

## IMPROVED BRAKES ON HEAVY COMMERCIAL VEHICLES

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### Abstract

Heavy vehicles' brakes are exposed to a great deal of stress and tough climatic conditions. The total distance they cover varies from several tens of thousands of kilometres to around 250,000 kilometres per year. Heavy vehicles drive up to 10 times further per year than cars and their brakes require a great deal of maintenance work. However, the technical design of brakes does not match market requirements for operating safety and lifespan. A large proportion of heavy vehicles' brakes fail to pass the Swedish Vehicle Inspection Company yearly vehicle tests. The vehicle testing methods used in inspections could be improved in order to make tests more repeatable and improve assessment of the technical condition of brakes. In order to protect legal rights, the method must be designed so that no vehicles fail the test on incorrect grounds. Operators in the road transport sector, haulage contractors, suppliers, garages, testing bodies and authorities must cooperate and adopt measures to improve the technical condition of heavy vehicles' brakes.

**Keywords:** Heavy vehicles, Brakes, Maintenance, Inspections

### Résumé

Les freins de poids lourds sont soumis à des efforts importants et à des conditions climatiques particulièrement rudes. La distance totale qu'ils parcourent varie de plusieurs dizaines de milliers de kilomètres à environ 250 000 kilomètres par an. Les poids lourds parcourent jusqu'à 10 fois plus de kilomètres par an que les voitures et leurs freins nécessitent de nombreux travaux de maintenance.

Cependant, la conception technique des freins ne correspond pas aux besoins du marché en termes de sécurité de fonctionnement et de durée de vie. Une grande proportion de freins de poids lourds échoue aux tests annuels de l'organisme suédois de contrôle technique des véhicules. Les méthodes de test utilisées lors des inspections pourraient être améliorées dans le sens d'une plus grande reproductibilité des tests et d'une meilleure évaluation des caractéristiques techniques des freins. Pour protéger les droits des personnes, la méthode doit être conçue de façon à ce qu'aucun véhicule n'échoue au test pour des raisons indues. Les acteurs du transport routier, les entrepreneurs de transport, les fournisseurs, les garages, les organismes de contrôle technique et les autorités doivent collaborer et adopter des mesures permettant d'améliorer les caractéristiques techniques des freins des poids lourds.

**Mots-Clés:** Poids lourds, freins, maintenance, inspections

## 1. Maintenance and repair of vehicles

Scheduled preventive maintenance should be carried out on vehicles in accordance with manufacturers' recommendations. Manufacturers and general agents for lorries and trailers should assume more responsibility for ensuring that their products are maintained in their prescribed condition at a reasonable cost through effective cooperation with lorry retailers and garages in after-sales services for haulage contractors.

Preventive maintenance of trailer and semi-trailer brakes should ideally be performed at the same time as the truck or tractor unit.

Trucks are often better looked after than trailers, which is due among other things to:

- trucks being replaced new twice as often as trailers
- special agreements for repairs and service often being signed in connection with new truck purchases
- trailers often being parked away from the workshop when the truck is taken in for service
- most service workshops specializing in one make of truck and only offering trailer service when time permits



**Figure 1** – Maintenance of drum brakes on a heavy truck

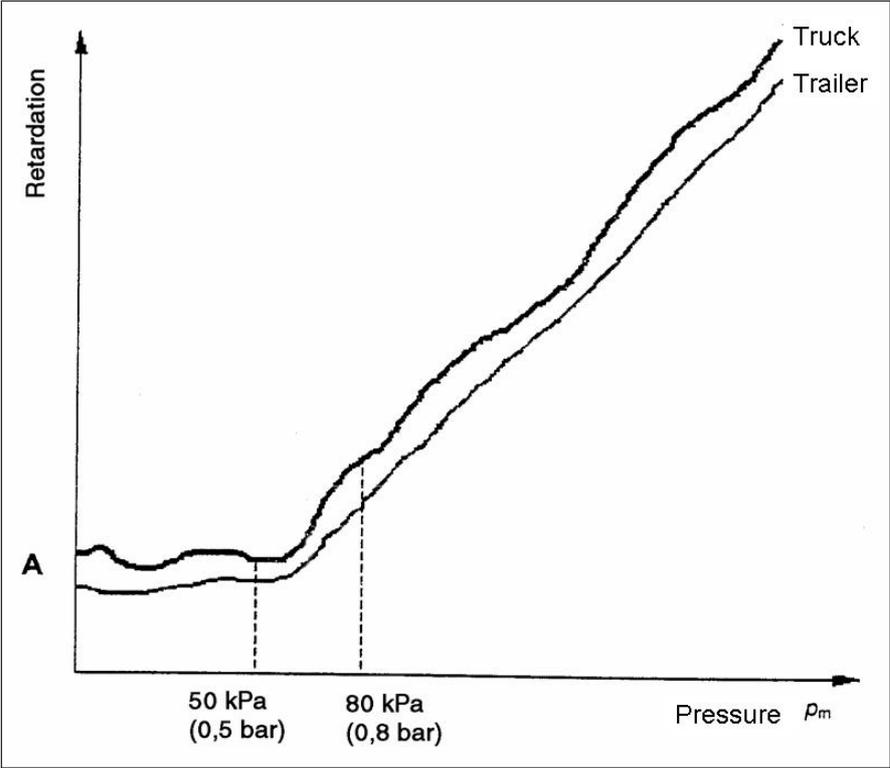
## 2. Construction of new vehicles' brakes

The construction of braking systems on lorries and trailers means that too much maintenance is required to keep them in their prescribed condition. In similarity with vehicle emission efforts, manufacturers' obligations regarding heavy vehicle brake durability ought to be considered. Vehicle emission checks are simplified, but emission defects at vehicle test inspections are very few in comparison to brake defects. Standards for vehicle emissions have nevertheless been raised a number of times during the past 12 years, from Euro I in 1993 to today's Euro IV and Euro V engines.

The manufacturer of the vehicle chassis should be subject to manufacturers' obligations relating to the durability of heavy vehicles' brakes – that they should last 8 years or 1,600,000 km – should be considered for potential adoption within the EU. These obligations should

cover all components and systems required for the operation of braking systems in order to meet legal requirements for the duration of the obligations, regardless of the existence of any sub-suppliers, with the vehicle being maintained in accordance with the manufacturer's instructions.

With a requirement for manufacturers' obligations regarding durable heavy vehicle brakes it would be in the suppliers' interests to develop more robust, low-maintenance brakes.



**Figure 2** – Start pressure for braking effect for both truck and trailer should be in the interval 50kPa till 80kPa, measured in the control pipe.

### 3. Operation of brakes and adjustment of brakes between vehicle units

The start pressure in the control pipe for the trailer and brake cylinders and the guaranteed operating pressure should be tested to allow better diagnosis of the condition of braking systems. Brakes should be adjusted for all vehicles according to the standard with the working name of FDIS 20918 proposed by Sweden for adoption as an international standard. This will enable all vehicles to be connected and will also allow satisfactory brake operation to be maintained, with all wheels starting to brake at the same time and braking their proportion of the vehicle's weight.

### 4. XTB - Supplementary Brake Testing

From October 2002 Supplementary Brake Testing (XTB) was introduced for heavy vehicles in Sweden. XTB involves a voluntary, supplementary annual brake test at an accredited workshop.



**Figure 3 – Roller brake test on heavy truck**

XTB is carried out at workshops in accordance with the Swedish Motor Vehicle Inspection test programme approx. 6 months before the annual inspection and also comprises, once per year, start pressure, which in the trailer brake control pipe (duo-matic) must be between 0.5 – 0.8 bar and max 0.7 bar in the brake cylinders. Approved vehicles receive an XTB decal at the workshop and again at the annual inspection.

An XTB brake check certificate is issued, which is valid in Sweden for six months. XTB vehicle tests came into force during 2003. The police have the right to refrain from further brake checks on vehicles which have undergone a brake test within the previous six months.

XTB aims to promote:

- improved brake economy for the vehicle owner
- increased traffic safety
- customer benefits for the transport purchaser
- time savings

During 2003 - 2004, 80 per cent of heavy trucks and busses that underwent XTB checks were approved at vehicle tests in Sweden. All defects are repaired within one month of the vehicle test. With XTB, brake defects are remedied (100 per cent) a further time, six months later. It is therefore probable that an average of 90 per cent of XTB vehicles have approved brakes for an entire year.

## **5. Handling of vehicles and brakes**

Most drivers normally apply the brakes gently and therefore do not notice any gradual deterioration. Unfortunately, most modern vehicles require the brakes to be applied sharply every so often in order to maintain optimum performance. Some vehicle instruction books

encourage drivers to brake occasionally in wet conditions to keep brakes working efficiently. There should be no such need to use the brakes to keep them working efficiently. Brakes should perform within satisfactory margins in all driving conditions.



**Figure 4** – New vehicles’ brakes are approved and a certificate is issued stating that the legal requirements have been met.

On trailers equipped with “EU brakes” with the separate operating control – the so-called “Brussels valve” – drivers sometimes forget to apply the parking brake, which means that the trailer can begin to move when the pressure in the system drops. Trailers fitted with a “Brussels valve” should be equipped with systems that apply the parking brake automatically when the pressure in the system drops, regardless of whether the control is switched on.

## **6. Testing of brakes on new vehicles prior to delivery to clients**

New vehicles’ brakes are approved and a certificate is issued stating that the legal requirements have been met. The operating controls of the brakes do not need to be tested on a roller brake tester in certain cases. We suggest introduction of requirements for testing operating controls of brakes before or during registration inspections. These tests should be carried out by garages, suppliers or vehicle inspection companies using a roller brake test.

Legal rules and requirements should prioritize checks on the operation of components and systems that are important for road safety and where an associated cost benefit can be clearly demonstrated.

The maximum discrepancy in braking force between the left and right wheels for all axles was previously 50 per cent and is now 30 per cent. 30 per cent is considered to be unnecessarily strict and therefore a higher value, e.g. 40 per cent, should be considered. It is most important for this requirement to be applied to front steering axles, but it should also be applied to all axles for the sake of simplicity.

## **7. Testing and inspection methods**

Testing methods are currently being developed by the inspection bodies, but this also imposes requirements for organisation and harmonization between countries to ensure observance of the legal rights of vehicles in roadside checks. Increased harmonisation is necessary since,

according to the Nordic Road Association, NVF, there are still great differences among the Scandinavian countries and probably also compared with other EU states.

**Table 1** – Calculated brake retardation for the same measured value varies to an unacceptable degree in Nordic countries.

	Denmark/ Faeroe Islands	Finland	Sweden	Iceland	Norway
Truck	DK / FR 0.51 / 0.43	0.68	0.58	0.55	0.49
Trailer	0.44 / 0,44	0.50	0.53	0.50	0.45

The limit for approved brake retardation for vehicle testing or roadside inspections for heavy vehicles is 0.45 (braking force/vehicle weight) in all Nordic countries. When theoretical brake retardation is calculated in different countries (table 1) for the same measured braking force, results vary for a non-approved retardation of 0.43 in the Faeroe Islands to an approved retardation of 0.58 in Sweden. The reason for different results depends on different calculation formulas, different maximum pressure, starting pressure and correction factors. These are unacceptable results that threaten the legal rights of road haulage companies. A vehicle with approved brakes in Sweden can have a driving ban imposed at a roadside inspection in Norway.

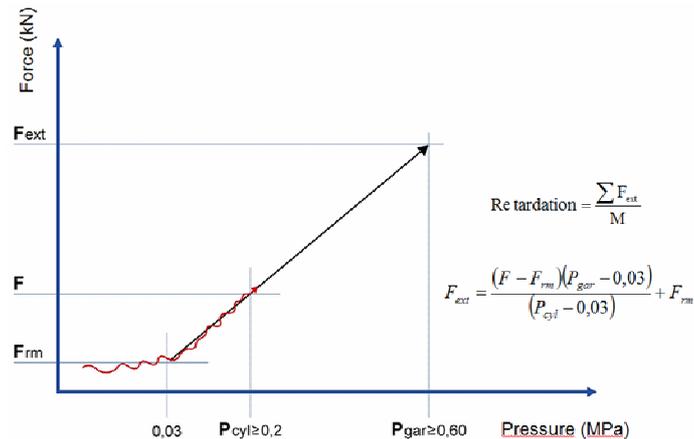
Work on Nordic harmonization is being carried out by The Nordic Road Association, Vehicles and Transport:

- All Nordic countries test heavy vehicle brakes in accordance with Directive 96/96/EG
- Measurements and checks of important valves and mechanical components in braking systems are carried out in different ways.
- Measured braking force results are calculated and treated in different ways.
- Negative consequences for traffic safety, the legal rights of drivers and vehicle owners and competition.
- A future goal is for heavy vehicle checks carried out in one Nordic country to be accepted beyond its borders.

The Nordic Road Association, Vehicles and Transport suggests the following:

- Nordic inspection regulations and measuring practices
- Specification of requirements for roller brake testers
- Qualification requirements for inspection personnel

Formulas for calculating brake performance need to be revised to achieve satisfactory repeatability in brake checks. New calculation formulas (figure 5) and start pressure assessments have been suggested for future testing programmes where values for adjustment of load-sensitive valves must also be checked. A study should be carried out to verify whether a level higher than 30 per cent would be accepted for the uneven braking requirement.



**Figure 5** – Formulas for calculating brake performance (Jorge Soria Galvarro)

Manufacturers should verify that braking systems meet legal requirements before delivering new vehicles.

There should be an increase in roadside inspections when no evidence of scheduled preventive maintenance on the vehicle, such as voluntary tests on the brakes, can be shown. It is not practical to perform roadside retardation tests for reasons of road safety or cargo securing or because vehicles are not fully loaded.

A brake test with benchmark braking forces should be introduced in future vehicle testing plans to provide safer, simpler brake tests.

## 8. Costs

A complete heavy vehicle brake inspection, maintenance and repairs costs a lot of money. According to the Swedish Road Hauliers Association, the costs for brake repairs and maintenance are the biggest expenditure in a truck's maintenance budget. Over a four-year period this can amount to 10,000 Euro for a timber truck and trailer.

Brake repairs are carried out largely as the result of failure to pass a regular vehicle inspection and all too seldom as preventive maintenance. Some companies use a Swedish Motor Vehicle Inspection check as a work order for the workshop's repair measures. Because of high brake maintenance costs there is a manifest risk that only clearly-identified defects are repaired.

From a costing point of view it should be in everyone's interest to find better technical brake solutions that reduce service and repair costs even if investment costs are higher for improved brakes. For long distance vehicles the proportion of depreciation costs is roughly the same as the proportion of the costs for repairs. For shorter distance vehicles depreciation costs are greater than repair costs.

Depreciation costs as a proportion of annual costs for various vehicles differ, e.g. 14 per cent for round timber vehicles with 3 + 4 axles and 6 per cent for a tractor with 2 axles. Repair costs for round timber vehicles are approx. 12 per cent of annual costs compared to around 7 per cent for the tractor.

If the purchase price for a new vehicle with better brakes were for example 10 percent higher, the annual depreciation costs and consequently the freight charges would increase by 1.4 per cent for a round timber vehicle and by 0.6 per cent for a tractor. Note that a 10 per cent higher purchase price for a round timber vehicle combination 3 + 4 axles is approx. Euro 20,000, and for a two-axle tractor around Euro 10,000.

A higher purchase price for vehicles with leading-edge technical equipment, e.g. better brakes, is negligible in terms of annual costs and therefore also in terms of transportation costs. In fact, higher brake quality and improved technical performance mean a reduction in yearly repair costs that outweighs the required investment. Today's braking systems incur high maintenance costs. One prerequisite for avoiding further rises in brake costs is for maintenance to be carried out on schedule. A reduction in brake operating costs is essential.

## **9. Summary**

Operators in the road transport sector, haulage contractors, suppliers, garages, testing bodies and authorities must cooperate and adopt measures to improve the technical condition of heavy vehicles' brakes.

The vehicle testing methods used in inspections should be improved in order to make tests more repeatable and to improve assessment of the technical condition of brakes.

Legal rules and requirements should prioritize checks on the operation of components and systems that are important for road safety and where an associated cost benefit can be clearly demonstrated.

The manufacturer of the vehicle chassis should be subject to manufacturers' obligations relating to the durability of heavy vehicles' brakes – that they should last 8 years or 1,600,000 km – should be considered for potential adoption within the EU. With a requirement for manufacturers' obligations regarding durable heavy vehicle brakes it would be in the suppliers' interests to develop more robust, low-maintenance brakes.

Brakes should be adjusted for all vehicles according to the standard with the working name of FDIS 20918. This will enable all vehicles to be connected and will also allow satisfactory brake operation to be maintained, with all wheels starting to brake at the same time and braking their proportion of the vehicle's weight. This aim can also be achieved by a voluntary supplementary annual brake test carried out and comprised, start pressure, which in the trailer brake control pipe (duo-matic) must be between 0.5 – 0.8 bar and max 0.7 bar in the brake cylinders.

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