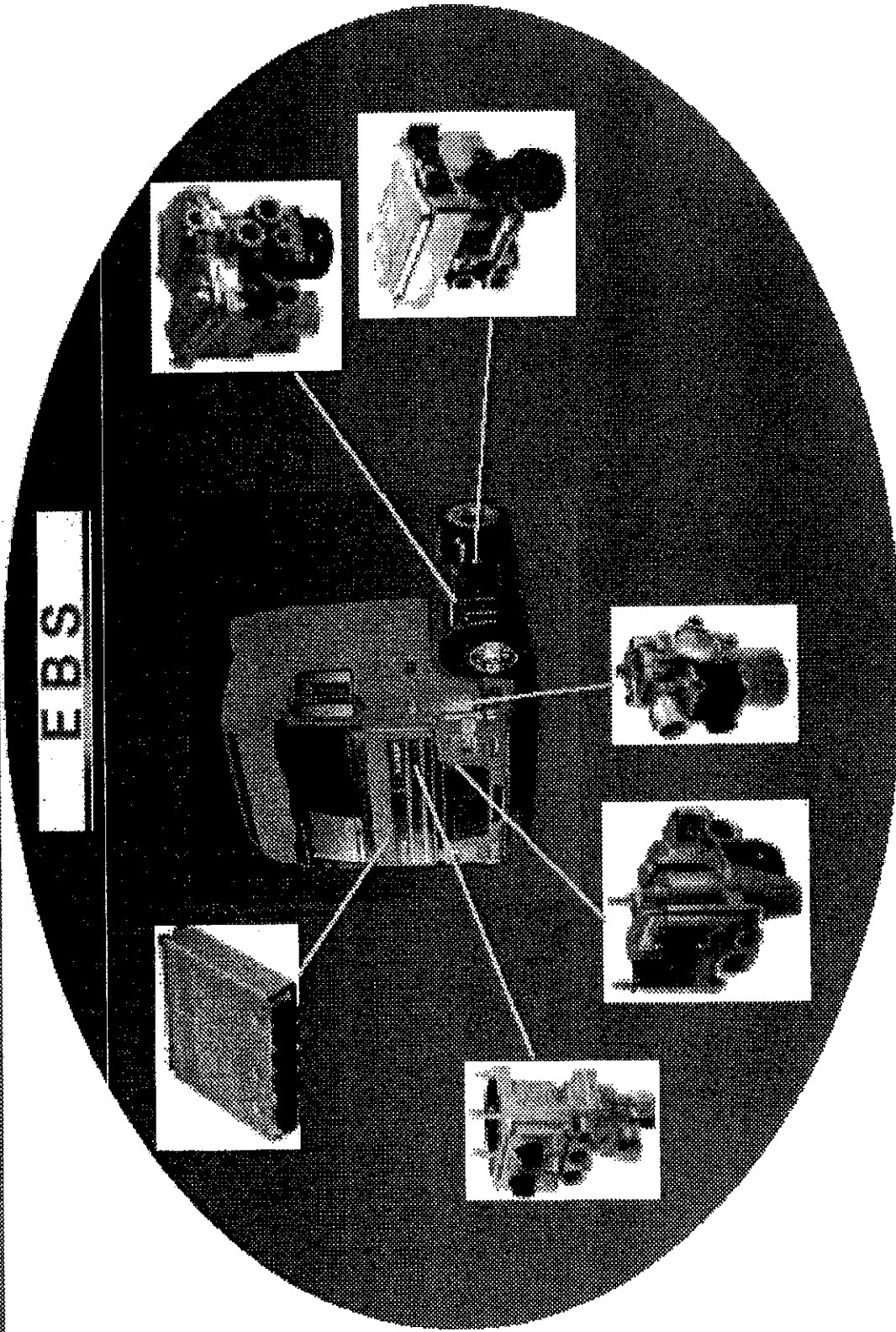


SIMON DE COCK
COMMENT ON THE DRAFT BRAKE RULE

Development of electronic brake systems



Contents

- **EBS system, principle of operation**
- **Overview vehicle specification**
- **Development and verification of tools**
- **Brake circuit diagrams**
- **EBS components**
- **EOL System Parameter setting**
- **servicing /Diagnostics possibilities**
- **Features of EBS**

EBS principle of operation

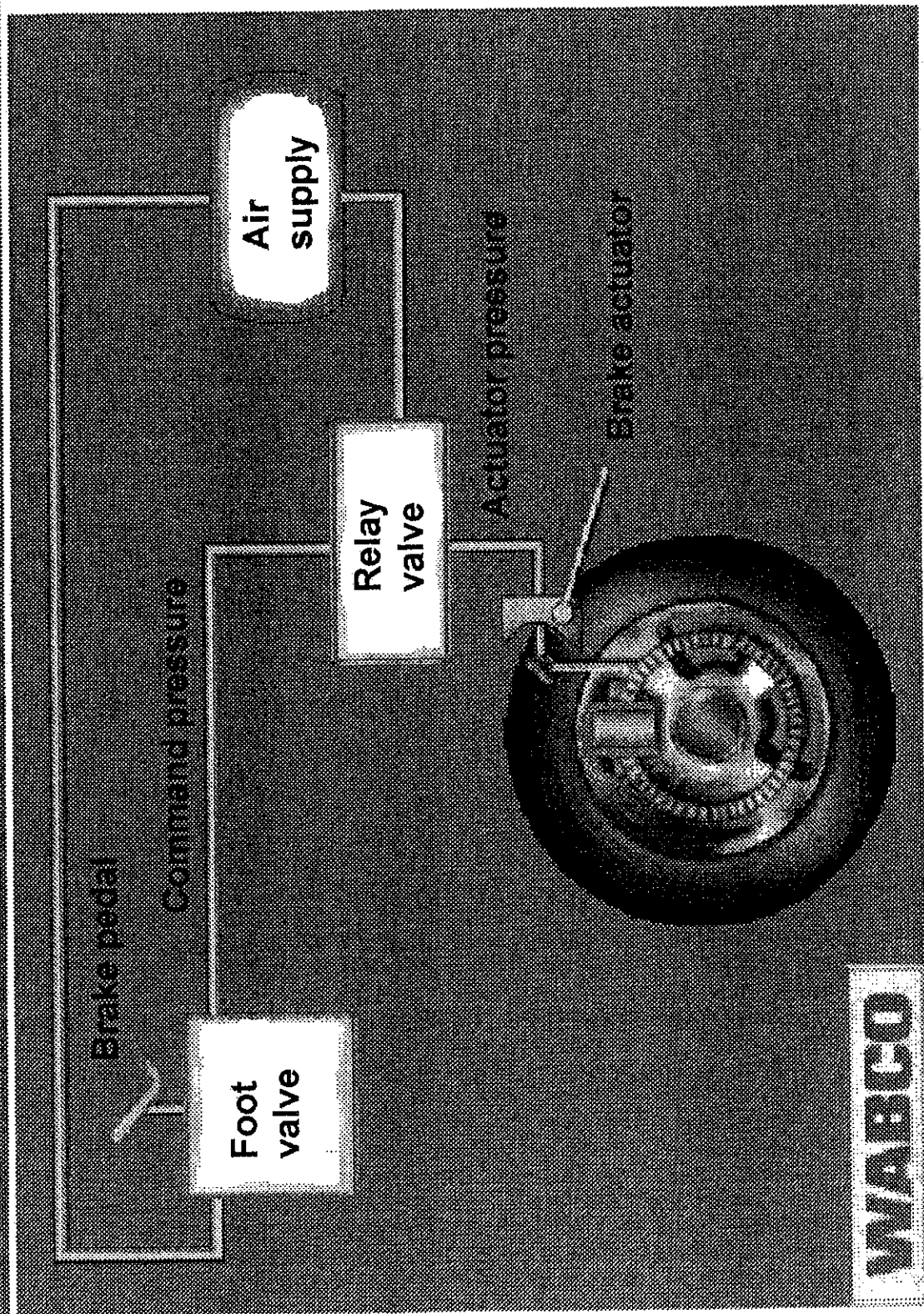
The brake control algorithms

- distribute the brake forces between the axles of the tractor.**
- distribute the brake forces between tractor and trailer.**

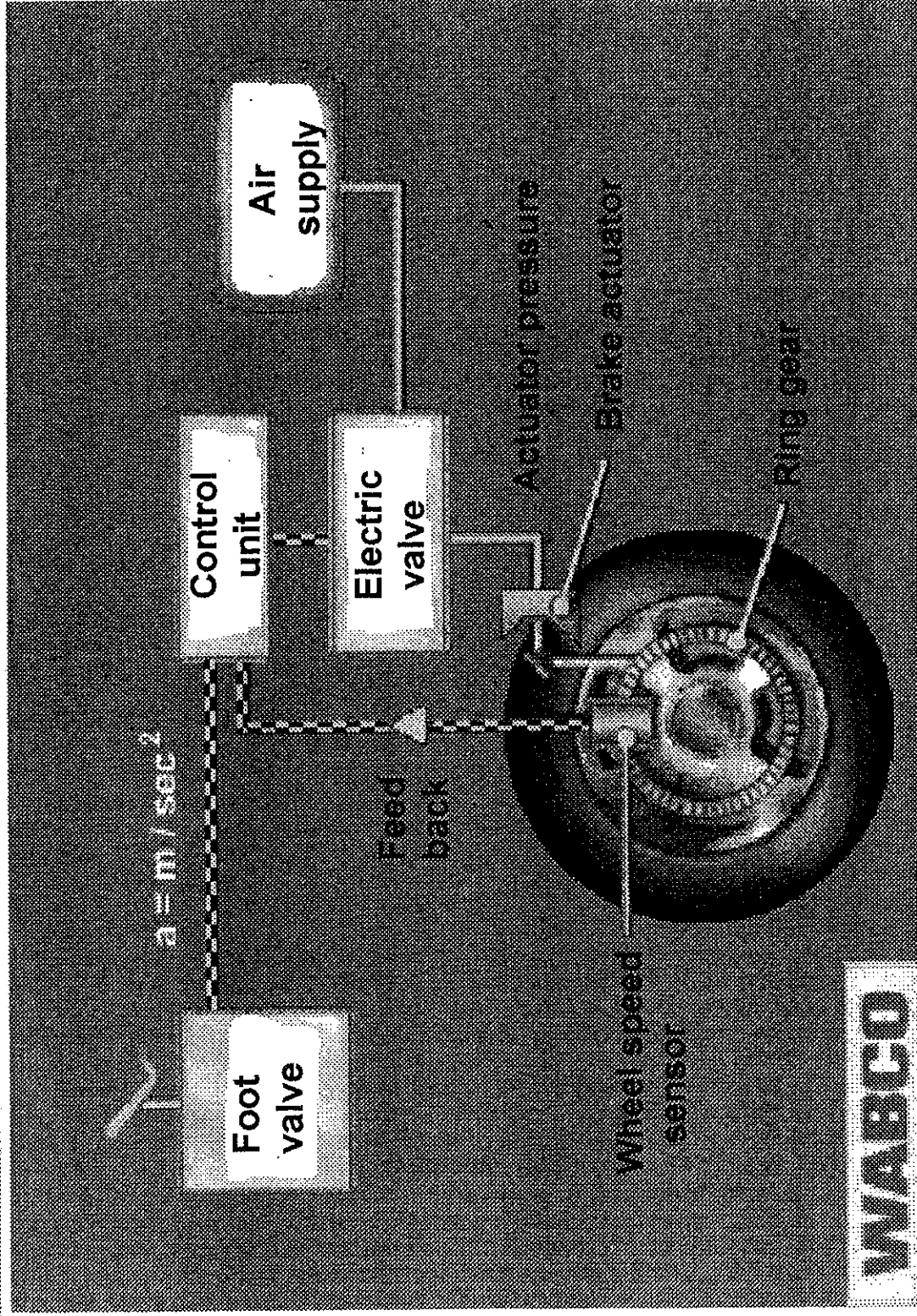
The brake management starts with the evaluation of the desired deceleration and ends with the generation of the desired retardation. In addition the endurance brakes are integrated in the vehicle brake system.

The next picture shows the chain of the functions.

Pneumatic system: principle of operation

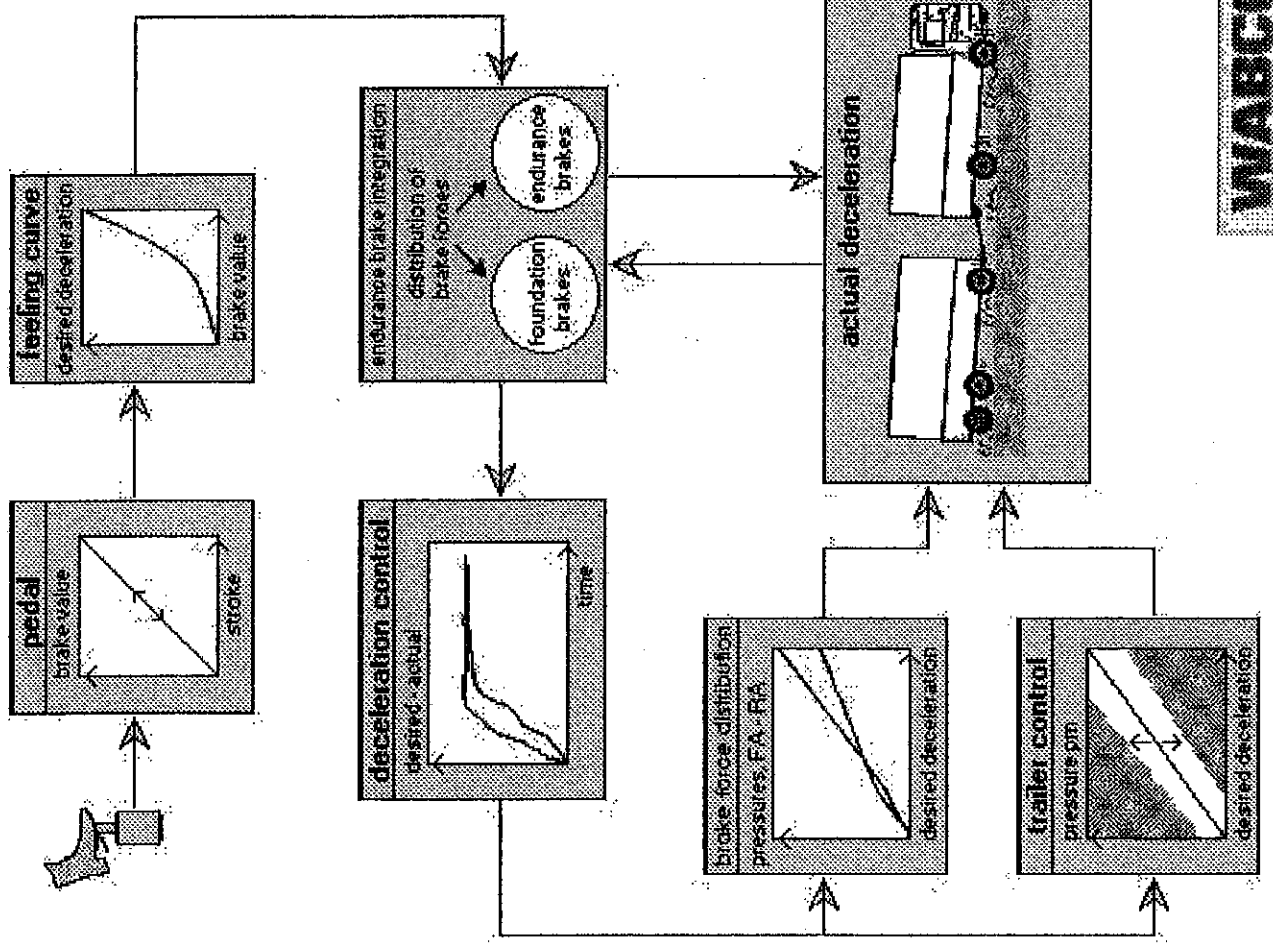


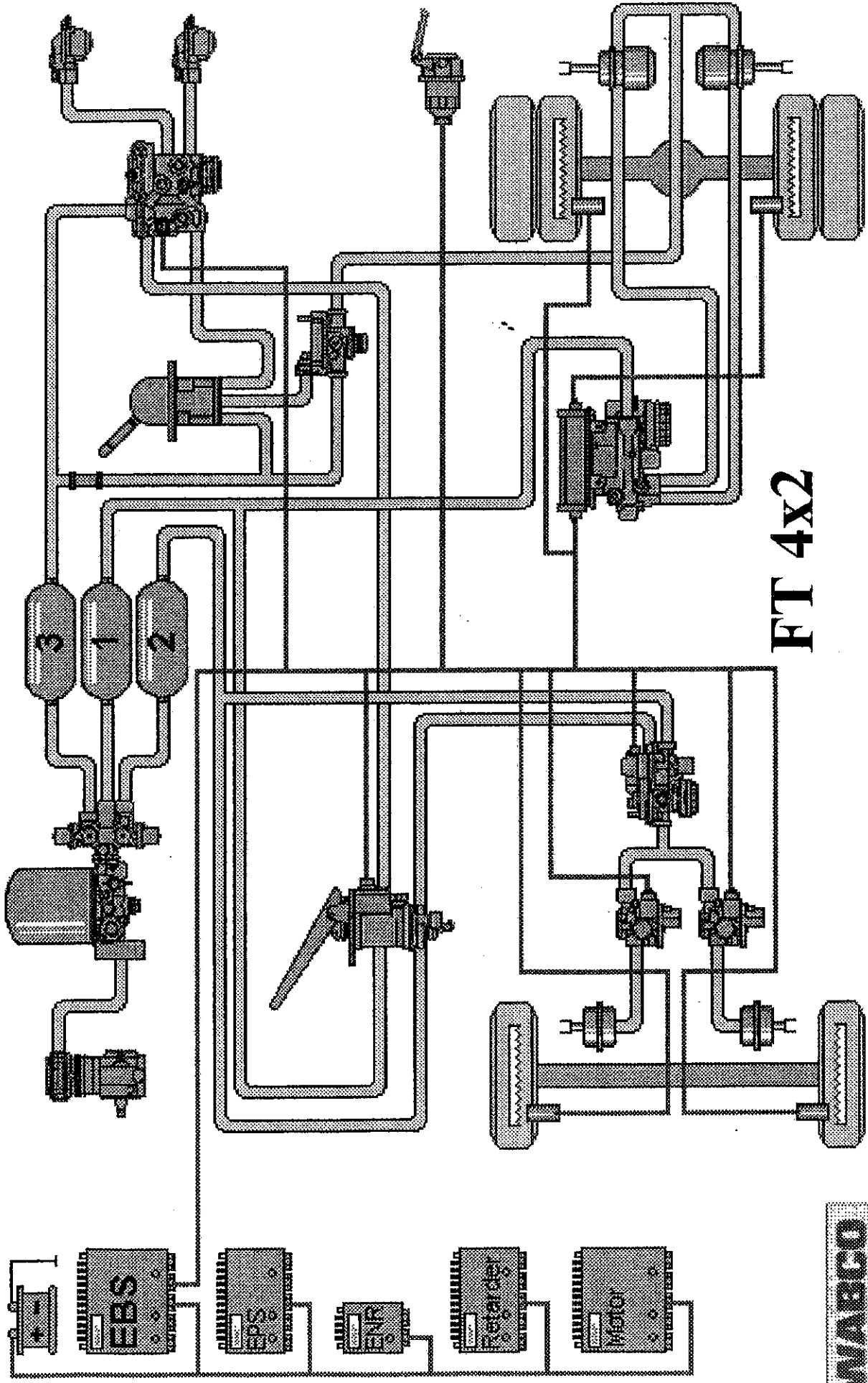
EBS principle of operation



EBS principle of operation

- **The retardation demanded by the position of the foot pedal is fed to the controller as an electrical signal.**
- **The controller calculates the actuator brake pressures required and sends corresponding signals to the actuators.**
- **The air pressure levels are dependent on GVW.**
- **The brake force distribution between the axles with wheel speed feedback is controlled on the basis of wheel slip.**





FT 4x2

WABCO

New brake components

- **ECU**
- **Brake Signal Transmitter**
- **Proportional Relay Valve**
- **ABS Valve (front axle)**
- **Axle Modulator (incl. ABS and ASR)**
- **Solenoid Relay Valve (Redundant)**
- **Trailer Control Valve**

differences EBS - Pneumatic system

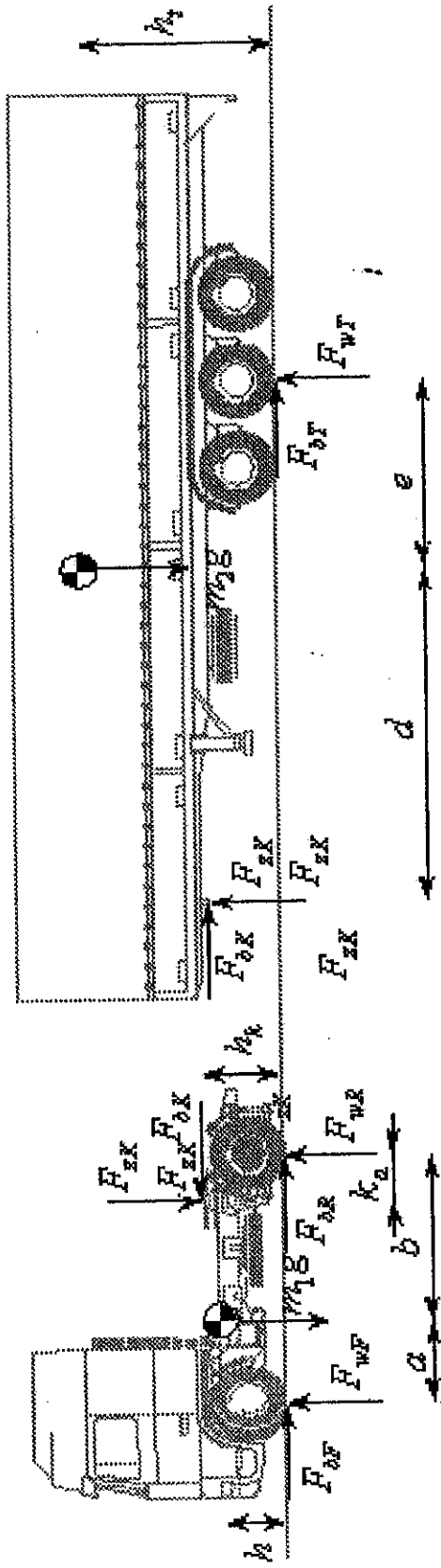
- **Electronic control (i.o. pneumatic)**
- **Retardation controlled (i.o. pressure controlled).**
- **Adaptive load determination (i.o. load sensing).**
- **Adaptive lining wear balance (i.o. delta-P).**
- **Redundant 2-circuit pneumatic back up;**
- **CAN interface, tractor & trailer.**
- **Integration 3-rd brake optional (retarder etc.).**
- **Optional SMR control of natural engine braking effect**
- **Optional vehicle stability controller (in preparation)**

Development and verification tools

- **System analysis**
- **SIL software in the loop**
- **HIL hardware in the loop**
- **Testing**

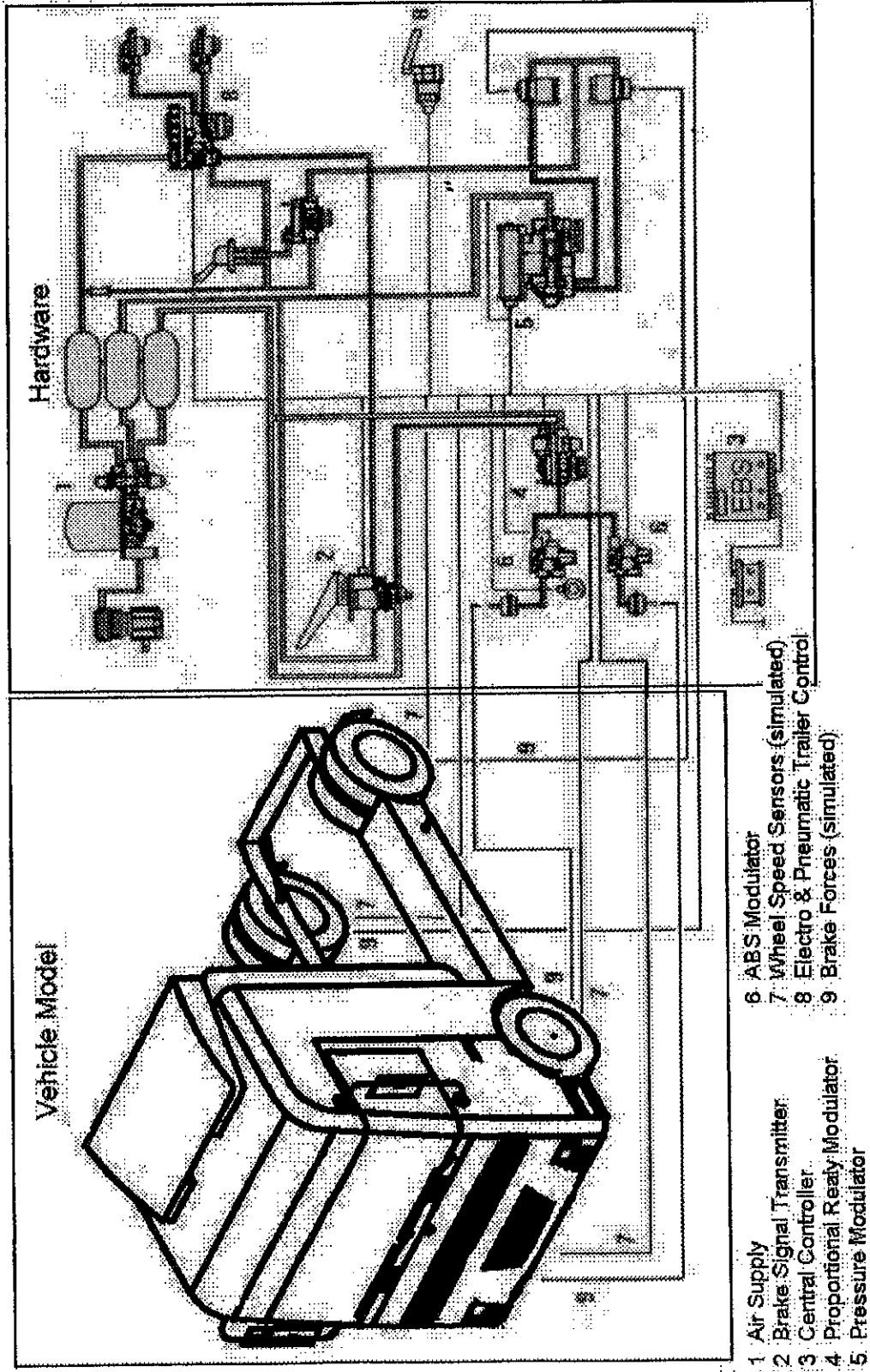
Development and verification tools

SIL



Performance and sensitivity analysis of the EBS-control system for several vehicle configurations, load situations and conditions (fading)

Development and verification tools



Number of brake cylinders

Conventional

EBS vehicles

Variety 26

Variety 10 + (4)

Combinations 67

Combinations 16 + (16)

EOL Parameters

- **System-configuration**
 - > redundant
 - > trailer connection
 - > ASR
- **Vehicle configuration**
 - > brake performance and pressure distribution
 - > tyre dimensions
- **Additional items**
 - > lining wear control
 - > options (integration 3e brake, SMR)

Diagnosis / Service possibilities

- **Internal check at start, driving and braking**
 - > checking components and wire harness
 - > checking system reactions:
plausibility check interchanging tubes, pressure control and function
- **Logging of failures**
 - > read out of actual and earlier failures
 - > measure values by DACAT and DAVIE
- **Simple brake system check**
 - > by active components check
 - > by read out of measured values using
DACAT and DAVIE

Features EBS

- 1. High degree of safety**
- 2. Brake comfort / feel**
- 3. Deceleration control**
- 4. Slip-optimized brake force distribution**
- 5. Brake force distribution in 4 areas**
- 6. Tractor / Trailer harmonisation**

Features EBS

- 7. Equal lining wear**
- 8. Lining wear indication**
- 9. Integration 3^e brake (DEB, Intarder)**
- 10. Integrated SMR (Slepp Moment Regelung)**
- 11. Shorter response times**
- 12. Shorter pressure build-up times**

Features EBS

Features	Benefits of EBS	Explanation
<p>1. High degree of safety</p>	<ul style="list-style-type: none"> • Shorter stopping distance 	<p>The shorter response times of the electrically brake control gives theoretically a stopping distance reduction of the length of a passenger car when braking from a speed of 100 km/h.</p> <p>The present DAF-vehicles have already a very good brake system.</p> <p>Factors who can influence the stopping distance;</p> <ul style="list-style-type: none"> - Brake temperature - Tyres - Road

Features EBS

Features	Benefits of EBS	Explanation
<p>1. High degree of safety</p>	<ul style="list-style-type: none"> • Constant monitoring of the system 	<p>Internal check at start, driving and braking</p> <ul style="list-style-type: none"> - Checking components and wire harness - Checking systems reactions: plausibility check interchanging pipes, pressure and functions <p>Store of failures</p> <ul style="list-style-type: none"> - Read out of actual and earlier occurred failures - Measure values by DACAT and DAVIE <p>Simple brake system check</p> <ul style="list-style-type: none"> - By active components check - By read out of measure values by DACAT and DAVIE



Features EBS

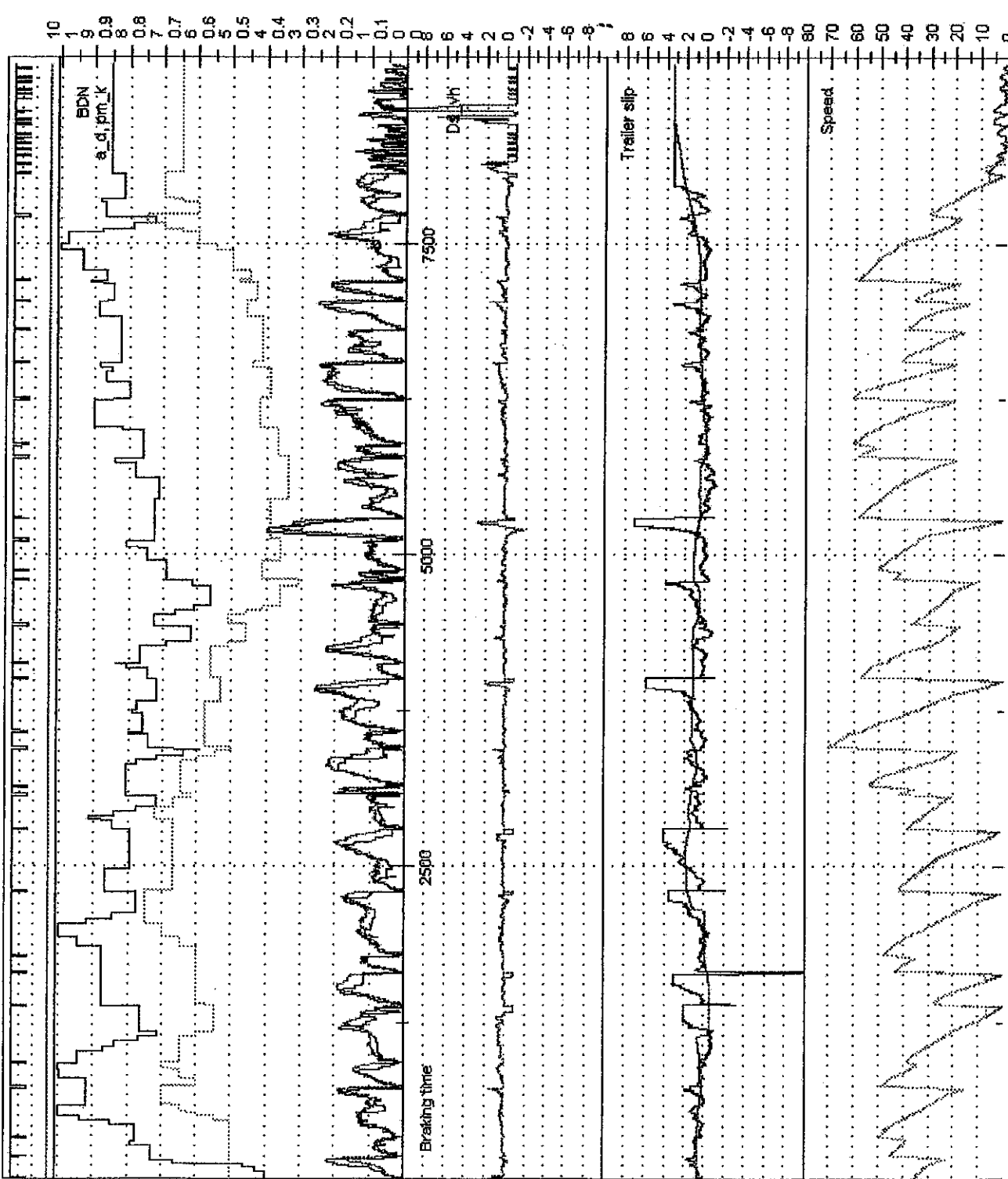
Features	Benefits of EBS	Explanation
2. Brake comfort / feeling	Feeling à la passenger car	<p>The feeling of the present DAF-vehicles is very good already. There is only a little improvement by EBS.</p> <p>Judging by 8 drivers Next experimental and production vehicles are compared:</p> <ul style="list-style-type: none"> • EBS-DAF FTG 6x2 with disk brakes • EBS-Actros 1831, rent production vehicle • EBS-Scania, rent production vehicle • DAF FT 95 conventional with drum brakes <p><u>Result:</u> The DAF-EBS vehicle is judged as the best</p>
3. Deceleration control	<ul style="list-style-type: none"> • Feeling independent of the load • Good release and response 	<ul style="list-style-type: none"> • Always the same deceleration by the same pedal travel, independent of the load conditions • Better dosage • Better release behaviour • The hysteresis of the service brake is quickly overcome through the deceleration control

10.707 EBS

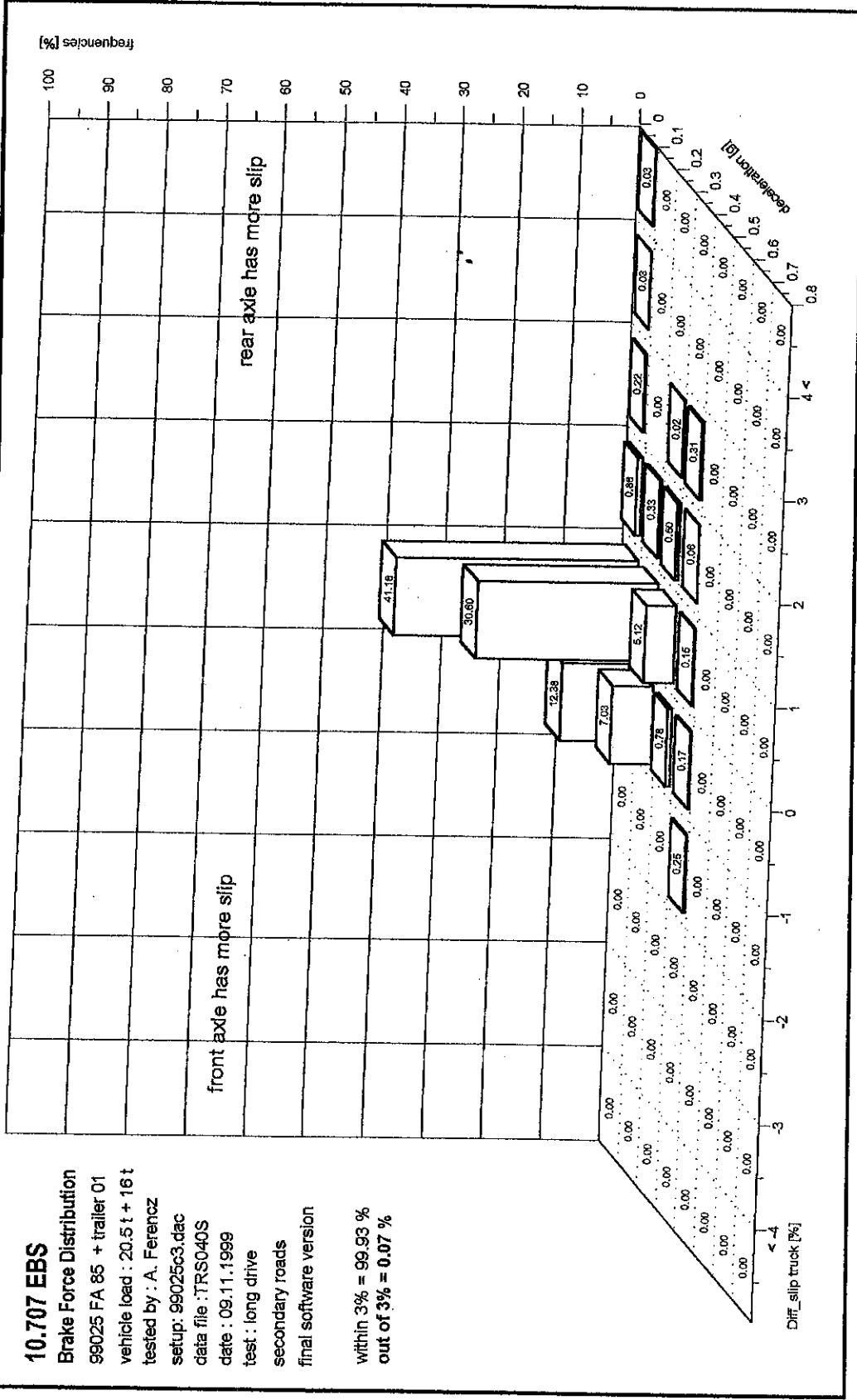
Brake Harmonisation

99025 FA 85 + trailer 01
 vehicle load : 20,5t + 16t
 tested by : A. Ferencz
 setup: 99025c3.dac
 data file : TRS04DS2
 date : 09.11.1999
 test : operational phase
 road μ : dry asphalt
 BON Nr.: 26924, 27507

- abs_active [0/1]
- BSwitch [0/1]
- BDN [bar/g]
- a_yeh [g]
- a_comp [g]
- pm_k [%]
- DSnoABS [%]
- tr_slip [%]
- tr_tendency [%]
- truck [km/h]
- trailer [km/h]



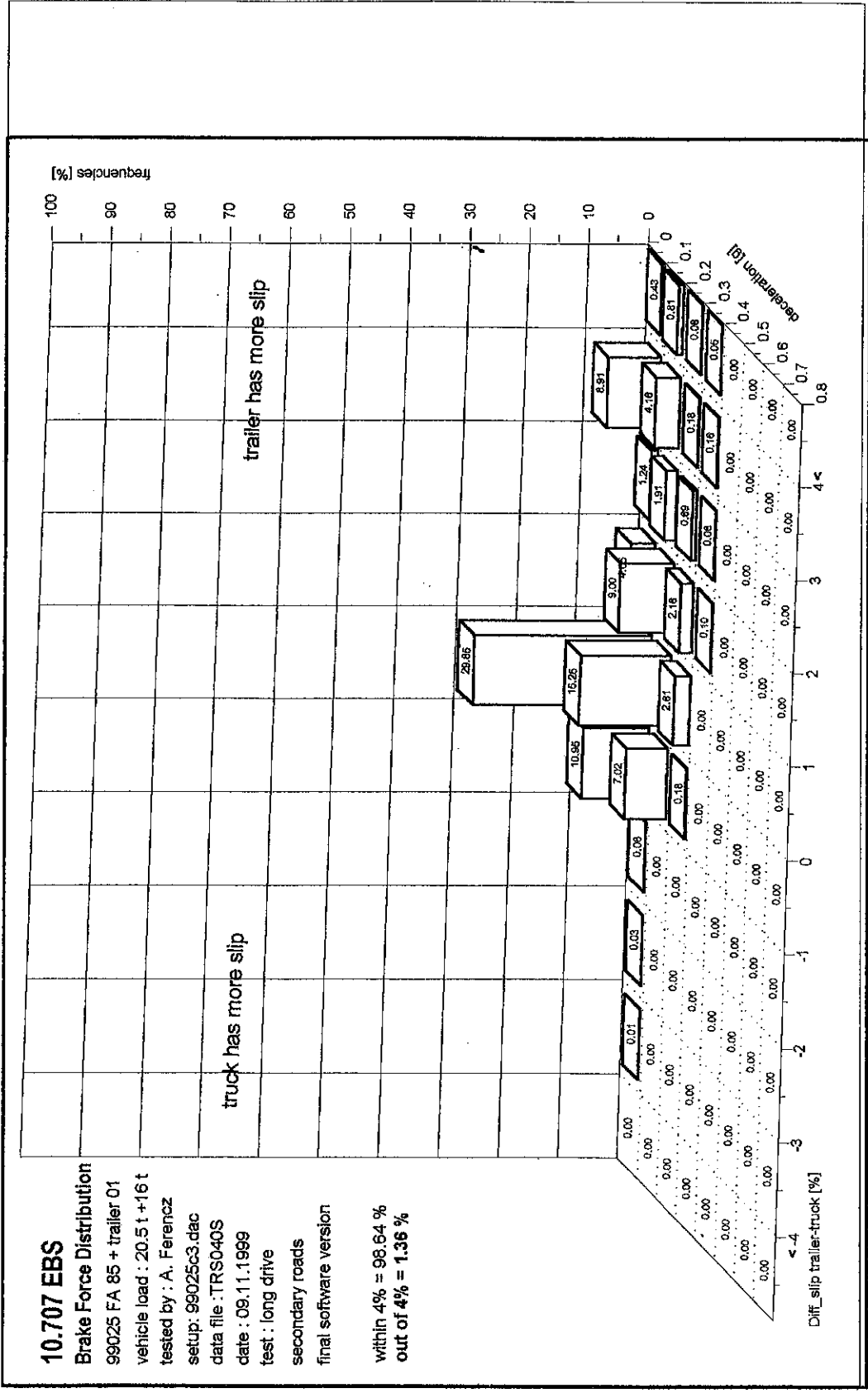
Slip difference front / rear axle



Features EBS

Features	Benefits of EBS	Explanation
<p>4. Slip- optimized brake force distribution</p>	<p>Optimal road friction use</p> <p>Elimination of:</p> <ul style="list-style-type: none"> • Load sensing valve • LSD-variants • LSD-adjustments 	<p>Adaptive, slip-optimized brake force distribution by using wheel speed sensors</p> <p>Always optimal road friction use in spite of variety of vehicles with different:</p> <ul style="list-style-type: none"> • Axle loads • Wheelbase • Height of gravity
<p>5. Brake force distribution 4 areas</p> <ul style="list-style-type: none"> • response time • Optimizing of wear • Optimizing of adhesion • Push-through 	<ul style="list-style-type: none"> • Quick response of the service brakes by inshot • Optimizing of wear and stability • Full supply pressure in the brake cylinders by full- braking 	<p>The service brakes are immediately stand by when the brake switch in brake signal transmitter is switch on.</p> <p>Difference between stability critical and stability non critical braking, therefore optimizing of wear possible.</p>

Slip difference Tractor / Trailer



10.707 EBS
 Brake Force Distribution
 99025 FA 85 + trailer 01
 vehicle load : 20.5 t +16 t
 tested by : A. Ferencz
 setup: 99025c3.dac
 data file : TRS040S
 date : 09.11.1999
 test : long drive
 secondary roads
 final software version

 within 4% = 98.64 %
 out of 4% = 1.36 %



Simon de Cock

Rig Testing

IRTEENZ conf 11-13 July 2000

Features EBS

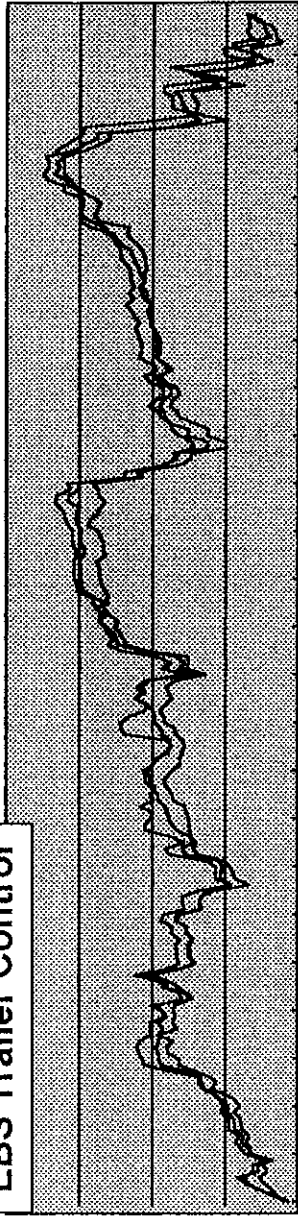
Features	Benefits of EBS	Explanation
<p>6. Tractor / Trailer harmonisation</p> <ul style="list-style-type: none"> • Trailer-Inshot • Response pressure • "Bandlage Regelung" 	<p>Improvement of the compatibility</p>	<ul style="list-style-type: none"> • De tractor and the trailer are adapted to each other by the "Bandlage Regelung" • Better compatibility especially by different combinations • Optimal compatibility by using the wheel slip if the trailer has also EBS
<p>7. Equal lining wear</p>	<p>Equal and longer durability of the lining</p>	<p><u>With lining wear sensors:</u> Different in wear will be minimized</p> <p><u>Without lining wear sensors:</u> _ By software, the same specific conversion of energy</p> <p>Tests are very extensive; results on the base of:</p> <ul style="list-style-type: none"> • Experience out in the field with EBS vehicles • Temperature measurements • Verification of the control by readjusting the lining wear sensors



Compatibility between Truck and Trailer

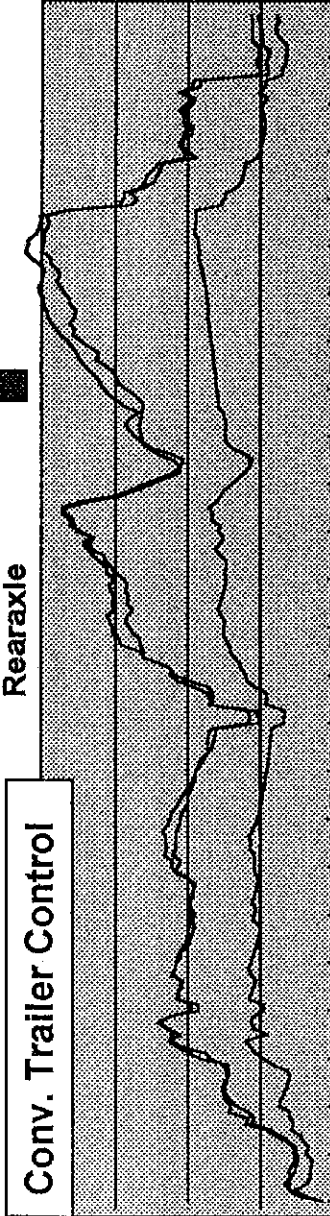
Lining Wear Balance

+ Lining Wear Rationalization
 + Minimum of total lining wear
 + Preservation of resources



EBS Trailer Control

■ Trailer
 ■ Truck Front and Rearaxle



Conv. Trailer Control

Course of Time

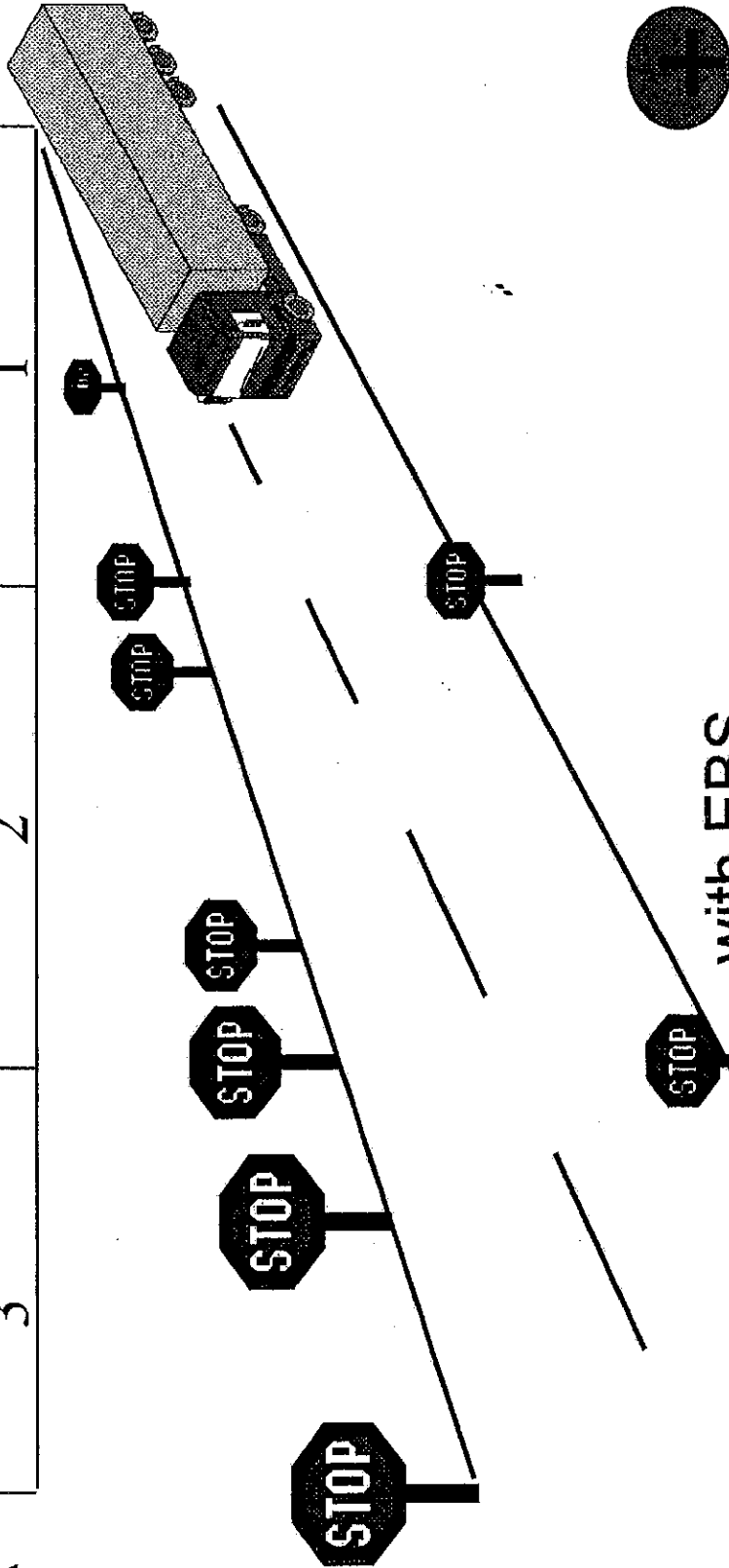
- Lining wear imbalance
 and
 - low service life level



w/o EBS

FA	5	4	3	2	1
RA	3		2		1

Lining wear changes



with EBS

FA STOP	3	2	1
RA	3	2	1

650.000 km



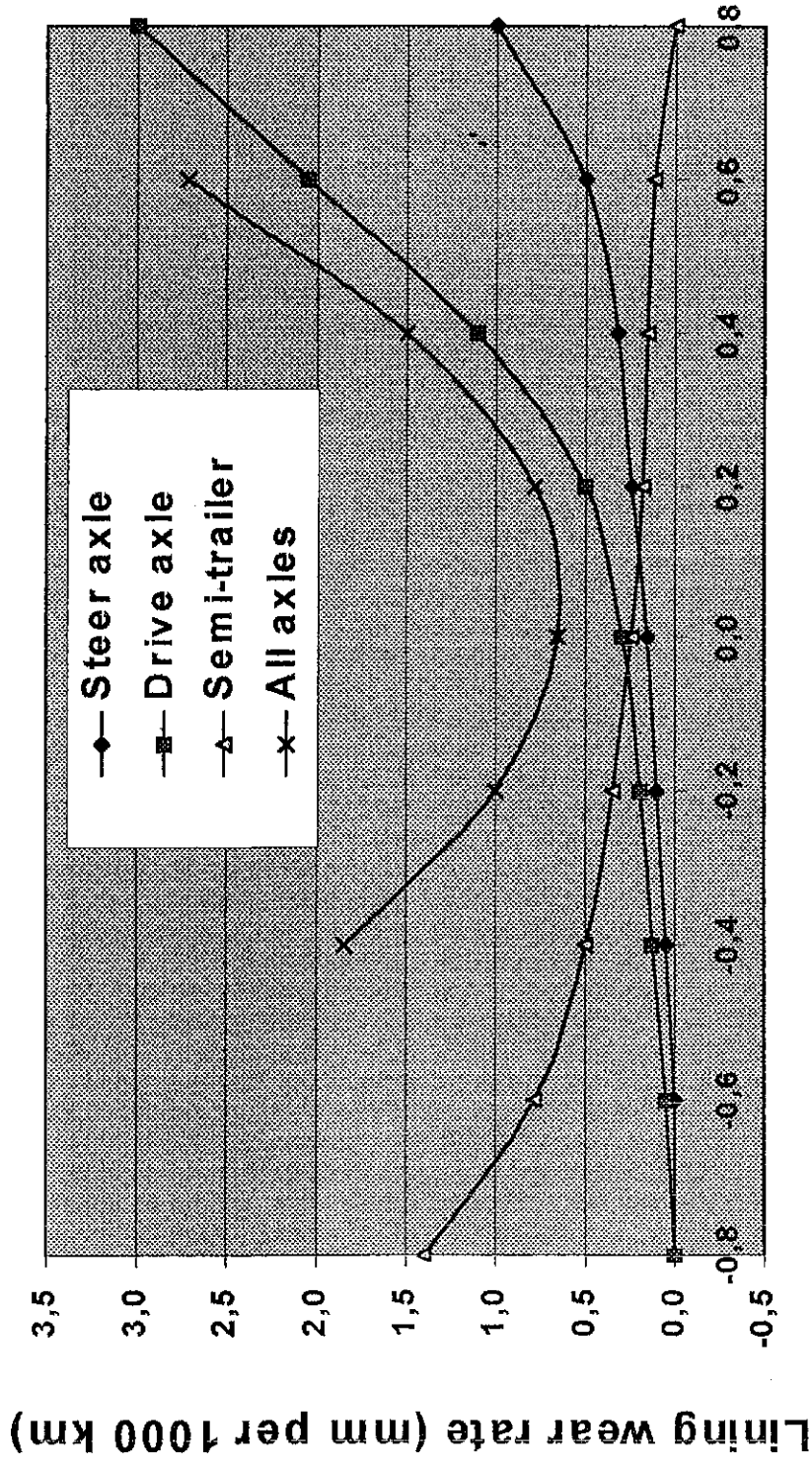
Features EBS

Features	Benefits of BS	Explanation
8. Lining wear indication	<ul style="list-style-type: none"> • Rest of the lining can be indicated • Efficient service-mean times 	<p>Make use of the signals of the lining wear sensors</p>
9. Integration 3 ^e brake (DEB, Intarder)	<ul style="list-style-type: none"> • Decrease of lining wear • Service brakes are staying cool, full performance for panic braking 	<ul style="list-style-type: none"> • The brake pressures in the cylinders of the total combination can be reduced until to the threshold pressure because of the contribution of the 3^e brake. The service brakes stay fully operational. • In the normal situation there is a small part of the service brake present to guarantee a comfortable control.
10. Integrated Stepp-Moment-Regelung (SMR)	Higher stability on low μ road	<p>Tendency to blocking of the driven axle(s) as a consequence of the friction moment in the drive line will be prevented by actively increasing the engine speed. Condition: the clutch must be closed</p>

Features EBS

Features	EBS-PROTO 95007 FTG 95 6x2	Conventional PROTO'S	Explanation
<p>11. Response times [ms]</p> <ul style="list-style-type: none"> • Front axle • Rear axle • Pm with 0,4 l 	<p>90 90 115</p>	<p>(FA 95)</p> <p>150 220 130</p>	<p>Average value <u>By EBS</u></p> <ul style="list-style-type: none"> • Equal response of the service brake at the front axle and rear axle by the inshot • Equal response of the service brakes of the tractor and the trailer if the trailer has EBS • Shorter response times
<p>12. Pressure build-up times [ms]</p> <ul style="list-style-type: none"> • Front axle • Rear axle • Pm with 0,4 l 	<p>320 300 320</p>	<p>270 tot 350 410 tot 420 290 tot 310</p>	<p>Average value</p> <ul style="list-style-type: none"> • With 6,6 bar, 75 % • One supply pipe to the PRV of the front axle <p><u>Bij EBS</u></p> <ul style="list-style-type: none"> • On front axle and Pm around the same, The rear axle considerable better pressure build-up times as conventional • Pressure build-up times on all axles around the same value

Influence of Threshold pressure



Threshold pressure difference
(semi-trailer - towing vehicle) [bar]

