

ARTSA MEETING ON BRAKES NOVEMBER 2003

discussion of factors
contributing to current
combination vehicle
brake incompatibility



PUBLISHED AGENDA

- European trucks with load sensing (EBS) and trailers without
- S-cam trucks and disc braked trailers
- Over-braking on disc braked trailers
- Premature pad wear on disc braked trailers

- Current ADR limitations
- Solutions?



BRIEF HISTORY

- 1979 – ADR35 introduced...
hot topic was combination vehicle
brake compatibility (or lack of!)
- 1984 – ADR38 introduced...
hot topic was combination vehicle
brake compatibility (or lack of!)
- 1987 to 1998 - review of ADRs...
hot topic was combination vehicle
brake compatibility
(or lack of!)



WHAT IS COMPATIBILITY?

- **ADHESION BALANCE**
Simultaneous application of brake force between each wheel and road proportional to its load (max decel before wheel lock/instability)
- **THERMAL BALANCE**
Dissipation of energy by each wheel brake proportional to its thermal capacity (even temp thus even wear)

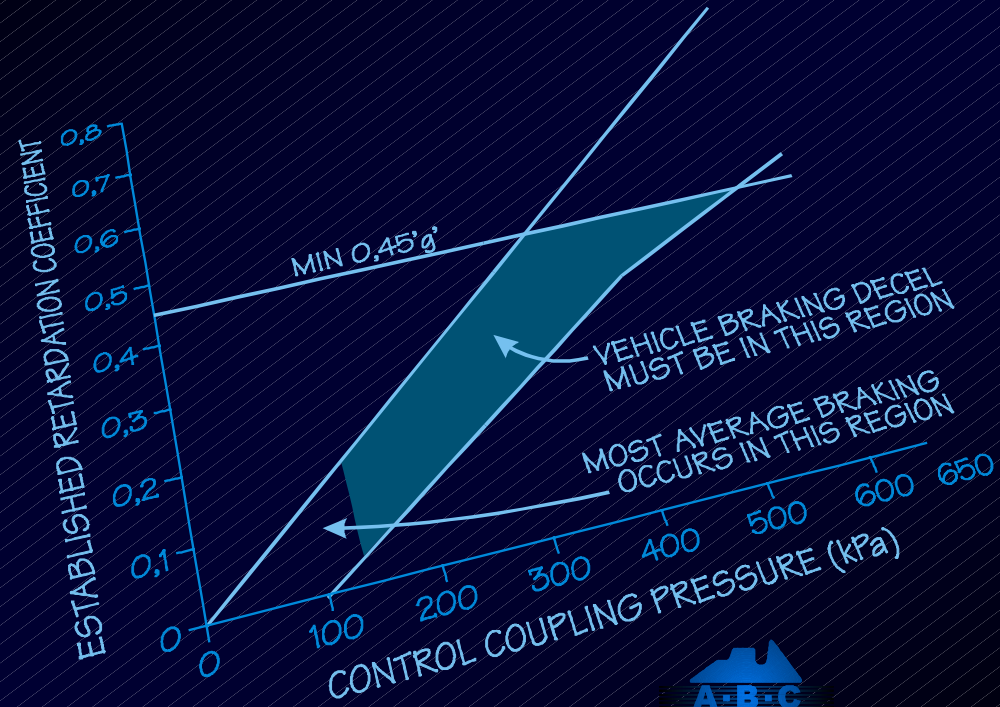


ADR LIMITATIONS

- ADRs primarily concerned with safety, and not very effective at that!
- Compatibility ('ERC') envelope only addresses laden condition
- Compatibility envelope too wide
- Wear balance NOT considered!
- Adhesion balance NOT assured
- Stability (ABS) NOT mandated



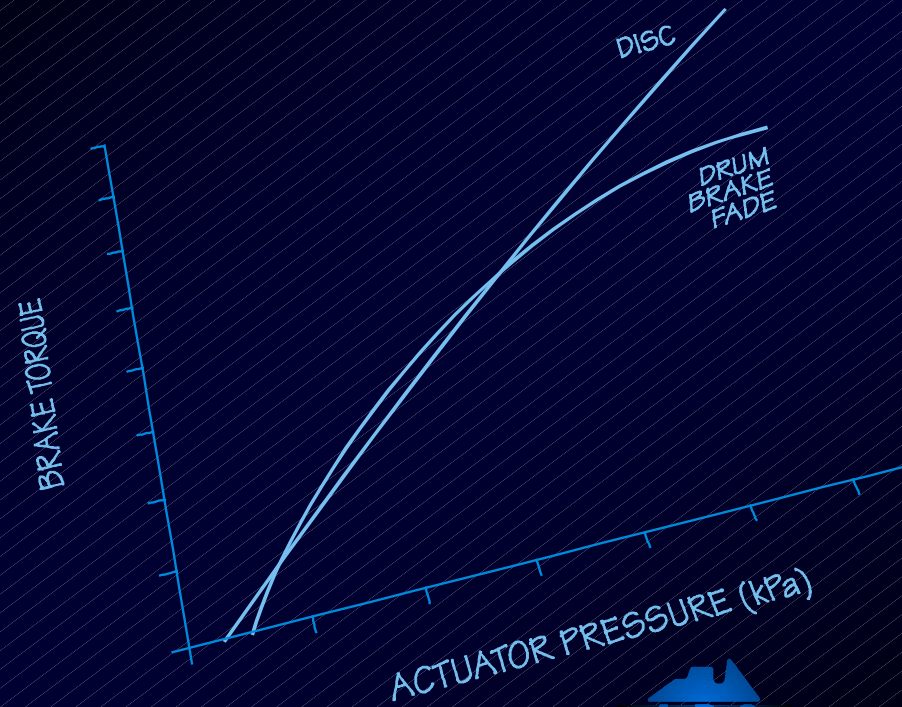
ADR LIMITATIONS



DRUM vs DISC

- Contact pressure different
- Pressure vs torque rise different...
- Servo characteristic?
- Fade (or lack of)
- Hysteresis

DRUM vs DISC

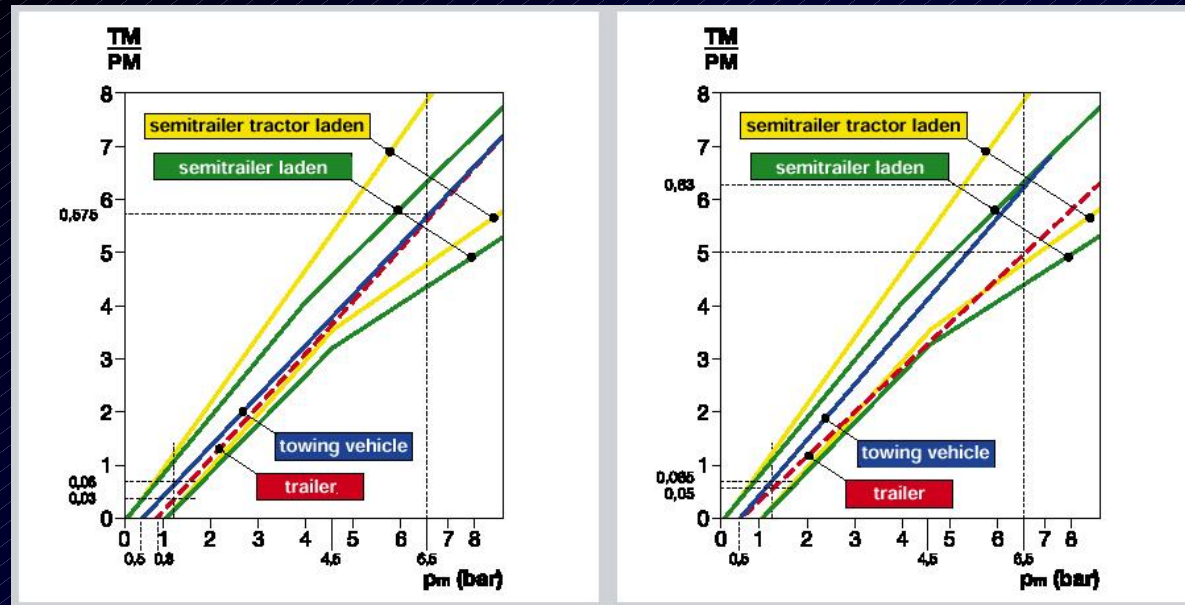


WHAT'S IT ALL MEAN?

- Wear balance (low pressure) and adhesion balance (mid to high pressure) not always in sync, even in fully laden condition
- ADRs allow both (in laden condition) but do not assure either
- Two examples of possible combination brake characteristics within ADR (ECE) envelope...



WHAT'S IT ALL MEAN?



poor wear
balance

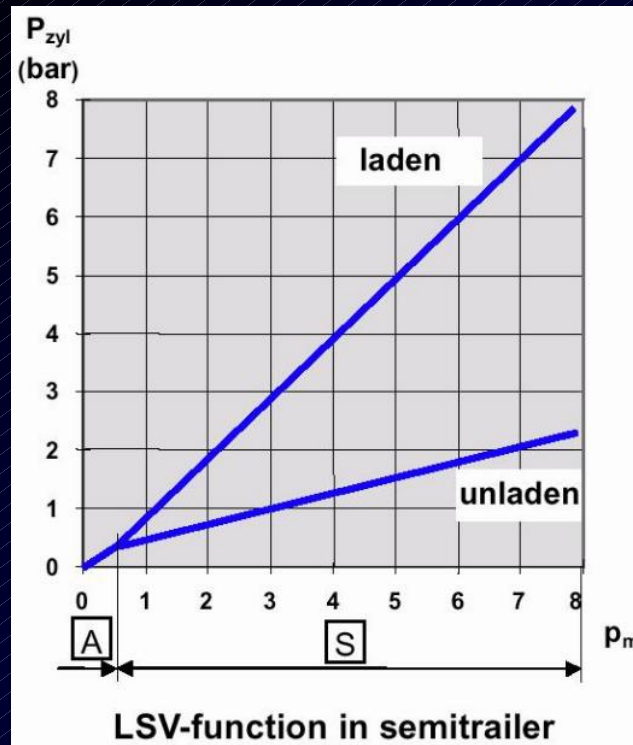
poor adhesion
balance

LOAD SENSING

- Standard in Europe since 1970s on both towing vehicles and trailers
- Primary purpose to improve unladen brake feel and adhesion balance, but only if on all vehicles in combination
- Can degrade adhesion balance (stability) and wear balance if not on all vehicles in combination
- Does NOT prevent wheel lock (instability)

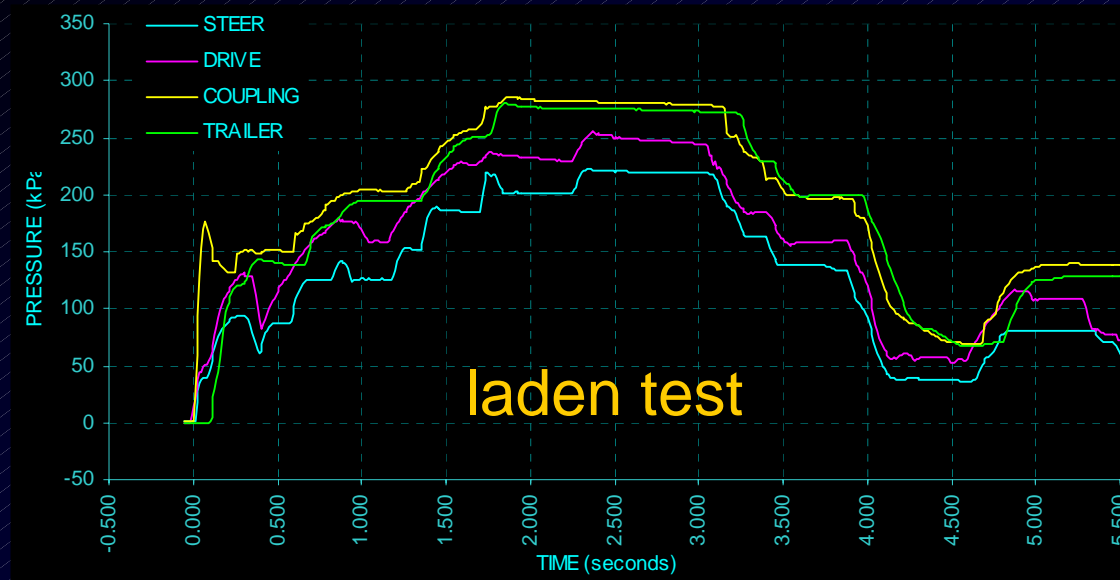


TYPICAL CHARACTERISTIC



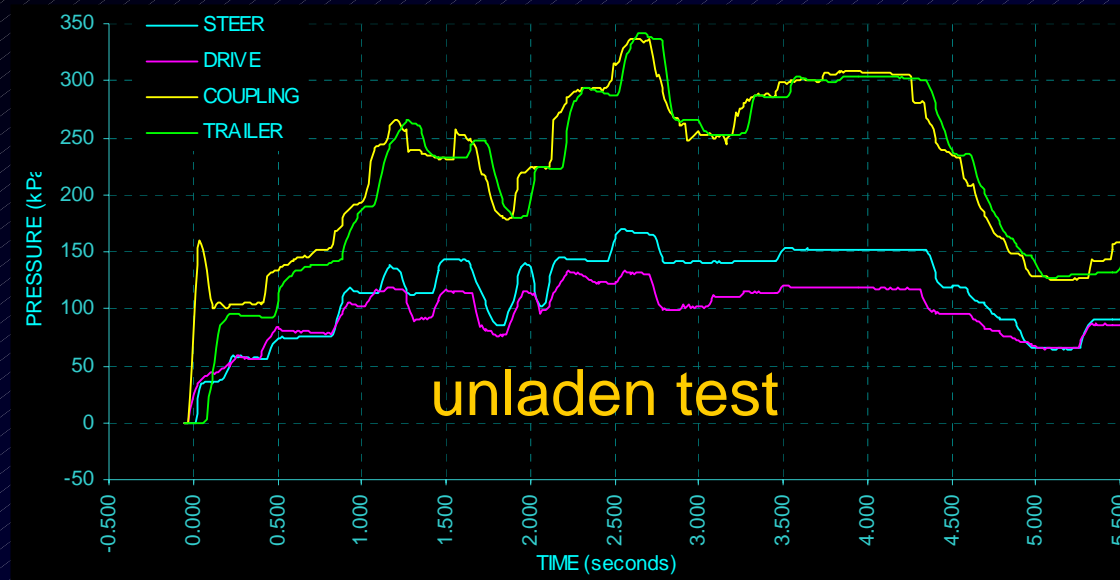
No effect till about 70kPa (when all brakes contact)
Dramatic effect in 'wear range' (up to about 200kPa) and beyond ('adhesion range')

LOAD SENSING



6X4 with load sensing (EBS)
triale semi without

LOAD SENSING



6X4 with load sensing (EBS)
triaxle semi without

LOAD SENSING and ADRs

- ADRs only affect new vehicles
- If mandated, load sensing will improve unladen feel and adhesion balance on new towing vehicles coupled to new trailers
- Will degrade adhesion balance (stability) and wear balance on new vehicles with load sensing coupled to older vehicles without (some years yet)



LOAD SENSING and ADRs

- Current ADR38 requires trailer LSVs to be disabled when coupled to towing vehicle without, to prevent possible instability (and uneven wear)
- ADR35 should arguably apply same logic, but does not, so new prime movers with load sensing (EBS) causing more and more incompatibility issues (uneven wear)



LOAD SENSING and ADRs

- Possible exception...
if vehicle in combination without load sensing has ABS, instability will be prevented (current PBS logic), but brakes will still wear unevenly
- Nevertheless, outside PBS, requires driver to identify vehicles with load sensing or ABS, and operate LSV override control accordingly

'HALF' LOAD SENSING

- Some promoting trailer load sensing with intermediate setting to balance adhesion of light tare trailers to towing vehicles without load sensing
- Difficult to write into ADR as setting dependant on towing vehicle
- Trailer still overbraked behind towing vehicle with load sensing

'HALF' LOAD SENSING

- Pneumatic load sensing valves...
20+ year old 'dumb' technology!
- Why adopt last century's outdated technology and then dilute it's effectiveness with a half way setting?
- Europe now adopting 21st century 'intelligent' technology (EBS)
- Even China now mandating ABS!



'IDEAL' BRAKE SYSTEM

- Should slow the vehicle down in a controlled, stable, predictable, and repeatable manner, regardless of road, load, weather, or partial failure
- In emergency, should retain all of above whilst stopping the vehicle in shortest possible distance
- Should never wear out, last forever, and cost nothing



'IDEAL' BRAKE SYSTEM

- Instant, consistent, and repeatable response to driver input (minimal pneumatic lag, hysteresis, load sensitivity, fade)
- Redundancy in system design
- Thermal load within design capability of friction brake (no overheating/fade)

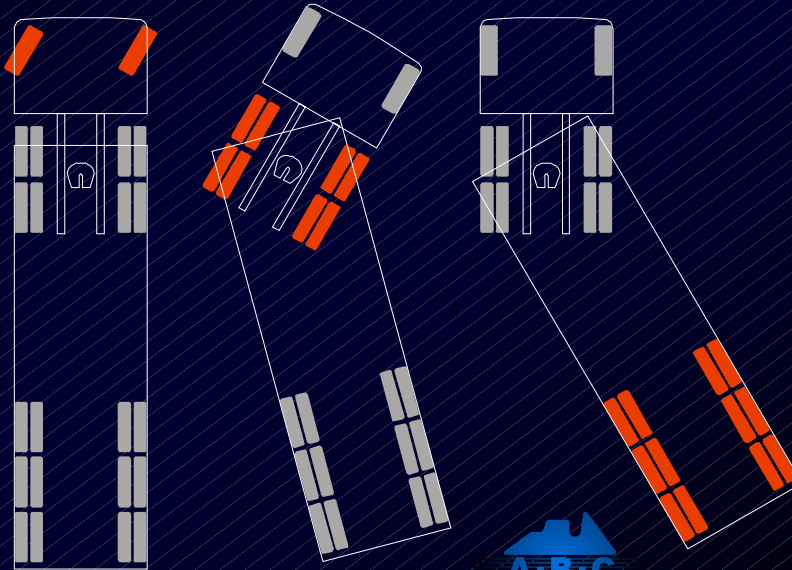


'IDEAL' BRAKE SYSTEM

- Utilise but not exceed max available adhesion for min stopping distance with no wheel lock (only possible in all conditions with ABS)
- Equal adhesion utilisation at all wheels (aim of ADR compatibility envelopes and load sensing but not necessarily essential with ABS)

ADHESION IMBALANCE

adhesion imbalance = premature wheel lock...



'IDEAL' BRAKE SYSTEM

- Thermal load within design capability of friction brakes (no overheating)
- Thermal load shared equally by all friction brakes, especially at low end (even temp = even wear)

Load sensing no guarantee unless contact pressure also balanced (load sensing generally set for adhesion balance)



ENTER EBS



- Faster apply and release for...
- Shorter stopping distance
- Synchronous towing vehicle and trailer braking (no pneumatic 'lag')
- Improved brake 'feel'

TEBS FEATURES

- Integral ABS for guaranteed stability
- Roll stability system (RSS) via active braking for safer cornering
- In dash warning of low trailer air
- Optional disc pad wear sensing
- Electronic load sensing for improved adhesion and wear balance (if towing vehicle and trailer/s are matched)

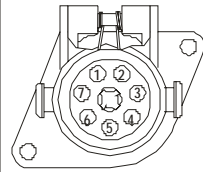
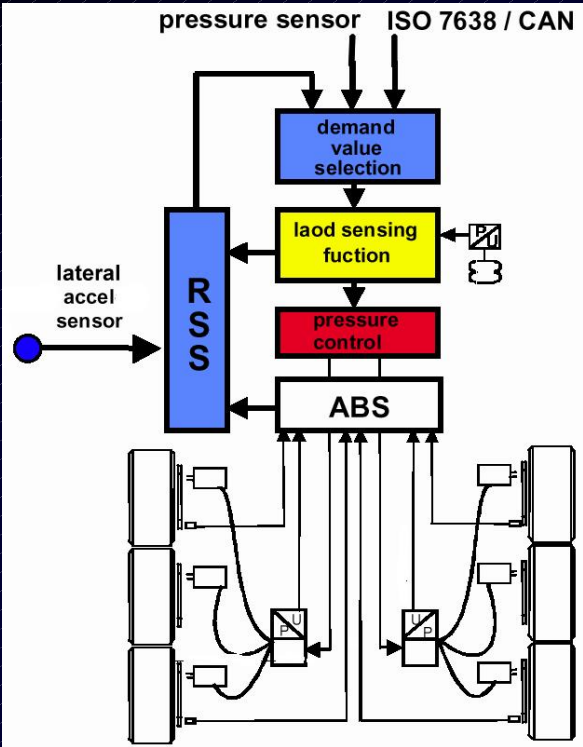


TEBS FEATURES

- Forthcoming software update will provide data logging functions...
- total and recent kilometres travelled
- average and maximum speed
- number of brake applications
- average and maximum pressure
- brake apps via hand control
- number of RSS events
- max lateral decels, etc.



TEBS FUNCTION



- 1 - battery +ve
- 2 - ignition +ve
- 3 - ignition -ve
- 4 - battery -ve
- 5 - dash lamp
- 6 - CAN high
- 7 - CAN low

block diagram

WABCO
D-GENeration
TEBS

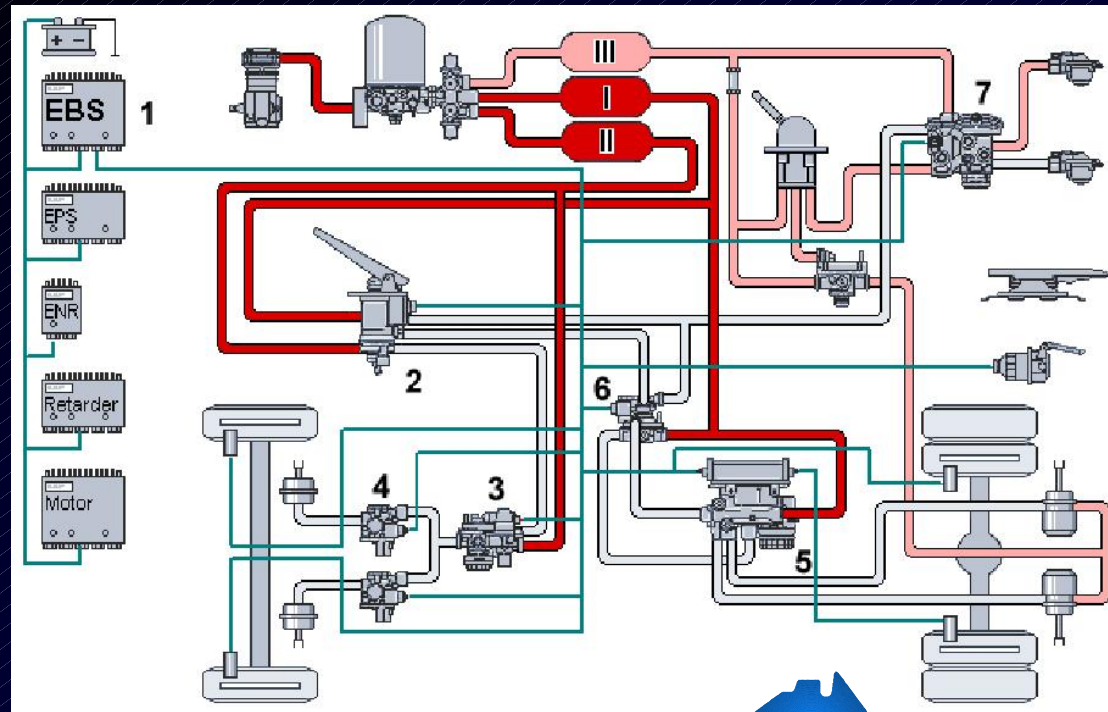


RSS (ROLL STABILTY)

- Lateral accelerometer in ECU/modulator assy
- When lateral accel exceeds 0.3g, 'test' braking is initiated
- If left and right wheels show slip difference indicating impending rollover, max braking is applied to slow vehicle below rollover threshold



TOWING VEHICLE EBS



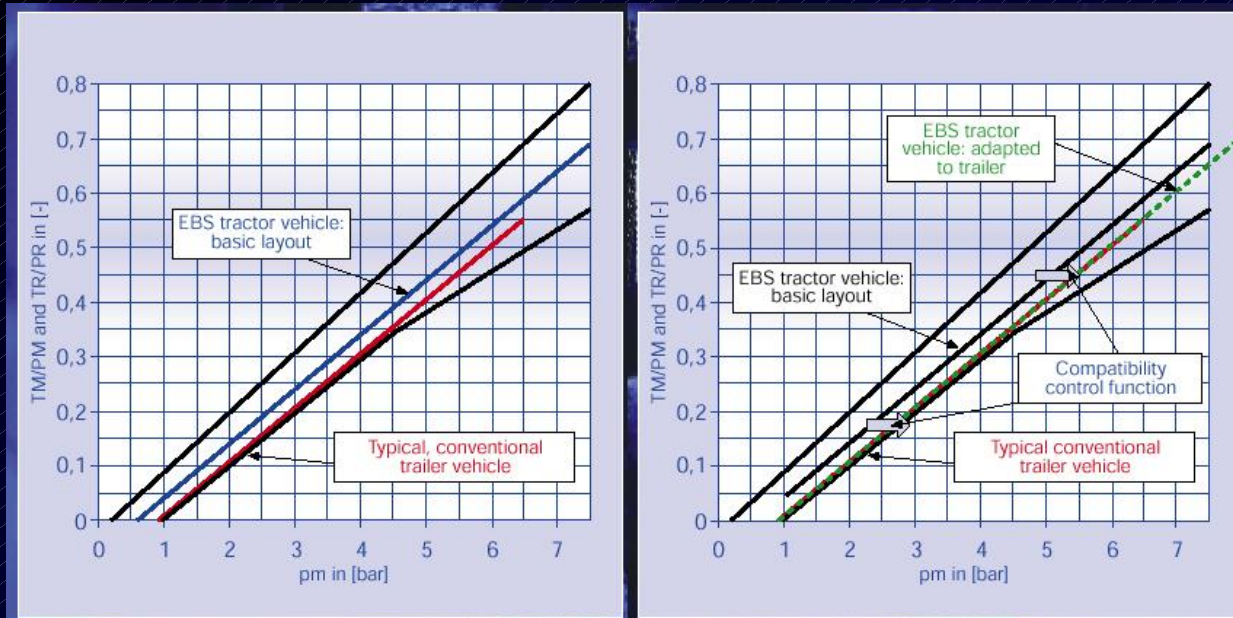
COMPATIBILITY CONTROL

- Automatic compatibility function by towing vehicle EBS...

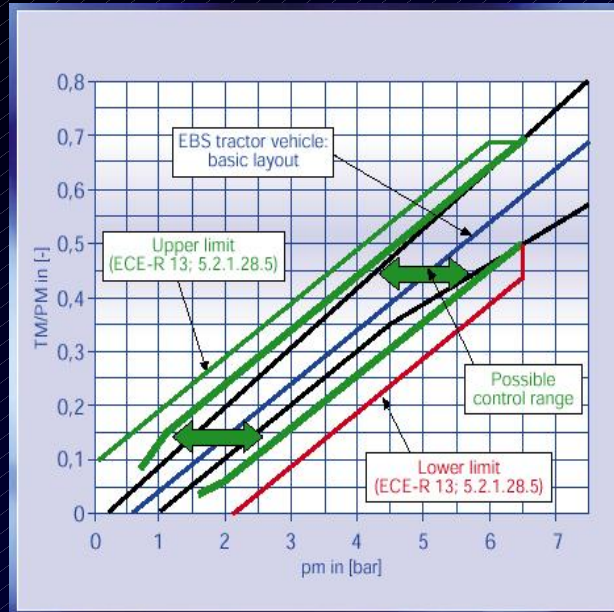
adjusts towing vehicle brake characteristic to 'fine tune' brake balance between towing vehicle and trailer (but assumes trailer braking somewhere near ECE bands... IE: load sensing)



COMPATIBILITY CONTROL



COMPATIBILITY CONTROL



ECE envelope widened for EBS towing vehicles to allow more scope for compatibility control to match errant trailers (but still won't match trailers w/o load sensing)

EBS and LOAD SENSING

- TEBS offers possibility of auto switching trailer load sensing function
- Behind towing vehicles with ISO7638 power (ABS), trailer electronic load sensing (and ABS/RSS) operative
- Behind older towing vehicles w/o ISO7638 power (IE: no ABS or load sensing), TEBS load sensing function is inoperative (also ABS/RSS)



EBS and ADRs

- TEBS currently only 24 volt
- Can be fitted with inverter to power off existing ADR spec 12 volt ABS connection (without CAN)
- However, generally spec'd for coupling to 24 volt Euro trucks with EBS, so best powered via 24 volt
- How to standardise for operation behind any towing vehicle?



FUTURE OF EBS

- Most towing vehicle EBS presently 'Euro' system – constrained by ECE 'compatibility' envelope, and 'expects' trailer with load sensing
- Forthcoming 'GEN2' EBS (on Japanese vehicles) adapts to trailers without load sensing – will have more aggressive truck brake characteristic
- Nth American EBS ?



SUMMARY

- Problems plaguing industry today are much the same as in the past
- Difference now is technology is available to fix most problems
- Difficulty as always in Australia is diverse vehicle mix (US, European, Japanese, 12/24V), poor appreciation of problem (and fix), and 'tech-shy' (read price-shy) market



BOTTOM LINE

- The 'IDEAL' brake system is now much closer with EBS
- EBS can deliver improvements in both performance (safety) and wear (maintenance), but...
- Careful consideration of fleet mix is still essential to ensure best possible compatibility with all vehicles

