“Road vehicles
— Endurance braking systems
of motor vehicles and towed vehicles
— Test procedures”

by
ISO TC22/SC2/WG6
SWG 6 „Endurance braking systems“

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1. Structure of ISO Working Group

Subworking group SWG 6 „Endurance braking systems“
Chairman Dr. Reinhold Pittius

• reporting to ISO 22/2/WG6 „Braking Systems“
Chairman Prof. v. Glasner

• Active members of SWG 6:

<table>
<thead>
<tr>
<th>DaimlerChrysler</th>
<th>TELMA</th>
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<tr>
<td>IVECO</td>
<td>VOITH TURBO</td>
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<td>MAN</td>
<td>ZF</td>
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• Status
  - Working Draft agreed by TC22 \( \rightarrow \) Committee Draft (CD)
  - Distribution as ISO DIS in Dec. 2003
  - Balloting until May 2004
1. Structure of ISO Working Group
2. The Target
3. Basic legal requirements
4. Basic understanding of equivalent energy
5. Specific properties of different types of retarders
6. Test methods
7. Conclusion
2. The Target

Standardization

- of testing procedures
- of vehicles
  - equipped with endurance braking systems
  - to be type approved
- according to existing legal requirements

- Detailed description of
- different test methods such that
- results are
  - objectiv,
  - realistic and
  - compatible
3. Basic legal requirements (1)

ECE-R 13, Annexe 4

para. 1.6 Type II

ECE-R 13, Annexe 4

para. 1.8 Type IIA

service brakes must not be used!
3. Basic legal requirements (2)

1.8.2. Test conditions and performance requirements

1.8.2.1. The performance of the endurance braking system shall be tested at the maximum mass of the vehicle or of the vehicle combination.

1.8.2.2. Laden vehicles must be tested in such a manner that the energy input is equivalent to that recorded in the same period of time with a laden vehicle driven at an average speed of 30 km/h on a 7 per cent down-gradient for a distance of 6 km. During the test, the service, secondary and parking braking systems must not be engaged. The gear engaged must be such that the speed of the engine does not exceed the maximum value prescribed by the manufacturer. An integrated endurance braking system may be used, provided that it is suitably phased such that the service braking system is not applied; this may be verified by checking that its brakes remain cold, as defined in paragraph 1.4.1.1. of this Annex.
3. Basic legal requirements (3)

1.8.2. Test conditions and performance requirements

1.8.2.1. The performance of the endurance braking system shall be tested at the maximum mass of the vehicle or of the vehicle combination.

1.8.2.2. Laden vehicles must be tested in such a manner that the energy input is equivalent to that recorded in the same period of time with a laden vehicle driven at an average speed of 30 km/h on a 7 per cent down-gradient for a distance of 6 km. During the test, the service, secondary and parking braking systems must not be engaged. The gear engaged must be such that the speed of the engine does not exceed the maximum value prescribed by the manufacturer. An integrated endurance braking system may be used, provided that it is suitably phased such that the service braking system is not applied; this may be verified by checking that its brakes remain cold, as defined in paragraph 1.4.1.1. of this Annex.
3. Basic legal requirements (4)

1.8.2. Test conditions and performance requirements

1.8.2.1. The performance of the endurance braking system shall be tested at the maximum mass of the vehicle or of the vehicle combination.

1.8.2.2. Laden vehicles must be tested in such a manner that the energy input is equivalent to that recorded in the same period of time with a laden vehicle driven at an average speed of 30 km/h or a 7 per cent down-gradient for a distance of 1 km. During the test, the service, secondary and parking braking systems must not be applied. The gear ratio and differential should be such as to maintain a speed of 50 km/h. The test shall not exceed 5 km and the maximum speed shall not exceed 90 km/h. In the case of a retarder which is integrated with the braking system, the retarder may be used, provided that it is suitably phased such that the retarder is not applied until the braking system is not applied; this may be verified by checking that its brakes remain cold, as defined in paragraph 1.4.1.1. of this Annex.
4. Basic understanding (1)

Key philosophy of ISO CD 12161 with regard to the standardization of performance tests of endurance braking systems

Equivalent energy!

\[ W = m \cdot g \cdot \Delta H \]

\[ = m \cdot g \cdot L \cdot \tan \alpha \]

Same average power!

\[ P = \frac{W}{t} \]

In the same time

\[ t = \frac{L}{v} \]

1) rolling resistance to be considered!
4. Basic understanding (2)

- Downhill test
  (preference IVECO)

- Towing test
  (preference MAN)

- Test bench
  (preference DC)

Equivalent Energy in time?
Yes → Approval!
5 Specific properties of different types of retarders (1)

Engine brake vs secondary (hydrodynamic) retarder

- Torque vs speed
- Power vs speed
- controllability
5 Specific properties of different types of retarders (2)

Electromagnetic vs hydrodynamic retarder

Thermal performance

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5 Specific properties of different types of retarders (3)

Service Brake
- Capacitive absorption
- Radiation via surface
- Time limited

Electromagnetic Retarder
- Capacitive absorption
- Radiation via surface
- Time limited
- Continus braking capability
- Elimination through cooling system

Hydrodynamic Retarder
- Capacitive absorption
- Radiation via surface
- Time limited
- Continus braking capability
- Elimination through cooling system
6.1 Test methods – Downhill test (1)

Specific criterias:

There is no real downhill track having exactly 7% and 6km length. Perhaps the height difference is available, but not exactly the length (resp. the slope). Even if the height and the length are correct, the slope may vary along the track.

Only small tolerances on equivalent energy and time!

But:
- tolerances on slope variation
- compensation on average slope
- compensation on height difference
6.1 Test methods – Downhill test (2)

Height profile of a realistic test track

- Parkplatz Torfhaus bei km 11,3 (810 m über NN)
- Parkplatz Steinbruch bei km 4,0 (370 m über NN)

Height Profile of Fed. Road B4 near Torfhaus

Akima-Fkt.
Downhill test
- procedure

• ”Qualifying“ of desired downhill track acc. to explained criterias
• Calculation of compensation parameters such as speed, mass etc.
• nearly no instrumentation necessary
• performance of the downhill test run
• measurement of the time needed
• if less then required time → DONE
6.2 Test methods – Towing test (1)

Specific criterias:

The braking force may vary due to retarder characteristic.

The speed of the combination may due to the variation or force.

If the the towed vehicle has not fully laden the rolling resistance must be considered at the evaluation of the test.

Only small tolerances on equivalent energy and time!

- tolerances on force variation
- tolerance on speed variation
- compensation of GVW and rolling resistance
6.2 Test methods – Towing test (2)

Towing test
- procedure

- „Qualifying“ of vehicles and test conditions
- Compensation of rolling resistance and determination of requ. force
- Instrumentation of vehicles necessary
- performance of the towing test 12 min and data recording
- postprocessing of test data → calculation of braking energy
- if equal to equivalent energy → DONE
6.3 Test methods –Dynamometer test bench (1)

Specific criteria:
The braking force may vary due to retar der characteristic.
The speed of the test bench may due to the variation or force.
If the measured vehicle is not fully laden the rolling resistance must be considered at the evaluation of the test.
A cooling device must simulate the air stream due to the vehicle speed.

Only small tolerances on equivalent energy and time!

but
- tolerances on force variation
- tolerance on speed variation
- compensation of GVW and rolling resistance
6.3 Test methods – Dynamometer test bench (2)

Simulation test - procedure

- „Qualifying“ and instrumentation of the test bench
- Compensation of rolling resistance and determination of required force
- Performance of the towing test 12 min and data recording
- Postprocessing of test data → calculation of braking energy
- If equal to equivalent energy → DONE
7 Specific test parameters for engine brakes (1)

Speed tolerance 30 ± 5 km/h

1.8.2.3. For vehicles in which the energy is absorbed by the braking action of the engine alone, a tolerance of ± 5 km/h on the average speed shall be permitted, and the gear enabling the speed to be stabilized at a value closest to 30 km/h on a 7 per cent down-gradient shall be engaged. If the performance of the braking action of the engine alone is determined by measuring the deceleration, it shall be sufficient if the mean deceleration measured is at least 0.6 m/s².

- All primary retarders shall be treated same as engine retarders
  - because they operate via the gearbox as well

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7 Specific test parameters for engine brakes (2)

Deceleration test $\geq 0.6 \, \text{m/s}^2$

1.8.2.3. For vehicles in which the energy is absorbed by the braking action of the engine alone, a tolerance of $\pm 5 \, \text{km/h}$ on the average speed shall be permitted, and the gear enabling the speed to be stabilized at a value closest to $30 \, \text{km/h}$ on a 7 per cent down-gradient shall be engaged. If the performance of the braking action of the engine alone is determined by measuring the deceleration, it shall be sufficient if the mean deceleration measured is at least $0.6 \, \text{m/s}^2$.

- The deceleration test is NOT covered by the ISO CD 12161
  - because this test is not „in line“ with the general idea of the equivalent energy
6 Conclusion (1)

- ISO CD 12161
- provides detailed definitions of three test procedures according to the principle of equivalent energy
- the test procedures have been harmonized based on the principle of equivalent energy
- allows adequate and individual decisions on the test procedure. It does not need high-end test facilities
- considers primary retarders in the same “family“ as engine retarders because all are operating via the gearbox
- does not cover the deceleration test in ECE-R 13
ISO/CD 12161
ISO TC 22/SC 2/WG
Secretariat: BNA

Road vehicles — Endurance braking systems of motor vehicles and towed vehicles — Test procedures

Véhicules routiers — Véhicules à moteur et véhicules tractés disposant de systèmes de freinage d'endurance — Procédures d'essai

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Thank you for your attention