH measurements must be run only on a dry test course, as moisture will influence tire temperatures.

4.3 Instrumentation:

4.3.1 Temperature Measurement System: The system shall be capable of measuring tire test temperatures with an accuracy of ±1 °C.

4.3.2 Thermocouple Probe Assembly: An instrument as described in Figure 1 is required to provide the functions of holding, guiding, and inserting the thermocouple; and a handle with connection to the reading or recording device.

4.3.3 Pressure Instrument: An instrument capable of measuring tire inflation pressure to an accuracy of ±6.9 kPa.

4.3.4 Weight Scale: A weight scale with an accuracy of 2%.

4.3.5 Timing Device: A standard stopwatch or stopclock capable of measuring 60 min or more, with graduations of 0.01 min.

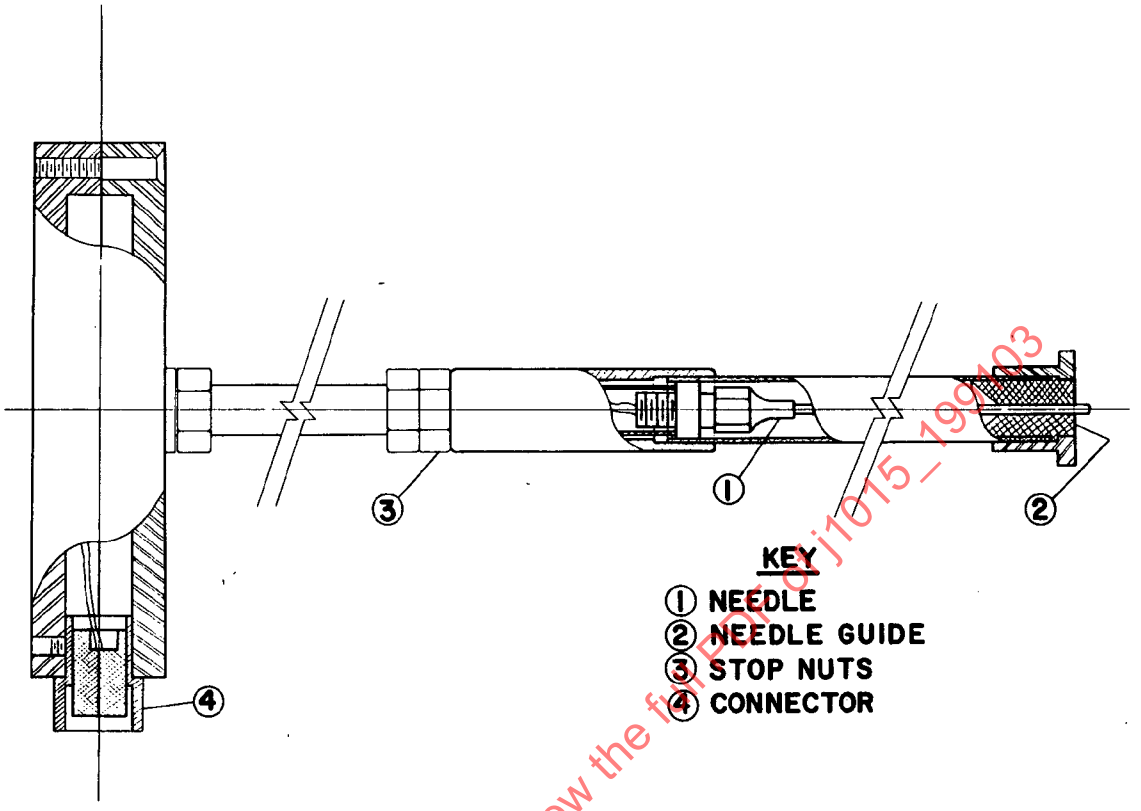

FIGURE 1 - Thermocouple Needle and Holder

5. PREPARATION FOR TESTS:

5.1 Tires:

Tires must be prepared for thermocouple probes by drilling 3 mm diameter holes from the tread surface to the top of the topmost reinforcement; i.e., breaker cord, belt cord, or carcass ply. These holes, drilled normal or perpendicular to the tread surface, must be located across the tread in such a pattern that one or more will be within 25 mm or less of the hottest point in the tire. To insure this, the following procedure is recommended.

5.1.1 Drill Hole Location:

5.1.1.1 With a caliper, measure the total tire thickness of each tread element around the tire at the centerline and shoulder. Determine the area around the circumference with the greatest total thickness.

5.1.1.2 Select a tread bar or contiguous tread element in this heavy gauge area as the probe location.

5.1.1.3 For tires of 16.00 cross section and smaller, locate holes in the center of the cross lug or contiguous tread element and at maximum increments of 25 mm from the tire centerline to each shoulder. For larger tires, locate holes at 50 mm increments.

5.1.1.4 Continuous rib design tires will require holes in the center of each rib. Ribs wider than 76 mm will require additional holes 25 mm either side of the center, but not closer than 12.5 mm from the rib edge.

5.1.1.5 Mark off increments as described in 5.1.1.3 and 5.1.1.4 across the crown of the tire.

5.1.2 Drill Hole Depth Determination:

5.1.2.1 Depth of the drilled holes should be such that the bottom of the hole is within 2.5 mm of the top of the highest reinforcement cord, but not into or through this cord.

5.1.2.2 If the carcass thickness is known, measure the total tire thickness at the location determined in 5.1.1.3 and subtract the known carcass thickness from this measurement; the drill depth should be 2.5 mm less than the difference.

5.1.2.3 If the total thickness is not known, then the drill depth can be determined by drilling test core holes.

5.1.2.3.1 Make core drillings not to exceed 6 mm diameter at the prescribed intervals (see 5.1.1.3 and 5.1.1.4) from the centerline to both shoulders on a tread element immediately adjacent to the intended probe location. On rib design tires, the cored hole must not be within 50 mm of the drill location. Cores should be drilled normal or perpendicular to the tread surface. Core drilling depths should not extend beyond breaker or belt plies into body plies or ply. In the case of steelcord construction tires, core drilling should not go deeper than when initial contact with the steelcord belt/breaker plies occurs.

5.1.2.3.2 Measure the reinforcement (carcass material) thickness on the plugs removed from the cored holes and subtract from the depth of the cored hole. This measurement less 2.5 mm determines the probe depth for that location.

5.2 Inflation:

New tires are to be inflated for 24 h prior to the first test. Test tires should be inflated to the TRA Yearbook pressure for the subject ply rating or load range.

5.3 Break-In:

New test tires are to be run for between 130 and 160 km at a load and speed combination estimated to produce an actual stable temperature within the limits listed below:

5.3.1 Bias ply (textile) tires, 87 to 107 °C.

5.3.2 Radial ply (steelcord) tires, 71 to 93 °C.

6. TEST PROCEDURE:

6.1 Test Conditions:

6.1.1 Selecting Test Load: The test load is determined by selecting a load of 85% of the TRA yearbook 48 km/h capacity table for both test tires. The load must be measured for each tire within 2% of the selected test load. This load will be used throughout the test.

6.1.2 Setting of Test Inflation Pressures: Immediately prior to the test, inflation pressures are to be adjusted with the tires at ambient conditions and the pressure corrected to a 15.6 °C standard. (See 5.2.)

6.1.3 Selection of Test Speeds: Three speeds are selected. These three speeds when multiplied by the test load (6.1.1) will generate three corresponding TKPH values to be used in TKPH determination.

6.1.3.1 Definition of Speed: Speed is an average speed calculated by using the total distance traveled divided by the total time from the initial machine start to the final stop.

6.1.3.2 Method of Speed Selection: Three average speeds are selected which will each produce level off tire temperatures in the approximate ranges shown in Table 1.

TABLE 1 - Level Off Tire Temperatures

Tire Type	Approximate Temperature Normalized for Ambient °C
Textile	93
	107
	121
Steelcord	79
	93
	107

6.2 Test Cycle:

The test cycle consists of running at a constant speed for approximately 60 min or 24.1 km and a fixed stop-period of minimum duration (not to exceed 10 min). The travel times or distances may be varied slightly to permit even laps around the course between stops. Once the speed or travel time of the cycle has been established, it must be accurately controlled within ±1%.

6.3 Measurement and Recording of Data:

6.3.1 Recommended Data Form (see Figure 2):

6.3.2 Tire temperatures are measured in the predrilled probe holes with instrumentation per 4.3.1 and 4.3.2. Temperatures should be taken as quickly as possible at the beginning of the stop-period. A specific measurement sequence should be maintained throughout the test. Measurements should be taken with the thermocouple probe within 1.3 mm of the bottom of the probe hole. With each temperature recorded, record the elapsed time from the beginning of the stop-period.

6.3.2.1 Hot Area Measurement: It will not be necessary to probe each drilled hole after a sufficient number of readings have been obtained to determine the area of the hot spots on either side of the centerline. After this area has been established, continue to record the hot point in each area and each point adjacent to make certain that the hottest points are being measured.

6.3.2.2 Cooling Rate Measurement: At the completion of the last probe measurement (hottest test condition), when the level-off condition (see 6.4) has been reached, each probe hole should again be measured in the same sequence as followed in the test (6.3.2), recording the continuing time lapse from stop for each probe measurement, in the same manner as has been done throughout the test. With the timing device continuing to record the time after the final stop, a third set of probe hole temperature data should be taken with its appropriate stop times, approximately 15 min after the previous readings. This procedure should continue for several more 15 min intervals until sufficient data are obtained to plot a uniform descending rate temperature versus time curve.

6.3.3 Ambient temperature should be recorded at the beginning of the timed test and 30 min before each stop-period. These data are to be used for normalizing the tire temperatures to 38 °C.

6.3.3.1 Minimum Ambient Limit for Valid Test: The test should not be run if the ambient is less than 10 °C.

6.4 Test Duration:

Temperature data are to be recorded at each stop-period until the level-off condition for each tire has been reached. The level-off condition is defined as when the variation in hot spot (see Section 7) temperature corrected to 38 °C does not increase more than 2.8 °C total for three successive stop-periods.

TKPH DATA

TEST NO._____ PAGE _____ OF _____ DATA BY _____ DATE _____
TIRE BRAND_____ SIZE _____ TYPE _____ PR _____
POSITION: (DRIVE OR TRAIL)
LEFT (_____) LOAD _____ kg SERIAL _____
RIGHT (_____) LOAD _____ kg SERIAL _____

TEST PLAN: GEAR _____ CYCLE TIME _____ Min TRAVEL SPEED _____

Probe Location		Meas. Temp.	Time After Stop	Meas. Temp.	Time After Stop	Meas. Temp.	Time After Stop	Meas. Temp.	Time After Stop	Remarks
LEFT TIRE C/L TEMP. ℃	OUTSIDE									
	C/L									
	INSIDE									
RIGHT TIRE C/L TEMP. ℃	OUTSIDE									
	C/L									
	INSIDE									

START TIME
STOP TIME
TRIP DIST.
TOTAL KILOMETERS
AMBIENT START ℃
30 MIN. PRIOR STOP ℃
TIRE kPa
(L) Start _____
(R) Start _____

TIRE TEMPERATURE:
(L) HOT SPOT ACT.
(R) HOT SPOT ACT.
ACT. AMB. CORR. ±
(L) CORRECTED
(R) CORRECTED

SUMMARY:
TOTAL DIST. _____ km TOTAL TIME _____ AVERAGE SPEED _____ TKPH _____
LEVEL-OFF TEMPERATURES:
LEFT: ACTUAL _____ ℃ AMB. CORR. _____ ℃
RIGHT: ACTUAL _____ ℃ AMB. CORR. _____ ℃

FIGURE 2 - Data Form

7. DATA REDUCTION AND ANALYSIS:

7.1 Temperature Correction for Time Lapse During Probe Measurements:

See 6.3.2.2. An additive correction shall be applied to each probe measurement based on the time lapse after stop. The amount of the correction is determined at the completion of the test, using the cooling curve established at that time.

7.1.1 Cool Curve: The cooling curve is plotted from data obtained as described in 6.3.2.2. The curve is not normalized for the ambient because the cooling rate correction is applied directly to the recorded data.

7.2 Ambient Temperature Normalization:

The highest temperature recorded (hot spot) on each tire during each stop is to be normalized to 38 °C by the following procedure:

a. If the ambient temperature recorded 30 min prior to tire temperature is less than 38 °C, add 60% of the difference to this highest temperature reading. That is,

$$0.60\ (38\ ^{\circ}C - amb)$$

b. If the ambient temperature is greater than 38 °C subtract 60% of the difference. That is,

$$0.60\ (amb - 38\ ^{\circ}C)$$

These normalized values are used to determine TKPH.

7.3 TKPH Determination:

The normalized level-off temperatures for the three conditions (6.1.3.2) are plotted on coordinate paper against the appropriate TKPH level at which they were generated (see 6.1.3). Data from both test tires are to be plotted for averaging purposes (see Figure 3).

The rating temperature (T°) is the temperature (given the state of technological development) which the tire can sustain with reliability. This temperature (T°) is separately determined by the individual tire manufacturers. The TKPH value for each of the test tires is read at the T° as established and published by the testing agency. The average of the test sample (minimum of two tires) is to be used as the rating. If temperature difference between test sample tires at the rating temperature exceeds 5.6 °C, the test is not considered valid and the sample size should be increased.

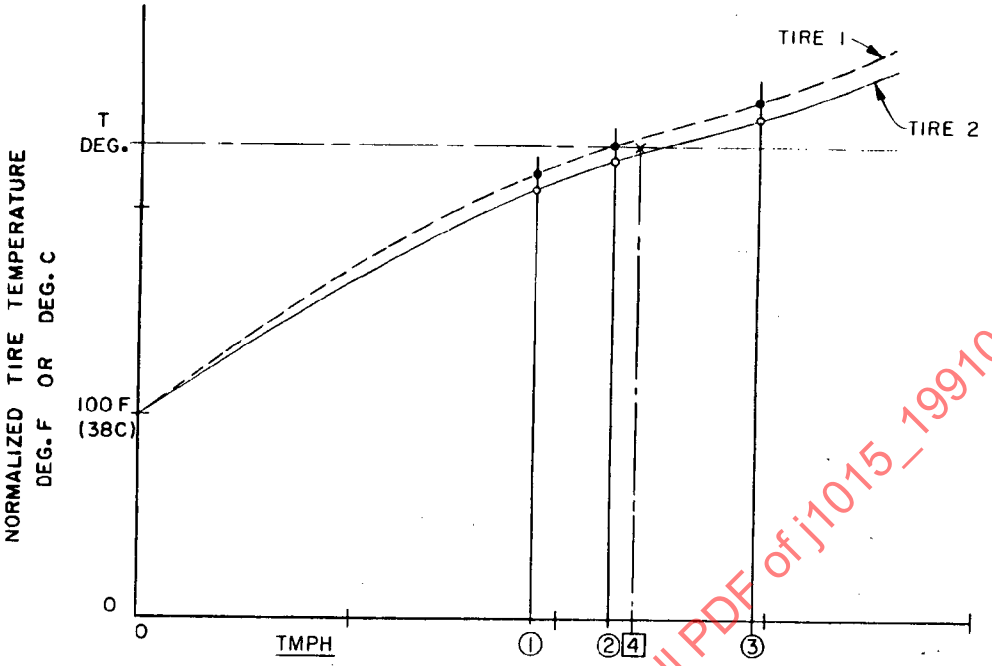

FIGURE 3 - Data Plot

8. TKPH RATING:

8.1 The value determined in 7.3, having followed the test procedure without exception and expressed with TRA size and TRA-SAE type code, shall be the TKPH rating.

8.2 Where: (a) other TRA standards for tire size, rim, inflation, and load (48 km/h maximum speed table) are used in the test, (b) a descriptive tire code does not exist, or (c) TRA supplementary service specifications are used rather than standard; the TKPH rating shall have a complete explanatory note which provides the specific description and conditions that are in variance with the test procedures.

9. NOTES:

9.1 Marginal Indicia:

The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

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