



Tire Modeling Tests for Virtual Tire Development using Flat-Trac Equipment

1 Introduction

Note: Nothing in this standard supersedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard is written to describe, in general terms, all tests required for virtual tire development input for Tire Suppliers, as specifically run on the Flat-Trac equipment (i.e., Light Truck Race Electric (LTRe), CT+, Flat Trac equipment designation available from MTS Systems Corporation, or equivalent model). The data generated by this test is used to create virtual COMPTIRE and SWIFT models for vehicle simulations of ride and handling performance and light truck tires.

1.2 Applicability. This test procedure is restricted to controlled laboratory tests on passenger and light truck tires.

1.3 Remarks.

1.3.1 The tire Force and Moment (F&M), dynamic cleat, other properties, addressed in this test, are important to various vehicle simulation groups, since these tire properties will dictate, to a great extent, the vehicle's response to specific control inputs.

1.3.2 When the capability is demonstrated, some, or all, of the required tire performance data can be created with math modeling instead of physical testing.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

SAE J670

2.2 GM Standards/Specifications.

GMW17359

GMW17360

GMW16590

2.3 Additional References.

- European Tire and Rim Technical Organization (ETRTO) Yearbook
- MTS Systems Corporation, Eden Prairie, Minnesota (www.mts.com)
- Rubber Manufacturer's Association
- Sourcing Documents
- Tire and Rim Association (T&RA) Yearbook
- Tyre Data Exchange Format (TYDEX)-Format Reference Manual, Release 1.3

3 Resources

3.1 Facilities. A facility equipped with MTS LTRe, CT+, Flat Trac equipment, or equivalent.

3.2 Equipment. The equipment used to measure F&M tire properties is a dynamic version of the MTS Flat-Trac, or equivalent (available through MTS Systems Corporation based in Eden Prairie, Minnesota).

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3.3 Test Vehicle/Test Piece.

3.3.1 Tire Test Specimen. The new tires must be free of all tags, tape, or other foreign material in the tread area.

3.3.2 Test Wheel.

3.3.2.1 The wheel must be selected properly to facilitate correct test results.

3.3.2.2 The wheel must be of the correct diameter.

3.3.2.3 The tire width must match that requested on the test request.

3.3.2.4 Tire rim flange contour must be approved by the appropriate standardizing body (e.g., European Tyre and Rim Technical Organisation (ETRTO) or equivalent.)

3.3.3 Test Surface. The flat test surface must be free of foreign material including, but not limited to, oils, rubber dust, and other deposits from previous usage. The flat surface abrasive material is 120-grit 3M-ite. The surface macro texture is reduced prior to the initial use, requiring eight (8) passes of the stoning roller over the surface before use, or equivalent.

3.3.4 Sample Size. Four (4) tires are required, three test tires and a spare.

3.4 Test Time.

Calendar time: 1 d

Test time: 6 h

Coordination time: 2 h

3.5 Test Required Information. All necessary information is provided through a completed Tire Test Request within the Global Tire-Wheel Test System (GTWTS). For the user's convenience, a partial list of critical information required to complete the Tire Test Request is provided in 3.5.1 for the tire and the test conditions.

3.5.1 Test Tire.

- Tire Size (be specific, prefix and suffix letters are important).
- Service Description (e.g., 98H, 120/124R).
- Construction Number (contact integration engineer, tire development engineer, or GM Design Release Engineer (DRE)).
- Load Rating (e.g., SL, XL, LL, C, D, E).
- Supplier (Tire Manufacturer).

3.5.2 Test Conditions.

3.5.2.1 Inflation Pressure. The inflation pressure will be the warm operating inflation pressure for the intended application vehicle. This will typically be 20 kPa above the placard pressure for passenger car tires and 35 kPa above placard for light truck or commercial tires. The test will generate data at multiple inflation pressure points based off of the inflation pressure given on the Tire Test Request. For split pressure placards, multiple tests are required, one corresponding to each placard pressure.

3.5.2.2 Nominal Load. Refer to GMW17359 (CompTire) and GMW 17360 (SWIFT) for vehicle load conditions.

3.6 Personnel/Skills.

3.6.1 Test operators must be trained in the safe operation of the measurement equipment. The measurement equipment, by necessity, involves moving parts and loading mechanisms which must be understood and operated using proper safety precautions.

3.6.2 Operators must be trained in the selection of test components and fixtures to facilitate the proper testing of the tires.

3.6.3 Operators must be trained to observe and correct, when necessary, the test surface condition. The surface condition and contamination level directly impact the quality of the test results.

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4 Procedure

4.1 Preparation.

4.1.1 Prior to test, store the tires in a staging area with the ambient temperature within $\pm 5^\circ\text{C}$ of the test room temperature for at least 24 h prior to testing.

4.1.2 Inspect the tire bead and the bead seat of the wheel to ensure this interface is free of damage, defects, and foreign material. Clean or replace test pieces as necessary.

4.1.3 Use only a thin film of an approved mounting lubricant to facilitate proper tire mounting and bead seating. Excessive mounting lubricant can cause slippage at the tire and rim interface during testing.

4.1.4 Inspect the bead area of the mounted tire and wheel assembly to ensure the tire bead is firmly seated on the wheel.

4.1.5 Inflate the tire and wheel assembly 30 kPa above the required test inflation pressure and allow the tire to stabilize at room temperature prior to testing while the previous tire is being tested.

4.1.6 Using a paint pen or similar instrument, place an arrow on the sidewall of the tire pointing at the location of the valve stem of the wheel. The relative location of this mark to the valve stem is to be noted during posttest.

4.2 Conditions.

4.2.1 Environmental Conditions. The ambient temperature in the room where the measurement equipment is operating shall be controlled to $21^\circ\text{C} \pm 3^\circ\text{C}$ to minimize the thermal gradients within the test equipment and instrumentation.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc. The determination of the test conditions is discussed in 3.5.

4.2.3 Test Sequencing.

4.2.3.1 Tire Warmup. Each tire used will be conditioned prior to testing using the appropriate tire warmup sequence, defined in GMW17359, based on the tire type and intended vehicle application.

4.2.3.1.1 In general, the tire type will select the magnitude of the maximum slip angle excursions executed during the sequence. This maximum slip angle is targeted to be approximately 75% of the slip angle at which the tire achieves peak lateral force at the nominal test load. For the purpose of choosing the warmup sequence, the tire types are passenger car, performance tires, and tires used on light trucks. Passenger car tires are those used on passenger car vehicles with a speed rating of V (240 km/h (149 mph)) or lower. Performance tires are those tires used on passenger car vehicles with a speed rating of W (270 km/h (168 mph)) or higher, including Z rated tires. Tires used on light trucks can include both passenger car tires and light truck or commercial tires. The distinguishing factor is their intended application on light truck vehicles.

4.2.3.2 Following the tire warmup sequence each of the four (4) test tires will be tested with a series from one (1) to three (3) specific test sequences, as defined further in GMW17359. The test sequences for each of the test tires are designed to solicit tire responses to specific inputs to the tire, while managing the overall state of the tire to the extent possible (e.g., tire temperature, tread temperature, and tread wear).

4.2.3.3 There are three (3) different test sequences depending on the tire type being tested (see Tables 2 through 4). The test sequence can be chosen from Table 1.

Table 1: List of Tests Performed for Virtual Tire Modeling by Tire Type

Test Tire Type	Test Sequence Location
Passenger Car Tires, Speed Symbol V or Lower	Table 2
Performance Tires, Speed Symbol W or Greater	Table 3
Tires for Use on Light Truck Vehicles	Table 4

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