Winter Tire Traction
Test Methods and Requirements

Smithers Rapra
Dean R Tener
Latest Developments: Winter Tires Required in Quebec

Section 440.1 of the Quebec Highway Safety Code stipulates as follows:

“Between 15 December and 15 March, the owner of a taxi or a passenger vehicle registered in Québec may not put the vehicle into operation unless it is equipped with tires specifically designed for winter driving …”

The Regulation also stipulates that, as of December 15, 2014:

“… tires specifically designed for winter driving will be exclusively those on which the symbol representing a mountain with a superimposed snowflake appears.”
History of Snow Driving Traction Testing
History of Snow Driving Traction Testing

1970s
First self-contained driving traction trucks
1974
CTI (now Smithers Rapra) creates the snow penetrometer
1979
GM adds a TPC snow traction requirement for tire suppliers

1980s
1985
SAE J1466 published;
First snow monitoring tire (Uniroyal Steeler P195/75R14 TPC1024)

1986
ASTM E1136 defines the SRTT;
RMA Snow tire spec. (M+S) is published

1990s
1991
Steeler production discontinued

1997
ASTM F1805 published using SRTT

1999
RMA publishes “Mountain Snowflake” spec.

2000s
2007
FMVSS 139 includes “Mountain Snowflake”

2008
ETRTO publishes snow braking test with F1805 equivalence

2010s
2011
UNECE R117 Rev 2 adds a snow traction requirement

2012
R117 Rev 2 Amend 1 adds a C3 driving test with truck snowflake
How the Mountain Snowflake Became Law

- Canadian government wants performance based snow tire definition
- RMA TISB 37/1 defines the Severe Snow Use Symbol (Mountain Snowflake)
- NHTSA incorporates the Mountain Snowflake into FMVSS 139
- ETRTO defines a snow braking test and specifies F1805 equivalence
- ECE incorporates the Mountain Snowflake into R117
- Work on ISO draft standard 18106 continues
The Mountain Snowflake and the EU

REGULATION (EC) No 661/2009 OF THE EUROPEAN PARLIAMENT says:

(8) … the Commission should be empowered to establish the specific procedures, tests and requirements … to define more precisely the characteristics a tyre must fulfil to be defined as … ‘snow tyre’…

(22) It is appropriate to establish allowances with regard to some of the rolling resistance or rolling noise limit values for certain specific categories of tyres to take into account their design or performance characteristics. In particular, it is appropriate to establish such allowances for tyres designed to have improved traction and braking performance in severe snow conditions.

11. ‘snow tyre’ means a tyre whose tread pattern, tread compound or structure is primarily designed to achieve in snow conditions a performance better than that of a normal tyre with regard to its ability to initiate or maintain vehicle motion;

The Commission shall adopt the following implementing measures:

(c) a more precise definition of the physical characteristics and performance requirements a tyre must fulfil to be defined as … ‘snow tyre’,
Published Snow Traction Test Standards

- ASTM F1805 Driving Traction Test
- ETRTO / ISO / R117 C1-C2 Braking Test
- ISO / R117 C3 (Truck) Driving Test
F1805 Driving Traction Test – Vehicle

- Self-contained test vehicle modified to run the F1805 test
- Drives at 5 mph (8 km/h)
- Applies increasing driving torque to test wheel (other wheels braked)
- Test wheel measures:
  - Vertical force
  - Traction force
  - Spinning speed
- Dedicated computer program/instrumentation
F1805 Driving Traction Test – Vehicle

- Dedicated vehicle modified for a wide range of loads and tire sizes:
  - Tire loads from 650 to 1,600 pounds
  - Rim diameters from 13” to 22”
- Encoders to measure vehicle/wheel speeds
- Two-axis load cell
- Automatic throttle control
- On-board jacks for tire change
- Adjustable suspension for leveling
- Removable weights
- No fenders
F1805 Driving Traction Test – Procedure

Each spin takes a few seconds:

• Tire is free-rolling
• Tire spins out and accelerates
• Test ends with the tire spinning 4x speed vehicle is traveling
• Engine returns to idle
• Test repeats
F1805 Driving Traction Test – Test Data

Spins are post-processed:

• Traction force is divided by load to get traction coefficient
  – higher is better (0.25 is typical on snow, vs. 0.80 on dry pavement)

• Spinning speed minus vehicle speed is used to get percent slip.
  – Free rolling is 0% slip
  – Spinning at 15 mph with vehicle at 5 mph is 200% slip
    \[
    (100\% \times (15 - 5) / 5) = 200\%
    \]

• Traction coefficient is measured over a range of percent slip and averaged to get reported values
F1805 Driving Traction Test – Test Data

A test consists of 10 spins:
- Average and standard deviation are calculated
- Outliers (> 1.5 \( \sigma \)) are removed
- Final average and standard deviation are calculated

Final coefficient is compared to the coefficient of a control tire
- Each test starts and ends with a control tire (Matrix)
- Control is re-run after every second test tire
  - \( \text{C} \rightarrow T_1 \rightarrow T_2 \rightarrow \text{C} \rightarrow T_3 \rightarrow T_4 \rightarrow \text{C} \rightarrow T_5 \rightarrow \text{C} \)

Each tire is tested on three or more days
F1805 Driving Traction Test – Control Tire

- Control (SRTT) is a better-than-average performing tire in snow

Changes are coming ...

Discontinued Tire Will Lead to ASTM Standard Changes

W. CONSHOHOCKEN, Pa., July 30, 2015—The expected discontinuance in manufacturing a standard-reference test tire will lead to changes to an ASTM International standard (E1136, Specification for P195/75R14 Radial Standard Reference Test Tire). Users of this specification are invited to join an ASTM task group that is working to manage this transition.

The tire has been used extensively since its introduction in the late 1980s. However, the materials used to produce the tire are dated and in limited supply because modern, mass-produced tires have evolved to use new kinds of polymers. As a result, it has become difficult for the sole manufacturer of the original tire (Michelin) to procure materials needed for reproduction. Michelin is working with ASTM Committee F09 on Tires on this issue.

The task group will explore the best ways to transition from the E1136 tire to an alternate reference tire (one possibility is F2493, Specification for P225/60R16 97S Radial Standard Reference Test Tire). Because the E1136 tire is still used in many standards and regulations, it is important to give regulatory bodies and industry time to consult with stakeholders, agree on an alternate specification, and publish revisions.

ASTM Newsroom, July 30, 2015
F1805 Driving Traction Test – Mountain Snowflake

• Mountain Snowflake requires tires to perform at >110% of SRTT
• True snow tires can be 130-150%
• Many all-season tires won’t make it
• Most LT tires won’t make it
• But 110 really isn’t good enough…
F1805 Driving Traction Test – Mountain Snowflake

- RMA TISB 37/1 says:

  …Tires designed for use in severe snow conditions are recognized by manufacturers to attain a traction index equal to or greater than 110 compared to the ASTM E-1136 Standard Reference Test Tire when using ASTM F-1805-2006 snow traction test with medium packed snow surface and equivalent percentage loads…

- Putting the Mountain Snowflake on a tire might be interpreted as a promise or an implied warranty of performance.

- A prudent manufacturer would probably include some margin above 110 to account for test variability and manufacturing variation.
F1805 Driving Traction Test – Test Conditions

Test load: 74% of test inflation rated load

- Inflation pressure is:
  - Standard load: 35/36 psi
  - Extra load: 41/42 psi
  - LT: 50 PSI

- For large tires (> 107 load index) load must be scaled and inflation pressure reduced.
ETRTO Braking Traction Test

Test vehicle: Standard Production Vehicle

- Uses vehicle’s ABS
- Instrumentation to measure speed and deceleration rate
- All four positions must have test tires (F1805 requires one tire)
- Test tire deceleration is compared against SRTT deceleration
F1805 Driving Traction Test – Test Conditions

• Test Surface: Medium Pack Snow
  – Softer than EU test surface
  – EU surface more like a well-driven road
  – F1805 surface is a better discriminator

• CTI penetrometer = 70 – 80

• SRTT coefficient = 0.25 – 0.41

• Boot leaves 3 – 5 mm deep footprint
ETRTO Braking Traction Test

- **Load:** C1: 60 – 90% of rated load, C2: 60 – 100%
- **Pressure:** 240 kPa (35 psi)
  - (no provision for XL tires)
- **Test Surface:** Medium Hardpack (CTI 75-85)
- **Control Tire:**
  - C1 uses ASTM E1136 SRTT (same as F1805)
  - C2 uses ASTM F2872 225/75R16C
  - Same C → T₁ → T₂ → C method as F1805
  - A reference tire set may also be used if test tires don’t fit on the same vehicle as control tires
ETRTO Braking Traction Test

- Test is 6 stops repeated on 2 days
- Test details:
  - Apply brakes at $\geq 28$ km/h (17 mph)
  - Measure average deceleration between 25 and 10 km/h (15 and 6 mph)
  - Compare average of all stops against control
- Mountain Snowflake criterion:
  - C1: 107% of SRTT 14
  - C2: 102% of SRTT16C
## ETRTO Braking Traction Test vs. ASTM F1805

<table>
<thead>
<tr>
<th>Measured Parameter</th>
<th>ETRTO Braking Test</th>
<th>ASTM F1805</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow CTI Index</td>
<td>75 - 85</td>
<td>70 - 80</td>
</tr>
<tr>
<td>Load</td>
<td>C1: 60-90% rated</td>
<td>C2: 60-100% rated</td>
</tr>
<tr>
<td>Inflation</td>
<td>C1: 35 psi for all tires</td>
<td>C2: Depends on load</td>
</tr>
<tr>
<td># events / test</td>
<td>6</td>
<td>10 / 8</td>
</tr>
<tr>
<td># repeats</td>
<td>2</td>
<td>3 or more</td>
</tr>
<tr>
<td>Mountain Snowflake criterion</td>
<td>C1: 107% of SRTT14</td>
<td>C2: 102% of SRTT16C</td>
</tr>
<tr>
<td>Test speed</td>
<td>6 – 15 mph</td>
<td>5 mph</td>
</tr>
<tr>
<td>% Slip</td>
<td>&lt;20%</td>
<td>40 - 300%</td>
</tr>
</tbody>
</table>
Winter Test Facility - Accredited for winter driving traction:

- ISO 17025 accredited facility
- GM TIP approved
- Has been audited/accepted by E2, E4, and E10