Application of new technologies

IRTENZ 2023

Laszlo (Les) Bruzsa, Chief Engineer (NHVR)

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Infrastructure challenges

- Australia's growing freight task is one of the biggest infrastructure challenges
- Between 2011 and 2031, the total domestic land freight task will grow by 80%
- Driven by unprecedented population growth, coupled with increased demand for freight and rapid changes in technology, e-commerce and consumer behaviour

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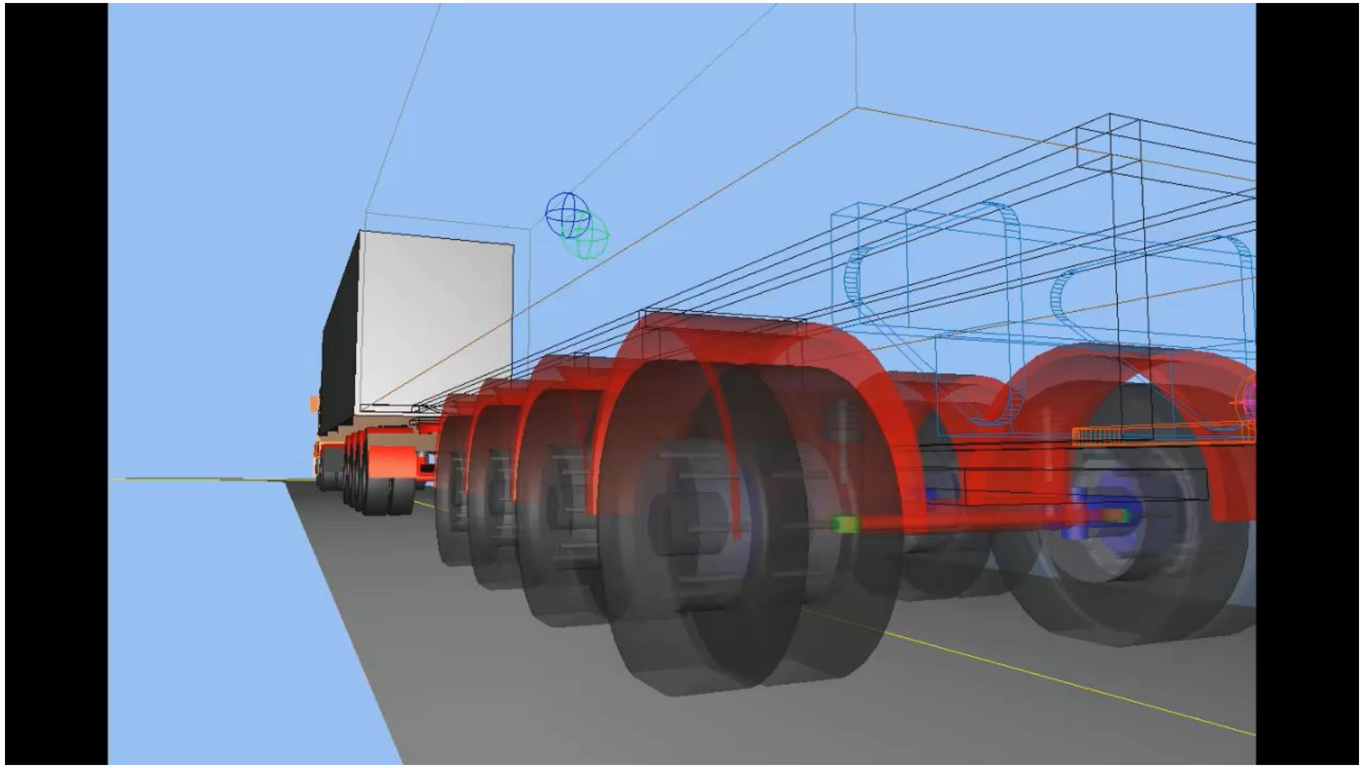
Application of existing technologies under PBS

- **Component designs:**
  - Steering systems: self steered or active steering systems, load transfer
  - Tyre technology
  - Braking systems
  - Axles
- **On-board mass systems**
- **Monitoring**
- **Vehicle dimensions**
- **Axle load limits**
- **Tyre inflation pressure limitations**
- **Exemptions from vehicle standards**



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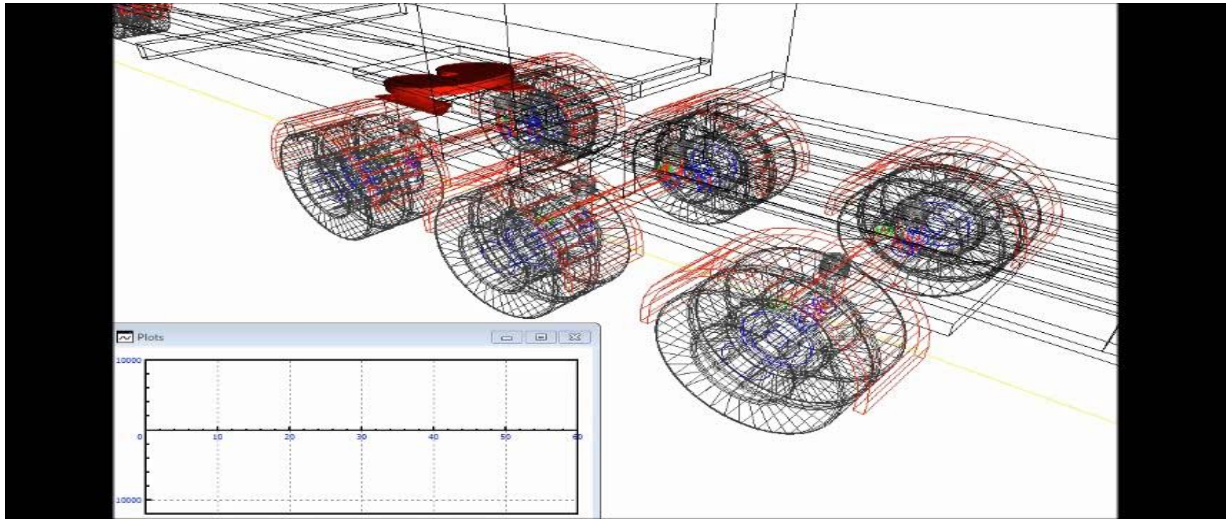
Steering systems

Application of steering technology



Application of technology

Steer axles are locked using Knorr-Bremse TEBS depending on the speed of the combination

One steer axle

Two steer axles

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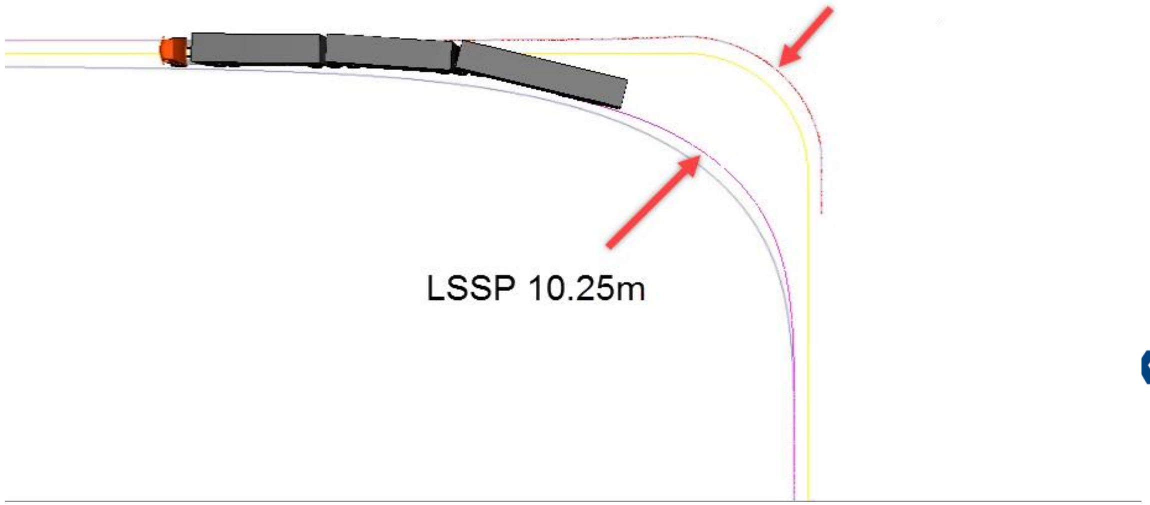
Knorr-Bremse TEBS (Trailer EBS) trailer brake module (TBM)

- PBS requirement for dual rear steer axles to lock at > 30km/hr
- Steer axles are "normally locked"
- Using the TEBS, the pneumatic output configured to apply air pressure to axle unlock actuators from 0 km/hr. to 30 km/hr. and then remove air supply (lock axles)
- Locking the axles for reversing represented a problem as steer axles may not be aligned
- Therefore the system was configured to operate a solenoid to cut supply to axle actuators and 'lock' axle at <6km/hr.



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Compliance with PBS specific performance requirements

- **PBS assessment specified self-steered axles for a PBS B-triple**
  - Self-steered axles are needed to achieve the required low-speed performance
  - Self-steered axles must be locked above 30 km/h
- **Knorr-Bremse TEBS (Trailer EBS) trailer brake module (TBM)**
- **The system provides full roll stability (RSP/RSC)**
- **TEBS has 9 programmable auxiliary functions available**
- **There are 8 electrical plus 1 x pneumatic functions**
- **Practically any function required that is related to speed or load may be configured**

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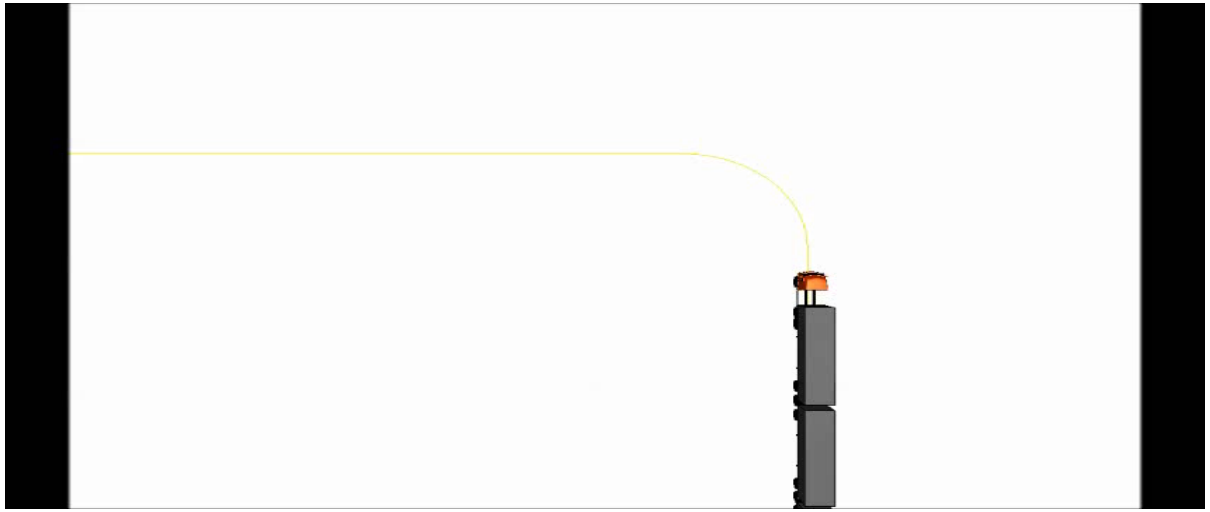
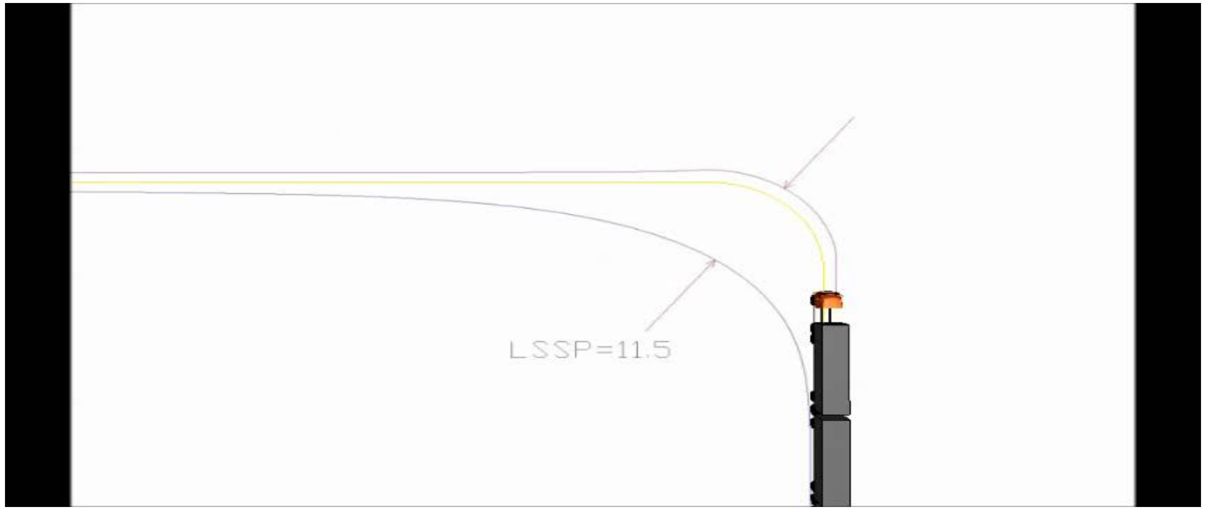
Application of technology

42m long PBS B-triple (no steer axles)



42m long PBS B-triple (steer axles)



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Application of technology - load transfer

- Improving performance by using technology: iCorner/iCargo
- A-doubles longer than 30 meters can comply with PBS Level 2 requirements – more bridge friendly
- iCorner is a function within the TEBS braking system which interfaces with the trailers air suspension system and monitors the input from the wheel speed sensors
- It detects when the vehicle is entering a turn, reduces the air pressure in the rearmost axle to improve cornering performance
- Lack of regulations

Source: Tiger Spider

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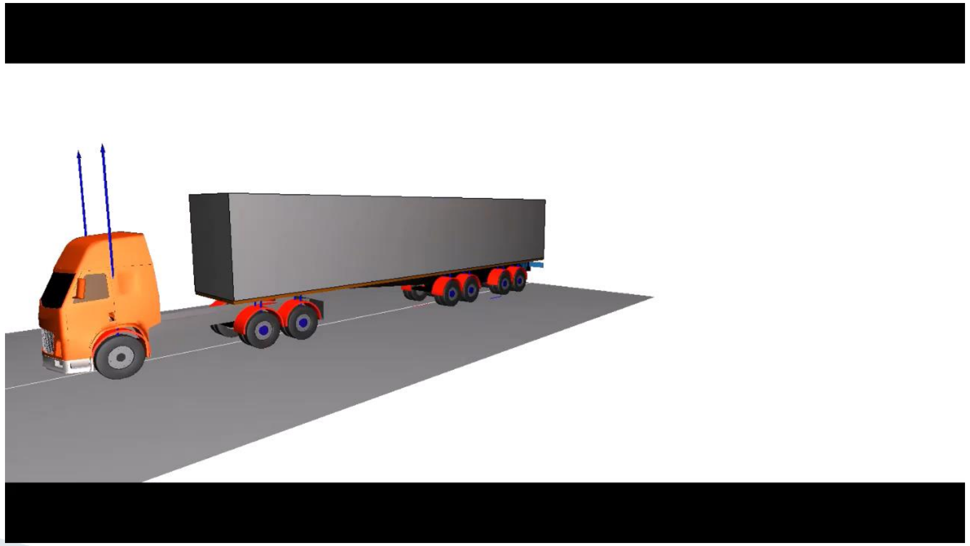
Steered axle on split axle combinations

Combinations fitted with two axle groups

- The popularity of these combinations are increasing
- Potential GCM increases
- There are no established standards for these designs
- Concerns/questions about load sharing performance under GML/CML/HML
- NHVR has organised field testing
- Access issues: impacts on bridges, pavements and registration categories and charges



Pavement Vertical Loading

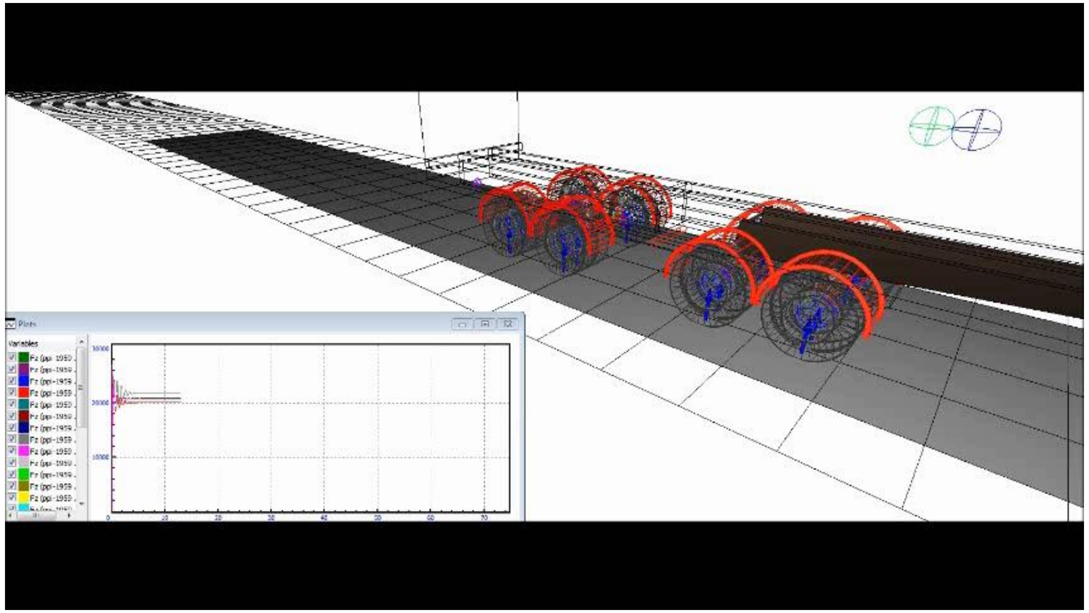
- To limit the stress imposed by the vehicle on the layers of the pavement
- Axle loads are specified in MDL
- PBS Vehicles have the same axle load limits as prescriptive combinations
- GML, CML, HML
- Quad axles can have 27.0t under PBS (QML)

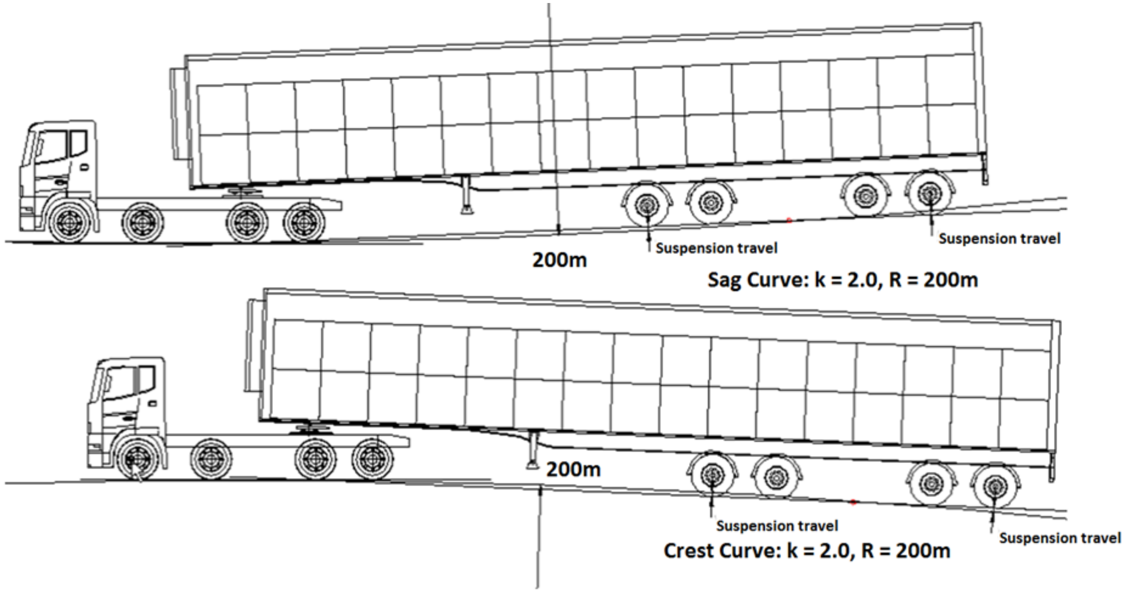
Axle Group Masses	GML	QML 1	QML 2
Steer (t)	6.5*	6.5*	6.5*
Drive (t)	16.5	17.0	17.0
Semi-Trailer (t)	20.0	21.0	27.0

* Complying steer axle

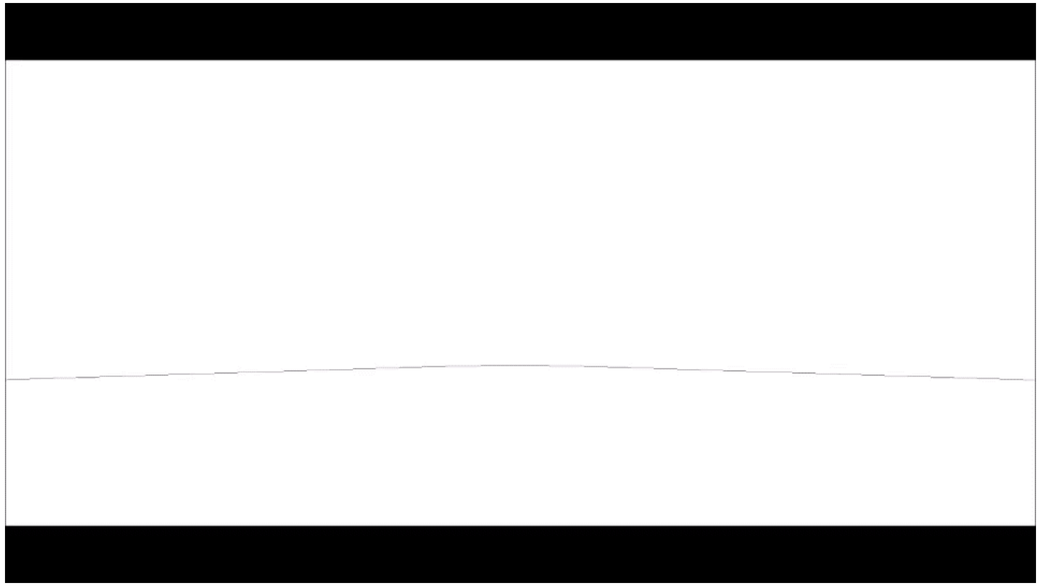
Axle type	Details	GML (t)
	Steer axle *Non steer axle, tyres < 375 mm*	*6.0* *6.0*
	Pig/tag trailer *Any other vehicle* *A typical bus*	*8.5* *9.0* *10.0*
	Single tyres on one ale and dual tyres on the other axle	*13.0*
	Pig/tag trailer *Any other vehicle* *A typical bus*	*15.0* *16.5* *14.0*
	Vehicles other than a pig trailer with single tyres of width at least 375 mm, or dual tyres	*20.0*
	Dual tyres on all groups, steerable rear axle, road-friendly suspension	*20.0*

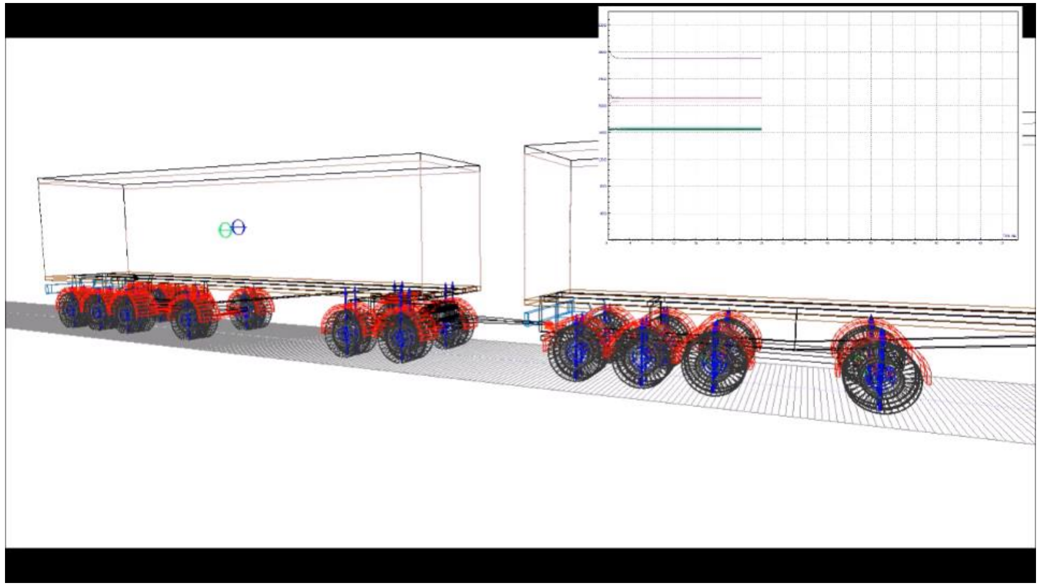
Split axle groups - new assessment methods are needed





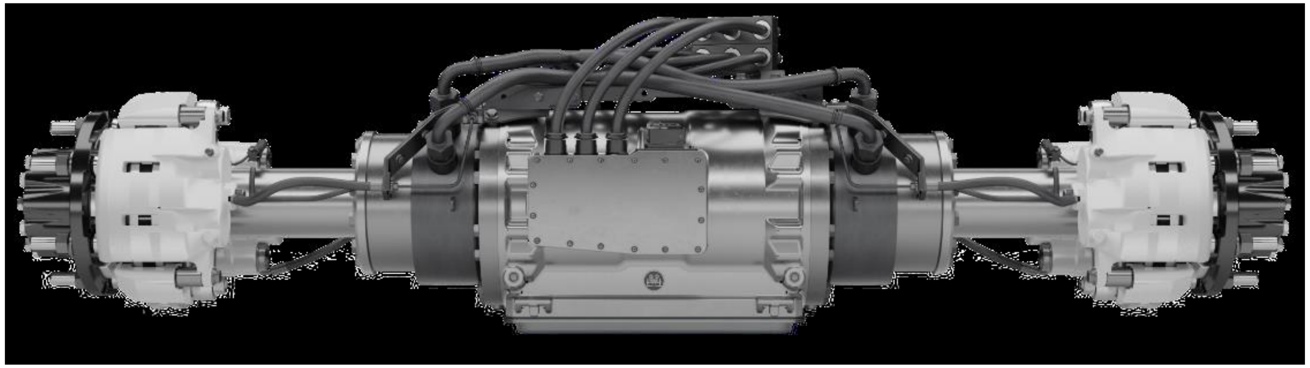
Split axle groups - new assessment methods are needed





Electric drive and trailer axles

- Application of electric drive axles on trucks and trailers
- Lack of regulations: not possible to register a trailer with a drive axle



Source: BPW

Decarbonization of the transport industry

- Significant challenge under the existing regulatory regime
- Example: Euro VI emission regulations will be introduced in Australian Design Rules (ADR 80/04)
- Mass limits increase is proposed for Euro VI trucks but additional road wear needs to be addressed
- Amendment of the Heavy Vehicle National Law (HVNL) to allow a 500kg increase in steer axle and gross mass limits for trucks over 15t GVM (does not apply for twin-steers and buses)
- If existing mass limits remain unchanged, this may inhibit the uptake of newer, safer and cleaner trucks
- Increased width limit for trucks (from 2.5m to 2.55m) would enable the use of wider tyres on drive axles as well as the steer axle
- Amendment of the relevant ADR requirements to increase the tyre pressure limit from 825 kPa to 900 kPa would also be required
- Increased width limit does not apply for trailers
- Electric trailers
- Low and zero emission truck trials in Australia
- Mass limits are different in different states
- South Australia:
  - Steer:7.5t, drive:18.5t
  - Twin-steer: 12t, drive:17t
- New South Wales: Steer: 8t, drive: 18.5t

Super single tyres are approved in PBS

NHVR

Project team

Funding and technical guidance: NHVR – HVSI Grant

Project lead by: Truck Industry Council

Supported by suppliers: Michelin and Goodyear

Pavement testing: Australian Road Research Board

Safety benefit: "The 7% improvement in the SRT when wide single tyres are fitted, should result in a 17% reduction in relative crash risk"

Member benefit: Support the efficient use of ultra-wide tyres and provide a wider choice of modern tyre designs and sizes.

Mass limits for super singles

- Current regulations for axle group limits are based on the section width of the tyre
- The regulations are based on three intervals, which do not sufficiently categorise the range of sizes available within the market
- The section width intervals are:
  - less than 375 mm,
  - between 375 mm and 450 mm,
  - greater than 450 mm

< 375 mm

- 255/70R22.5
- 265/70R19.5
- 275/70R22.5
- 11R22.5
- 295/80R22.5
- 315/80R22.5

375 mm and 450 mm

- 385/65R22.5
- 445/50R22.5

≥ 450 mm

- 455/55R22.5

Axle group	Single tyre (t)			Dual tyre (t)
	Width <375mm	Width >375mm & <450mm	Width >450mm	All widths
Single	6	6.7	7	9
Tandem	11	13.3	14	16.5
Tandem (HML)	11	13.3	14	17
Tri-axle	15	20	20	20
Tri-axle (HML)	15	20	20	22.5
Quad-axle[1]	15	20	20	20
Quad-axle (HML)[1]	15	20	20	27

Source: NTRO

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Current axle load limits

Axle groups on trailers	Single tyre (t)			Dual tyre (t)
	Width <375 mm	Width >375 mm & <450 mm	Width >450 mm	All widths
Single	6	6.7	7	9
Tandem	11	13.3	14	16.5
Tandem (HML)	11	13.3	14	17
Tri-axle	15	20	20	20
Tri-axle (HML)	15	20	20	22.5
Quad-axle[1]	15	20	20	20
Quad-axle (HML)[1]	15	20	20	27

1. PBS vehicles only

Note: Pig trailers have a reduced allowable mass

Source: NTRO

Current axle load limits



Axle groups on trailers	Single tyre (t)			Dual tyre (t)
	Width <375 mm	Width >375 mm & <450 mm	Width >450 mm	All widths
Tandem		13.3 - 3.2 t	14 - 2.5 t	16.5
Tri-axle		20	20	20
Quad-axle[1]		20	20	20

Source: NTRO

Current axle load limits

Axle groups on trailers	Single tyre (t)			Dual tyre (t)
	Width <375 mm	Width >375 mm & <450 mm	Width >450 mm	All widths
Single		6.7		9
Tandem		13.3		16.5
Tandem (HML)		13.3 0.0 t	← No HML	17 + 0.5 t
Tri-axle		20		20
Tri-axle (HML)		20 0.0 t	← No HML	22.5 + 2.5 t
Quad-axle[1]		20		20
Quad-axle (HML)[1]		20 0.0 t	← No HML	27 + 7.0 t

Source: NTRO

Motivation

Improving safety with increased uptake of next generation ultra base wide single tyres

Michelin
445/50R22.5

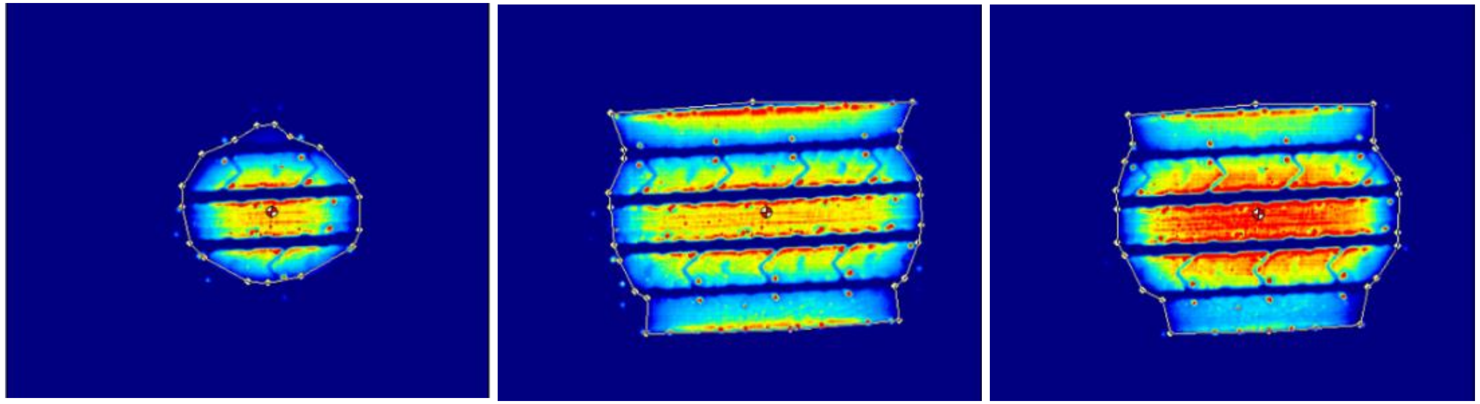
Michelin
385/55R22.5

Goodyear
11R22.5

Dunlop
255/70R22.5

Tyre / Pavement testing

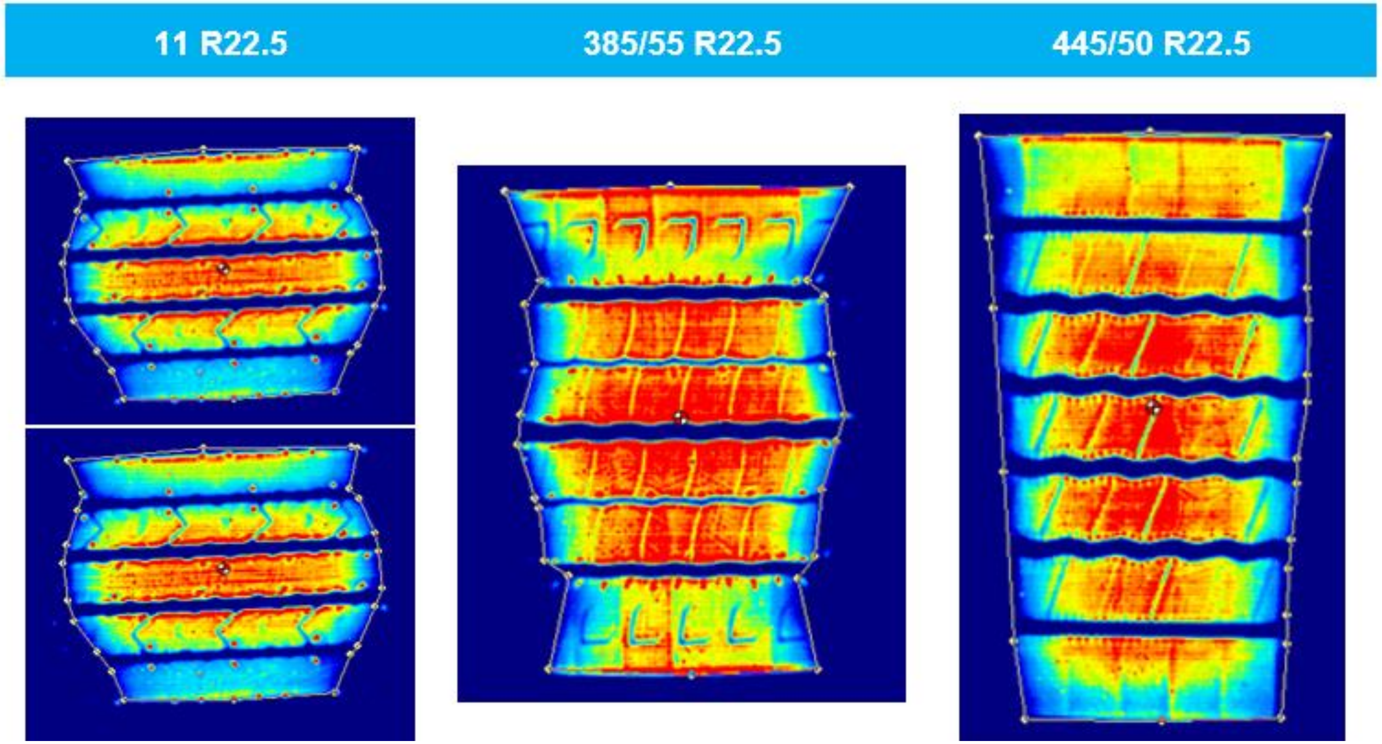
11R22.5 – Comparison of inflation pressure and loads



	Unladen 500kPa @ 1000 kgs	Laden 500kPa @ 1,875 kgs	Laden and Over Inflated 690kPa @ 1,875 kgs
Total Area	252 cm²	871 cm²	762 cm²
Average Pressure	98 psi	101 psi	112 psi
Percentage Area	34.7%	100%	83.5%

Author/s:
A.Germanchev, L.Bruzsa, C.Loose.

Pressure distribution comparison



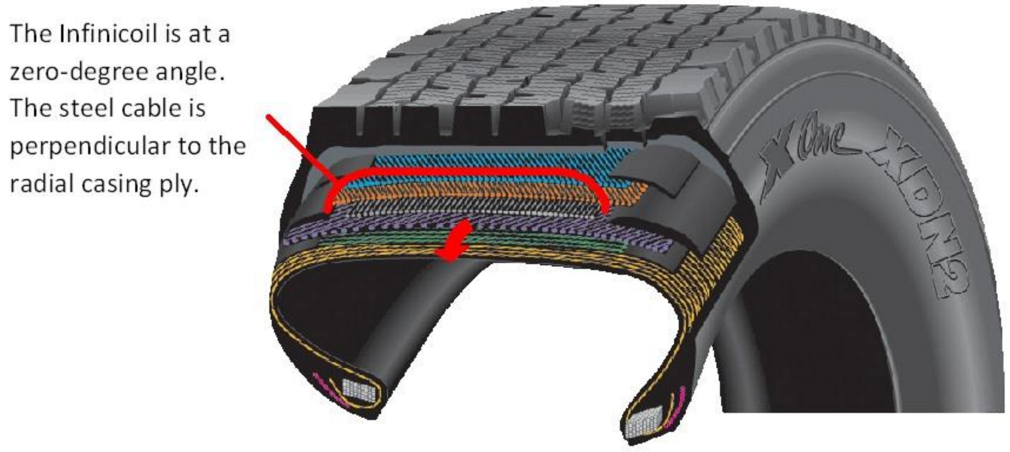
Centrally concentrated hotspot	hotspot – wider centre and edges	wider hotspot over a wider area

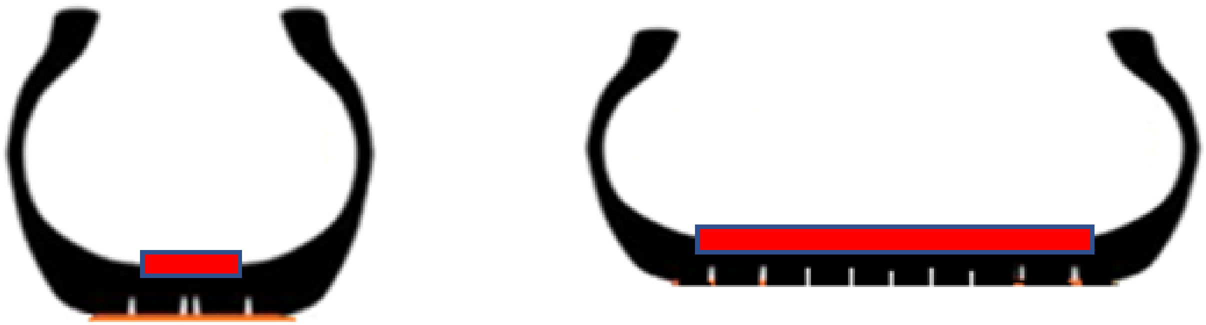
Author/s:
A.Germanchev, L.Bruzsa, C.Loose.

Modern tyre construction

- The construction of wide single tyres differs to an 11R22.5 tyre, due to lower sidewall height (low profile design) and wider tread width. The wide single tyre construction reinforces the tread area to retain a flat profile in the tread area (reducing the balloon effect) for a more consistent footprint and reduced deformation.

Michelin X One Ultra-wide





280 mm (11R traditional tyre)   445 mm (Ultra wide)

Test program completed

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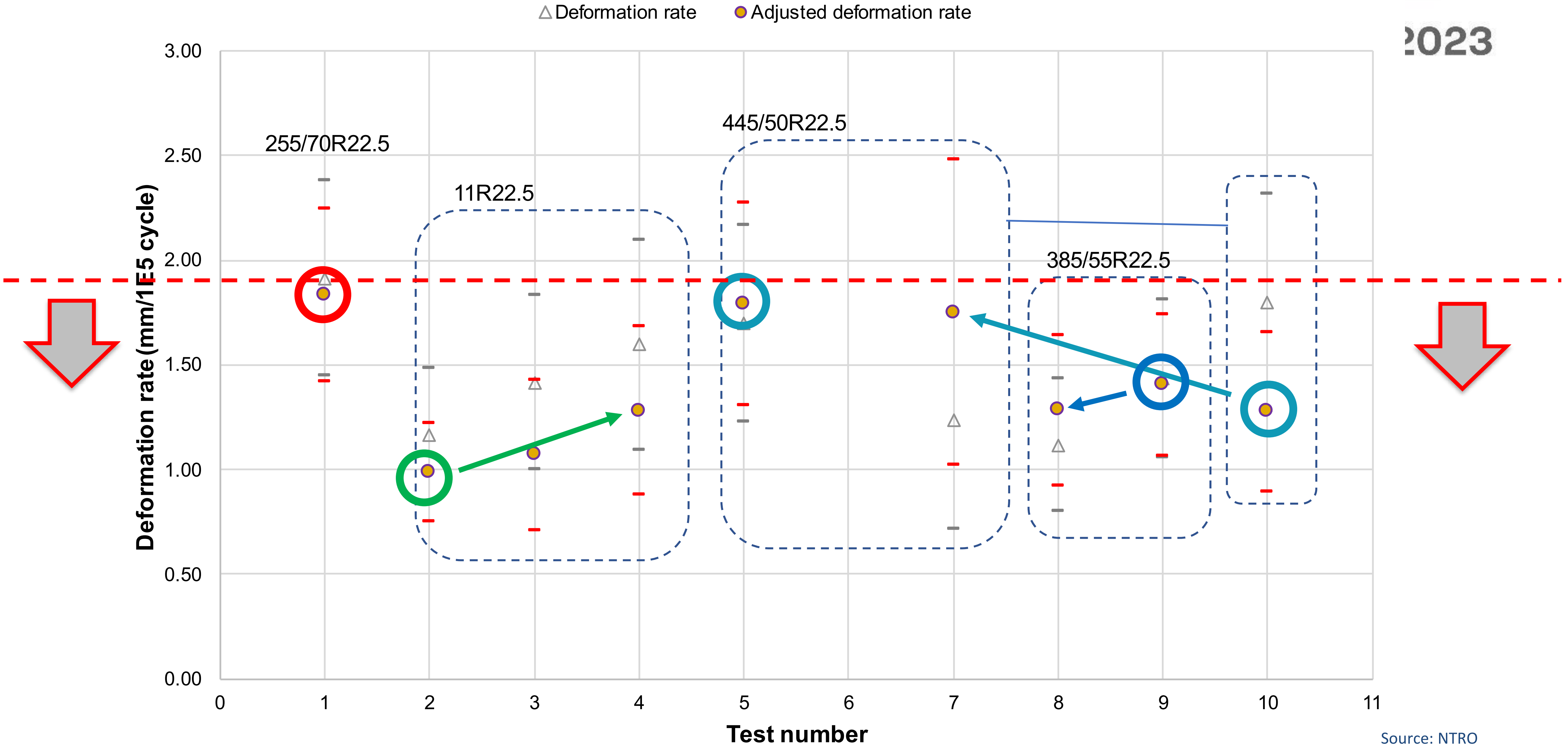
Test no.	Name	Load	Tyre size	Tyre type	Inner pressure	Outer pressure	Cycles
1	Most damaging	40 kN	**255/70R22.5**	DUAL	675 kPa (98 psi)	675 kPa (98 psi)	**75,000**
2	Most common	40 kN	**11R22.5**	DUAL	525 kPa (76 psi)	525 kPa (76 psi)	**52,500**
3	Most common - uneven	40 kN	**11R22.5**	DUAL	525 kPa (76 psi)	**682.5 kPa (99 psi)**	**52,500**
4	Most common - over inflated	40 kN	**11R22.5**	DUAL	**682.5 kPa (99 psi)**	**682.5 kPa (99 psi)**	**67,500**
5	Ultra-wide	40 kN	**445/50R22.5**	SINGLE	**700 kPa (102 psi)**	NA	**60,000**
6	Ultra-wide - under inflated	40 kN	**445/50R22.5**	SINGLE	**560 kPa (81 psi)**	NA	**60,000**
7	Ultra-wide - over inflated	40 kN	**445/50R22.5**	SINGLE	**840 kPa (122 psi)**	NA	**60,000**
8	Super single - max pressure	40 kN	**385/55R22.5**	SINGLE	**900 kPa (131 psi)**	NA	**60,000**
9	Super single - recommended	40 kN	**385/55R22.5**	SINGLE	**790 kPa (115 psi)**	NA	**67,500**
10*	Ultra-wide	40 kN	**445/50R22.5**	SINGLE	**700 kPa (102 psi)**	NA	**60,000**

Source: NTRO

Adjusted deformation rate



Source: NTRO

Conclusions - deformation

Deformation rates for both the dual tyres and single tyres were within a similar range (within the variability of the experiment).

The deformation rate of the 255/70R22.5 dual tyres was the highest.

Based on these results, tyre size **(section width) alone did not correlate** with deformation rate, with other contributing factors including contact patch area, shape and pressure distribution.

Author/s:
A.Germanchev, L.Bruzsa, C.Loose.

Conclusions - deformation

Based on the deformation rates, inflation pressure was found to have a significant effect on wear for the dual 11R22.5 tyres, but not for wide single tyres.
The differences were marginal when comparing the results representative of common practice:

11R22.5 dual tyres at 100 psi (689 kPa) → 0.0000128 mm/cycle
445/50R22.5 tyres at 102 psi (703 kPa) → 0.0000127 mm/cycle
385/55R22.5 tyres at 115 psi (792 kPa) → 0.0000140 mm/cycle

Author/s:
A.Germanchev, L.Bruzsa, C.Loose.

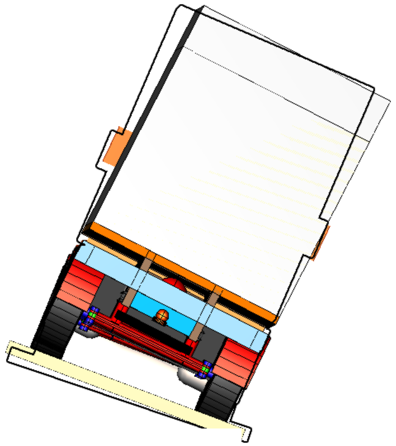
Results

Research fully supports adoption of wide single tyres

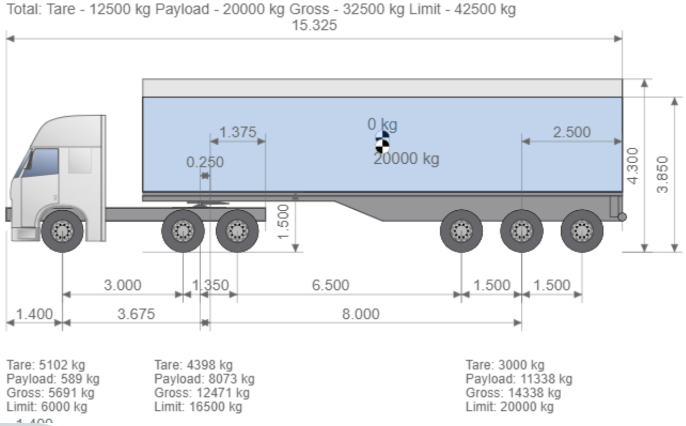
In a milestone media release, the Truck Industry Council (TIC) and National Heavy Vehicle Regulator (NHVR) have stated "there is no justification in limiting axle masses when using appropriate wide single tyres given the improved vehicle stability and efficiency they bring. They should be permitted to operate at the same mass as equivalent dual tyred axles".

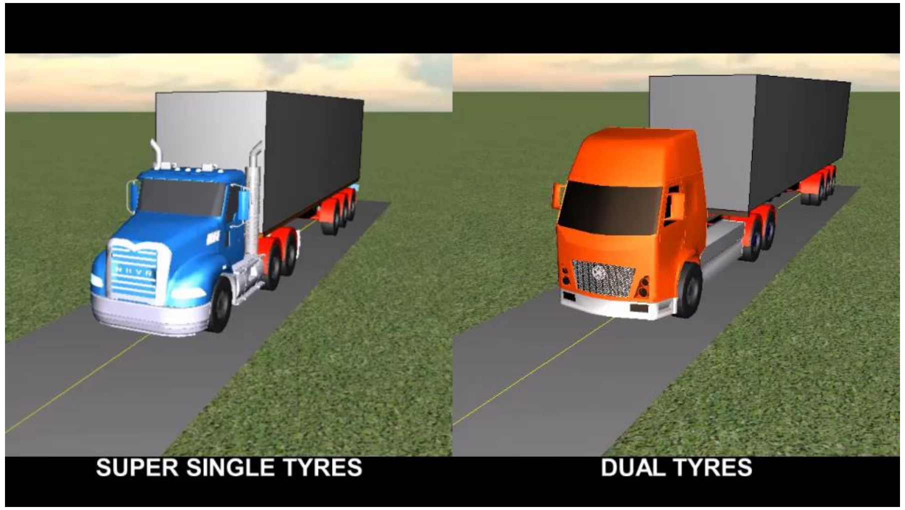
Benefits of super single tyres

- Increased payload
- Improved stability
- Reduced fuel consumption
- Reduced emission
- Reduced maintenance



Tyre Set	UD Payload Height (mm)	SRT (g)
Dual 11R's	2350	0.3527
SS 385's	2350	0.3804
SS 385's	2740	0.3502





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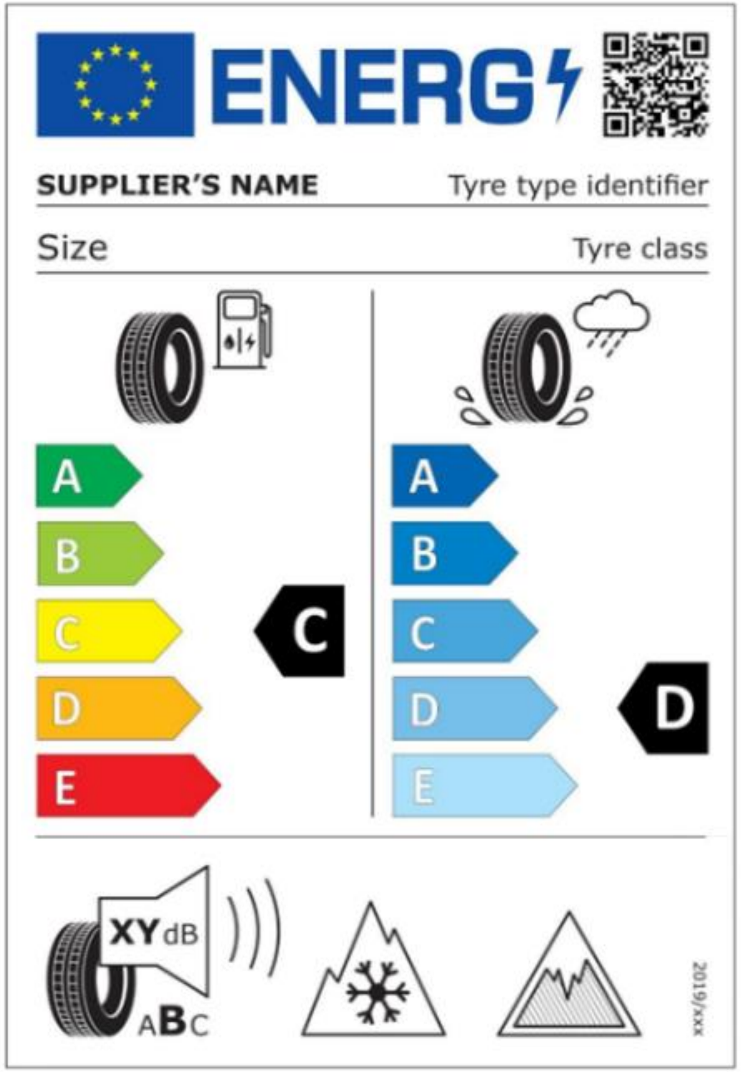
An emerging challenge...

Low rolling resistance tyres

- Increase in number of applications seeking to specify low rolling resistance tyres
- Practical considerations
  - How to specify without nominating brand/model
  - Key consideration for several PBS standards
  - Compliance and enforcement
- Is there a simple/practical way?
  - Avoid nominating brand/model
  - How to validate 'low rolling resistance' tyres
  - Is further guidance required to be provided to assessors?



OBM using TEBS: Knorr-Bremse iMass®

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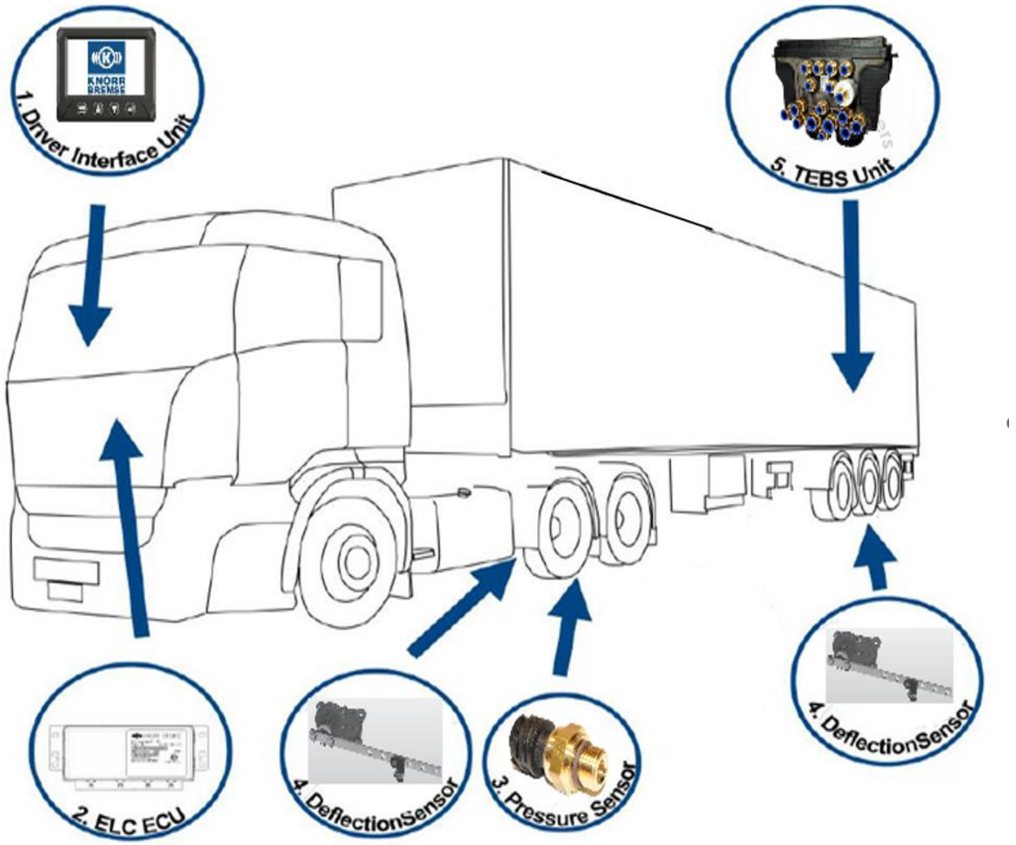
- First native for Type Approved Smart OBM utilizing solution existing TEBS technology
- Allows access to other messages which can be used to verify mass data
- Automatic VIN recognition via CAN
- Current system is Gen 1 only, more possibilities to be explored in Gen 2.



Author:
Rachel Michaud

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Regulatory telematics

IAP Intelligent Access Program	Enforcement and compliance, identifiable data
TMA Telematics Monitoring Application	Road analytics and compliance, identifiable data
RIM Road Infrastructure Management	Road analytics, anonymous data

Source: V-DAQ

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Regulatory On-Board Mass

IAP + Interim OBM Intelligent Access Program	Enforcement and compliance, identifiable data
TMA + Smart OBM Telematics Monitoring Application	Road analytics and compliance, identifiable data

- Evidence for increasing access
- Evidence for road network funding
- Allows sensitive structures to be monitored safely

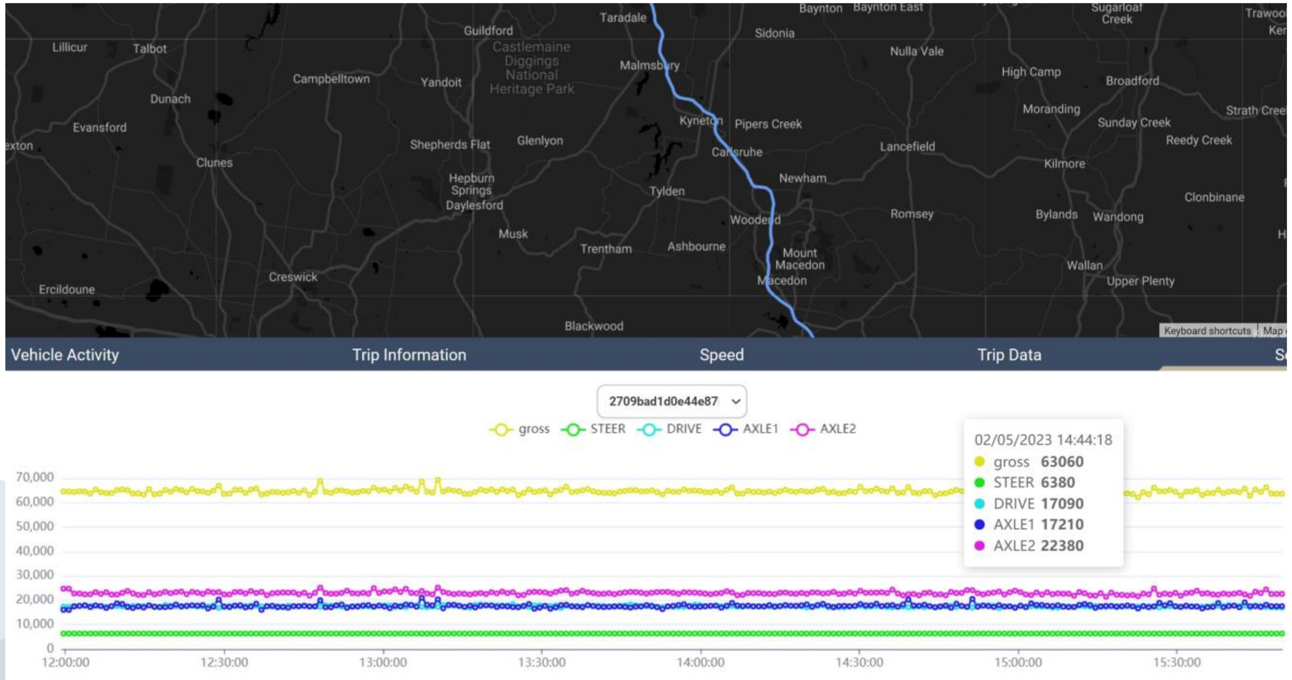
TMA + Smart OBM

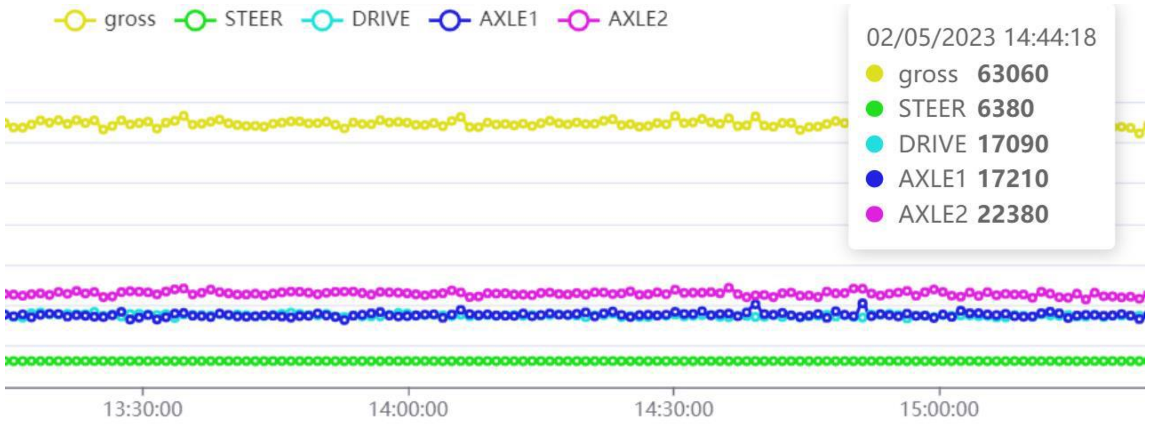
Source: V-DAQ

Implementation by jurisdictions

- TMA + Smart OBM in Victoria required for:
- PBS combinations > 68.5t GCM
- PBS quad-axle semi-trailers > 46t GCM
- PBS split-axle semi-trailers > 43.5t GCM

VIC	QLD	NSW
1 July 2023	1 June 2024	1 June 2024





Source: V-DAQ


Questions?
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