



NZ TRANSPORT AGENCY
WAKA KOTAHI

Review of HPMVs and quad axle sets

IRTEENZ – Innovative & High Productivity Vehicles 2013
Rotorua 18-20 June

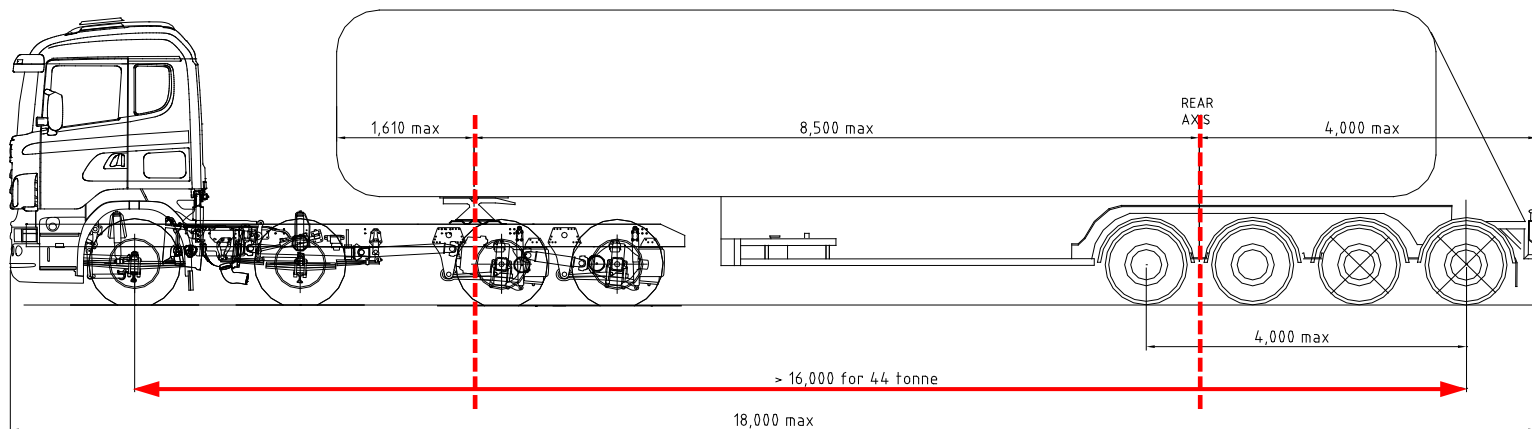
Doug Latto (Transport and Mechanical Consulting) & Bruce Currie: Principal Heavy Vehicle Engineer

Quad axle sets – use in New Zealand

Vehicle Dimensions and Mass Rule 2002 allows quad axle sets:

- 20 tonne maximum group load
- 3.6 – 4.0 metre axle spacing
- One or two self steering axles, 1 & 4 or 3 & 4
- Type 1 – two rear self steering axles has dominated

Type 1 quad (2+2)



Quad axle sets - Issues

- **Prototype 3+1 but RCAs stipulated 2+2**
- **Quad axle semi trailer with two rear steering axles (2+2) were not field tested before their introduction in 2002**
- **2+2 quad configuration unique – not used anywhere else in the world**
- **Detailed requirements for the setup and specification of self-steering axles were not carried over into the Land Transport Rule**
- **Tracking performance of the 2+2 quad both at low and high speeds had been implicated in crashes**

High-speed Offtracking (HSO)



HSO crash SH39 - 2006



HSO crash SH25 - 2009

High-speed Offtracking (HSO)



LSO crash SH25 2008

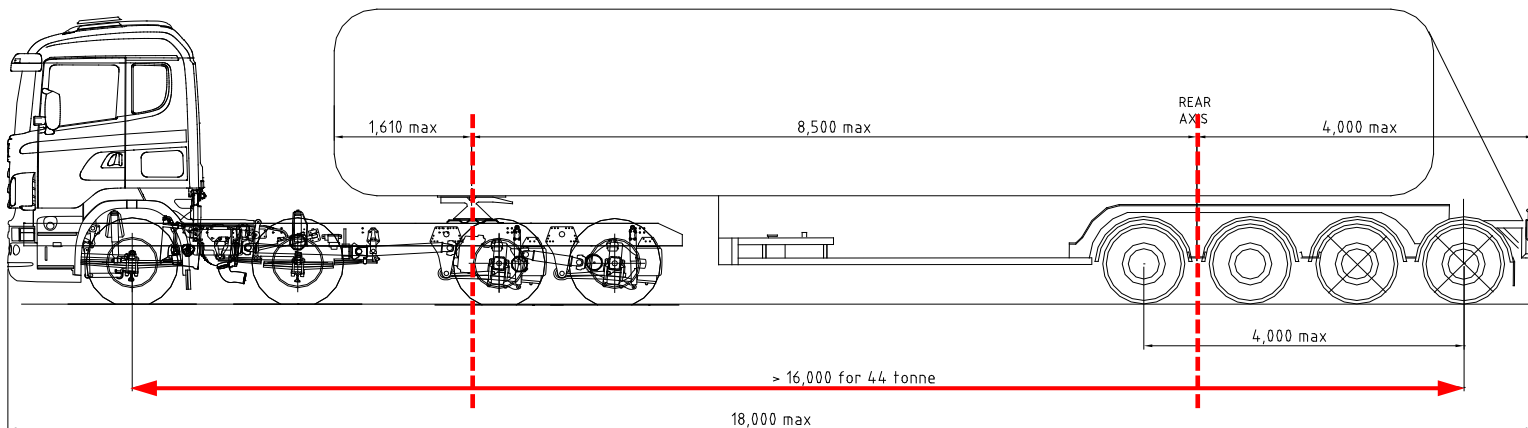


HSO testing Chch 2011

HPMV's and Performance Based Standards (PBS)

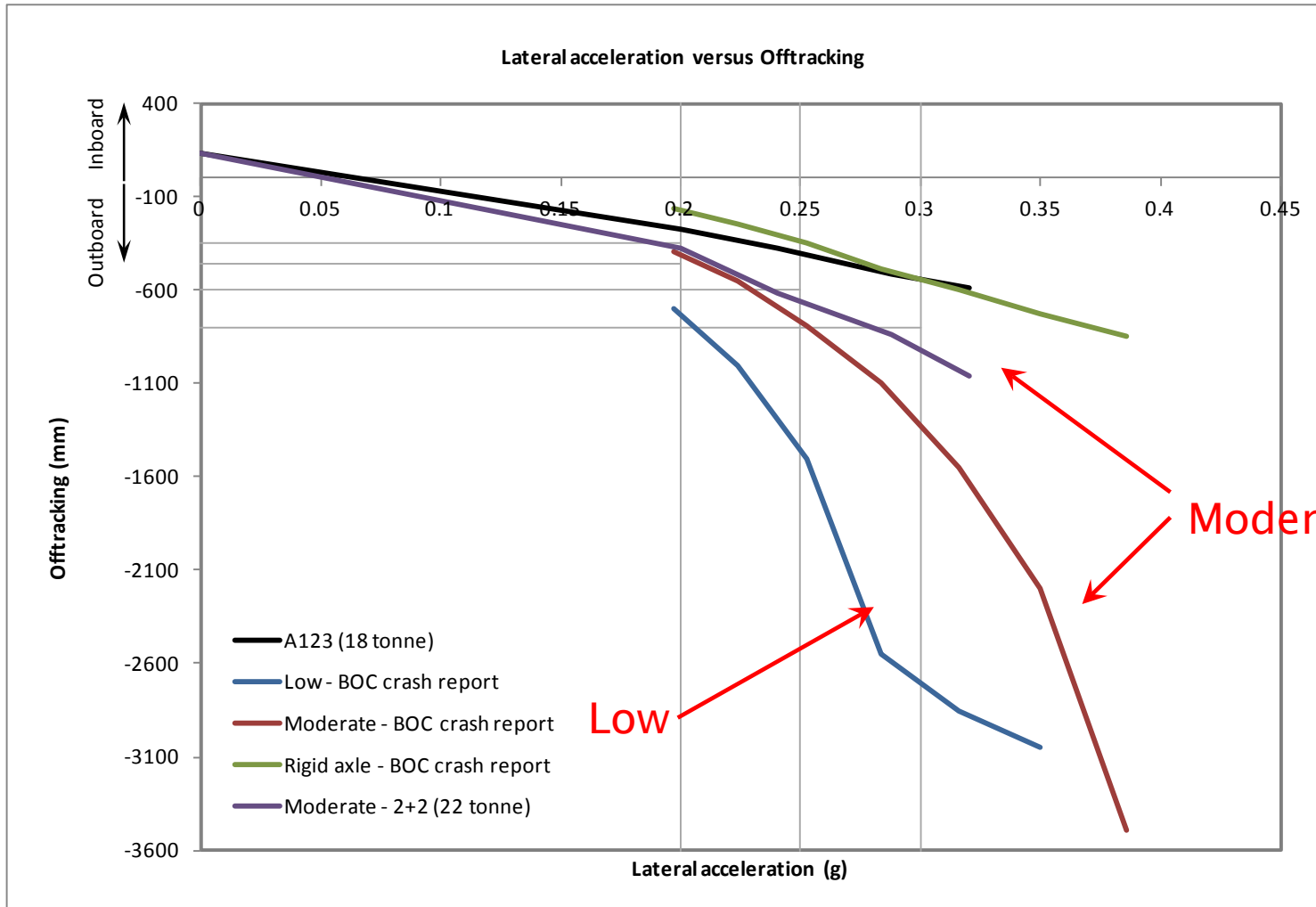
- **NZ PBS adopted from Australia via North America**

Type 1 quad (2+2)



- **This vehicle passes Australian PBS - Australia does not assess High-speed Offtracking (HSO)**
- **NZ road environment requires HSO assessment (narrow lanes with minimal corner shoulder) – view endorsed by John Billing as part of peer review of quad review**

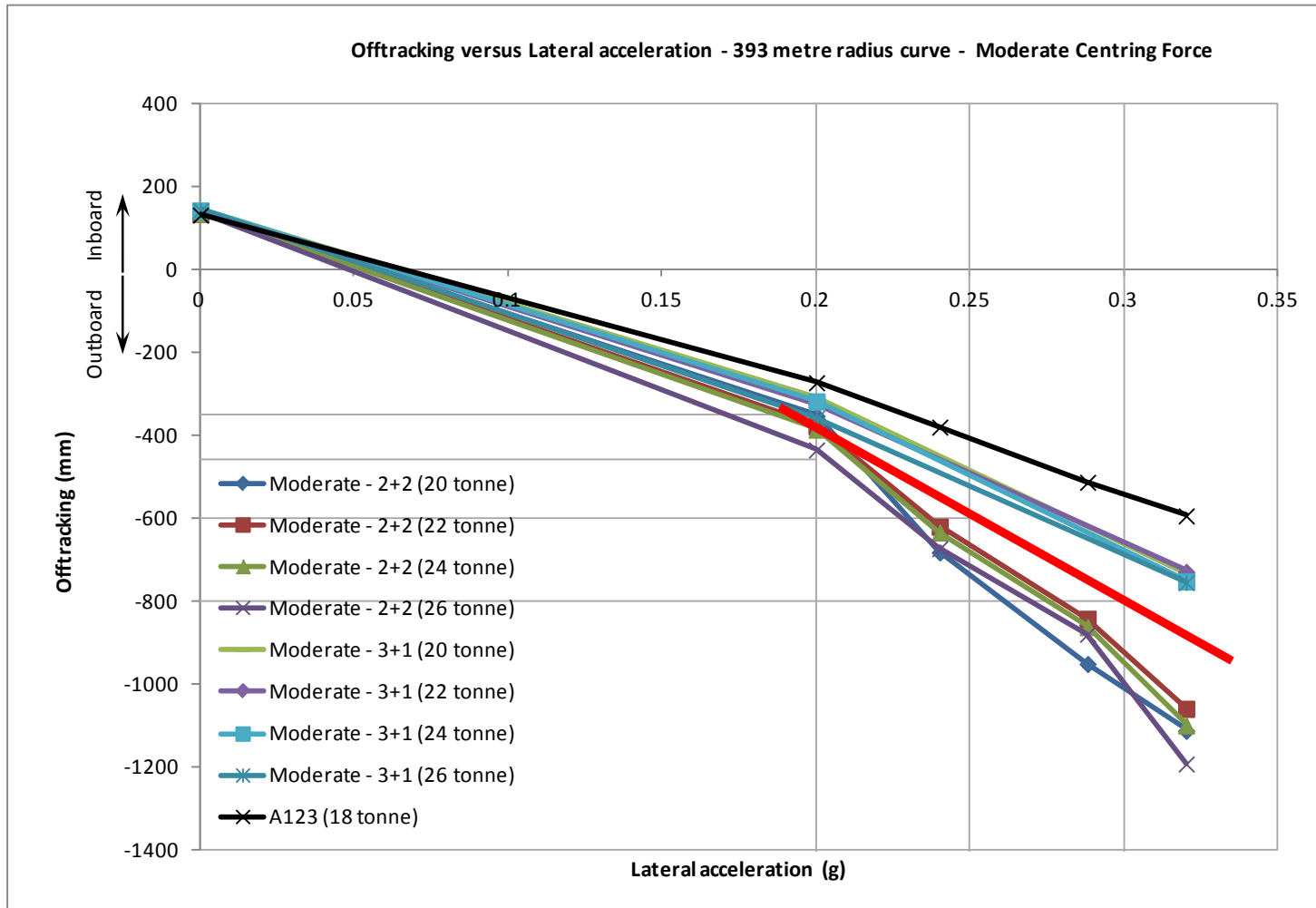
Offtracking vs. lateral acceleration



NZ road environment



Offtracking vs. lateral acceleration



Cornering speeds of heavy vehicles

Radius (m)	40	100	150	200	250	300	350
Speed (km/h)	40	59	75	89	84	92	86
Accel. (g)	0.31	0.27	0.29	0.31	0.22	0.22	0.17

- From the State Highway network 7 flat curves were selected which had straight approach and departure alignments
- 3 and 4 axle trailers of varying configurations including quad semis in the dataset
- Data captured over one week from GPS instrumented combinations
- Vehicles laden and unladen
- *HV rollover every 2-3 days (140 p.a.) at 0.35 g SRT*



2+2 quad review - key recommendations

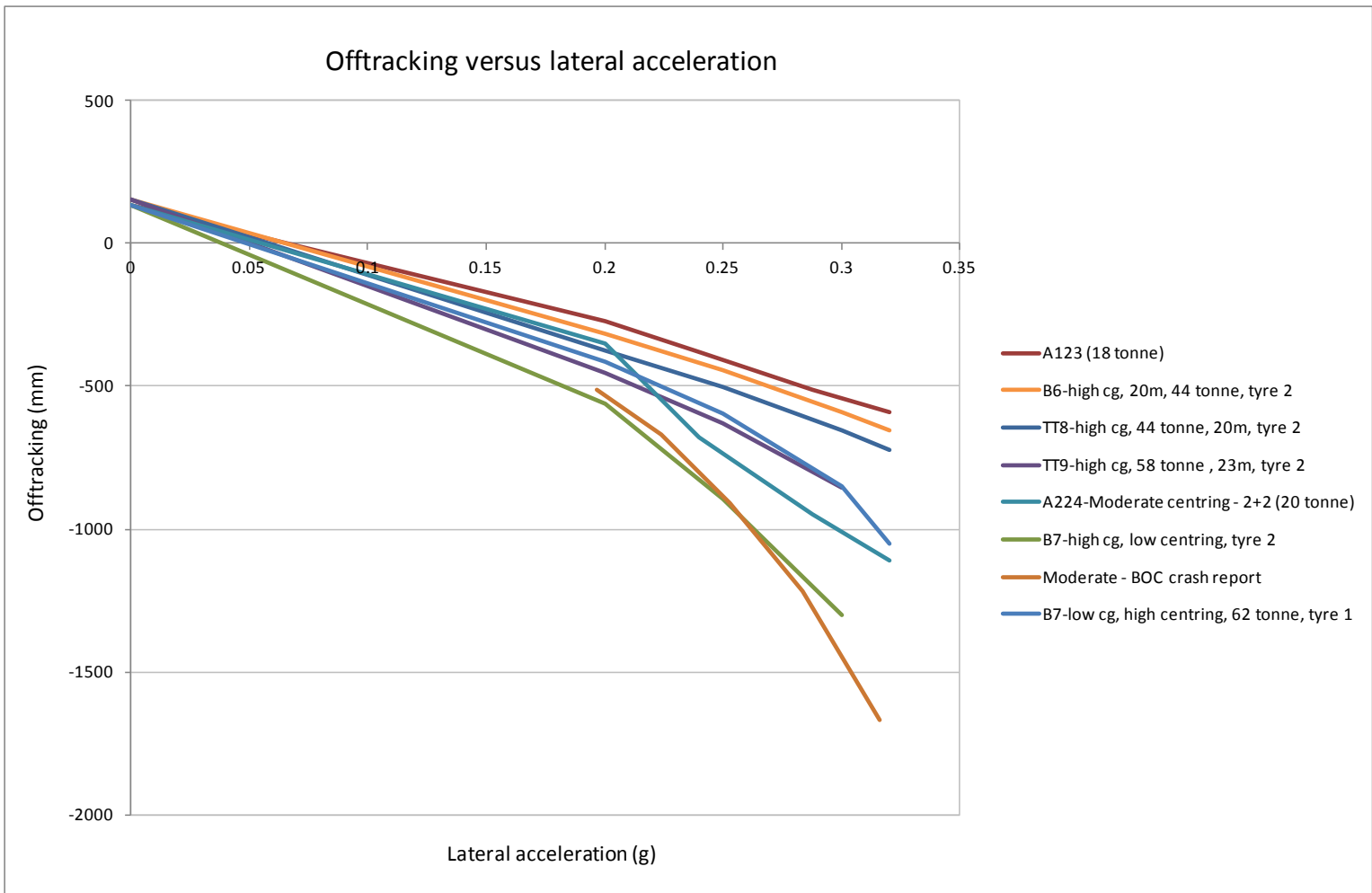
- **A date should be set when 2+2 quad-axle semitrailers will no longer be allowed to operate. They must be converted to another legal configuration by the specified date, or taken out of service**
- **If a 2+2 configuration is converted to the 3+1 configuration, the forward self-steer axle should be replaced by a rigid axle. However, an operator who intends to operate a 2+2 quad-axle semitrailer for a limited period (e.g., no more than 2 years) may elect within a short period from the date of the rule (e.g., no more than 90 days) to lock the forward self-steer axle permanently**



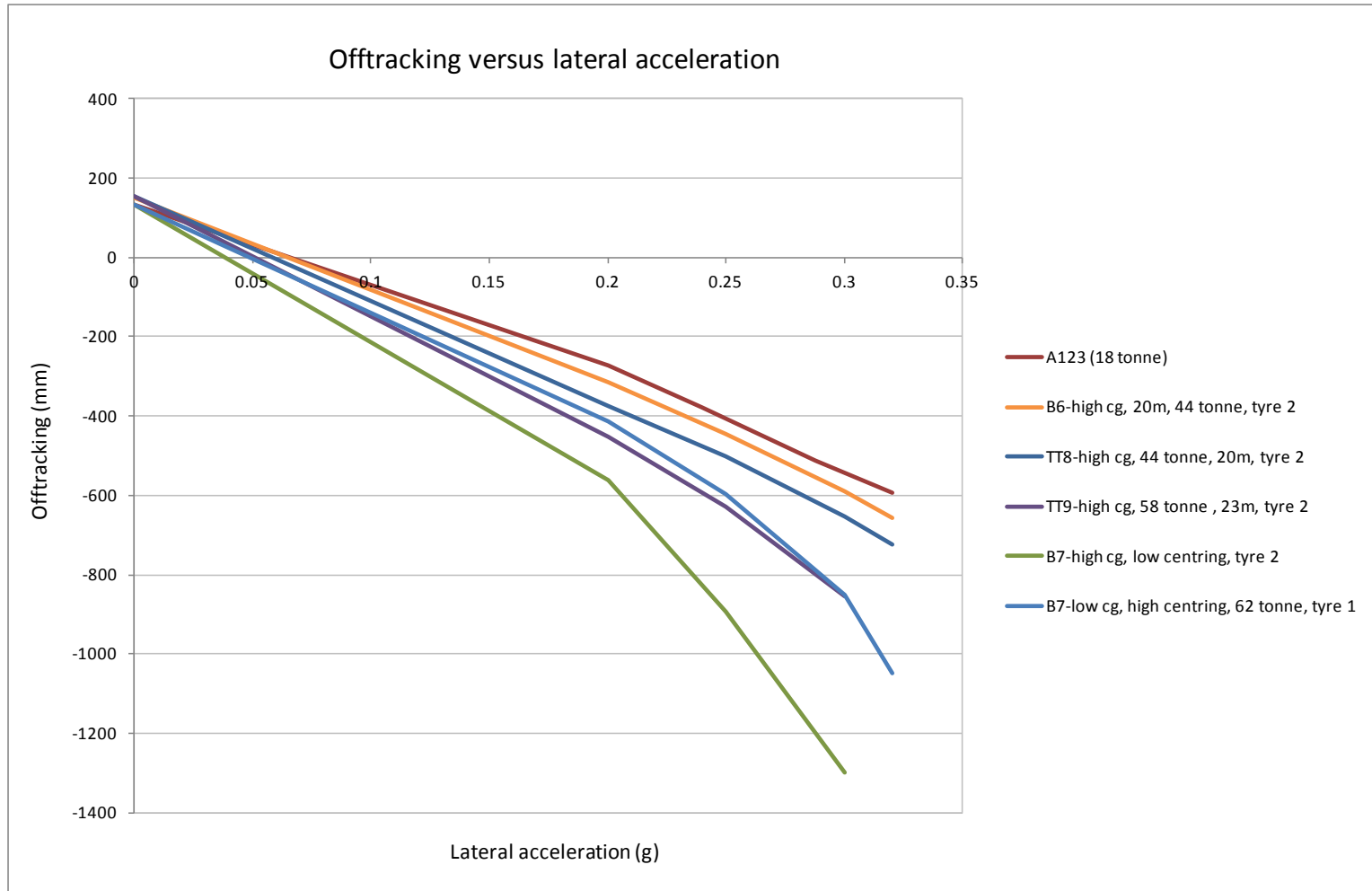
7-axle B-train



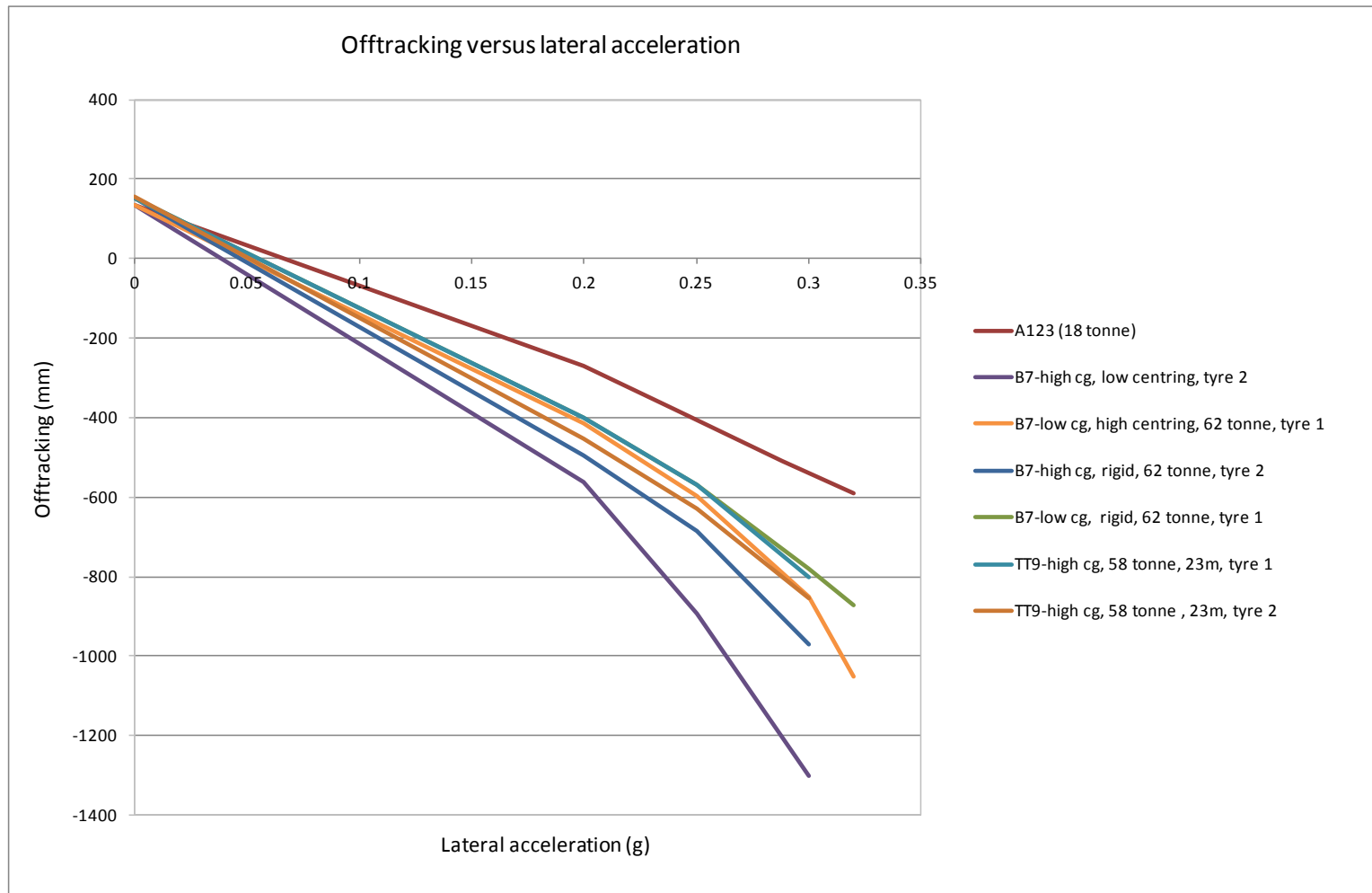
7-axle B-train – results (1)



7-axle B-train – results (2)



7-axle B-train – results (3)



7-axle B-train – next steps

- **Need to be sure we understand how innovative combinations perform across the expected range of vehicle properties and operating conditions**
 - Self steer axle properties
 - Tyre properties
 - Suspension properties
- **Investigate the use of ‘Smart suspension’ on LSO and HSO in the 7 axle b-train**
- **Finalise the HSO assessment criteria**
- **Potential field testing of vehicle combination**

Implementation of key quad recommendation

How do we go from this...



6.2 deg

4.4 deg

...to this



2.5 deg



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New Zealand Government

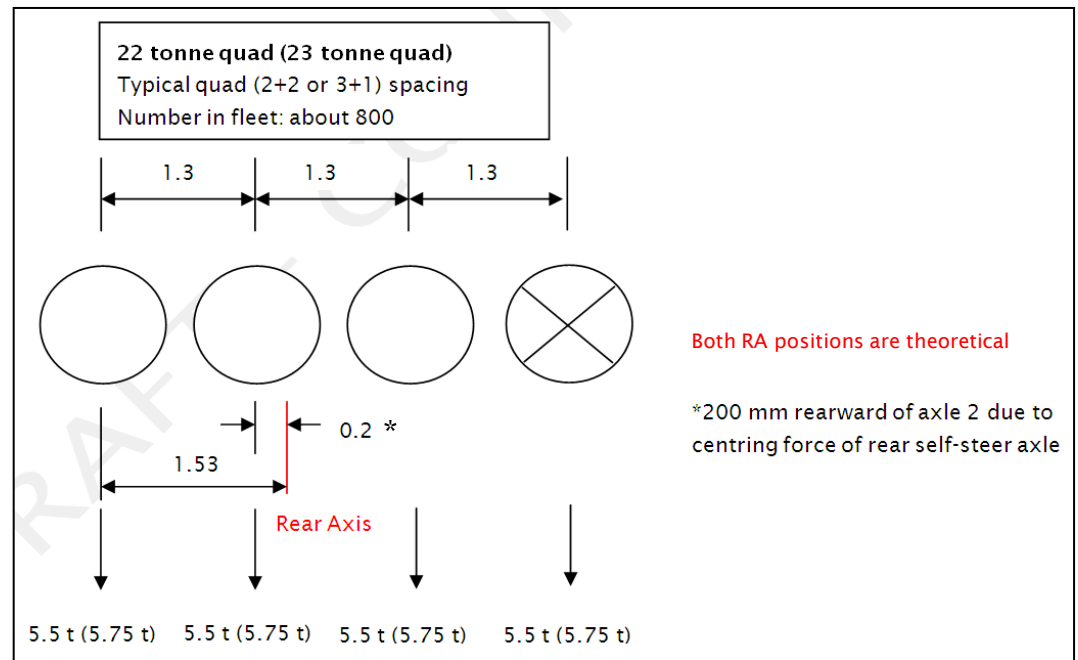
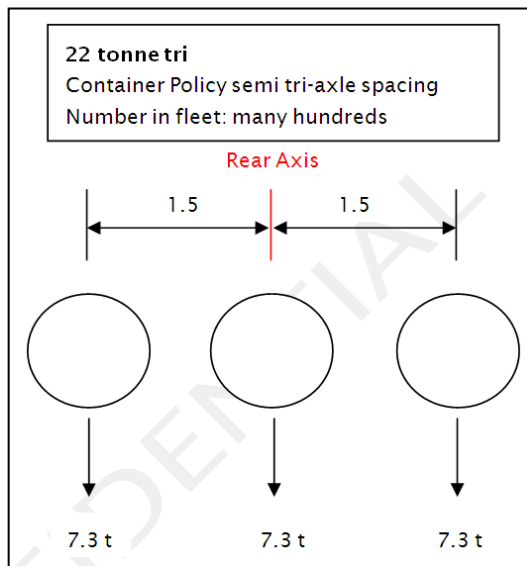
Pavement effects (vertical)

- Looked at wear equivalence between different axle groups (general access and HPMV)
- 22 tonne on a quad-axle generates same vertical pavement damage as 18 tonne on a tri-axle (Austroads Guide to Pavement Technology)
- A further one tonne increase on either generates the same additional damage on either axle type
- To put this in perspective note that the tri-axle and proposed quad-axle general access and HPMV limits still only generate two thirds of the pavement vertical damage of the tandem axle general access and HPMV limits



Pavement effects (horizontal)

- 3+1 (type 2) quads allowed since 2010
- Now 200 plus type 2 quads in operation
- No reported issues of accelerated wear or chip pull-out
- Less damaging than fixed tri on Container Policy (22 t)

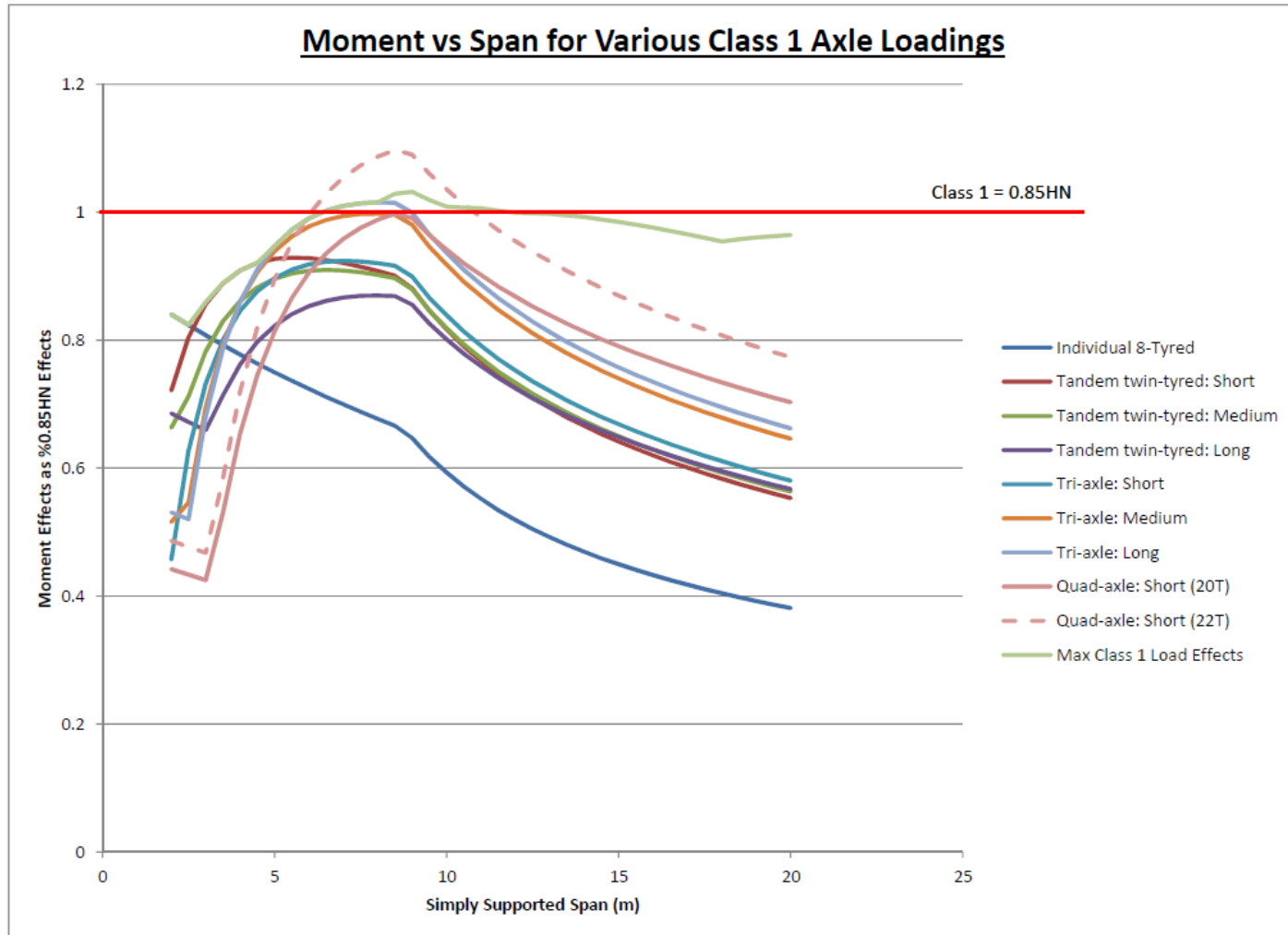


Bridge effects

- Review Class 1 and HPMV loading as defined in Rule
- Current quad limits are appropriate and consistent with other group limits in Rule
- Quad produces critical moment and shear effects on bridge element spans of 5 to 9 m
- An increase in current quad axle set mass limits produces structural effects inconsistent with and in excess of current Rule vehicle effects
- The inconsistency between 20 to 22 tonne (for Class 1) in terms of bending moment is shown in the following slide



Bridge effects



Quad mass review outcome

- **Vehicle safety (HSO and the need to convert from 2+2, plus greater roll-stiffness for improved SRT performance for overweight container transport)**
- **Network optimisation**
 - Bridge loading
 - Pavement wear equivalence
 - Productivity gain



Decisions on quad mass:

- **General access: 20 to 22 tonne**
- **Container: 22 to 23 tonne**
- Under consideration:**
 - **HPMV: 22 to 23 tonne**



Conditions for 22 t general access & 23 t container quads

- Open-ended exemptions if rigid axle conversion (LT400)
- Time-limited two-year exemption for lock-out of 3rd axle – locking methods must be approved by axle manufacturer (LT400)
- On-board mass management (calibration independently verified)
- NZTA auditable mass-management records must be kept
- NZTA-CVIU MOU for axle group mass tolerances applies (500 kg for axle and group)
- Import/export containers - 23 tonne quad, 45 tonne gross on approved route permits (as occurs now for 22 tonne tri, 44 tonne gross)
- Exemptions will be swiftly revoked if there is abuse!
- *Summary: We're offering more, but the risks are greater, so the tolerances are tighter and will be strictly enforced*



Import/export containers



The present...

...and the future...



Key learning from PBS reviews in NZ context

- **PBS pass does not always mean acceptable & safe**
- **PBS has limitations**
- **Local environment and conditions must be assessed and considered in terms of setting measures and reference values**
- **Model simulations alone can be dangerous**
- **Better to over than under analyse new vehicle types**
- **Model input data must be worst case or “as-built” process essential**
- **As-built process desired/required**
- **Need for robust new vehicle type design review**



Key learning from PBS reviews (2)

Australian PBS scheme:

- PBS designs are assessed by independent 3rd party assessors – there are 13
- Designs are approved by a PBS review panel – 11 on panel
- PBS certifiers inspect and ‘as-built’ vehicles – 7 certifiers
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- Proposal to begin modular assessments (allowing for interoperability)
- Proposal to allow manufacturer self-certification (‘as-building’ and modular units?)
- 6 ‘blueprint’ designs plus one-offs such as longer full trailer
- 1000 vehicles since 2007

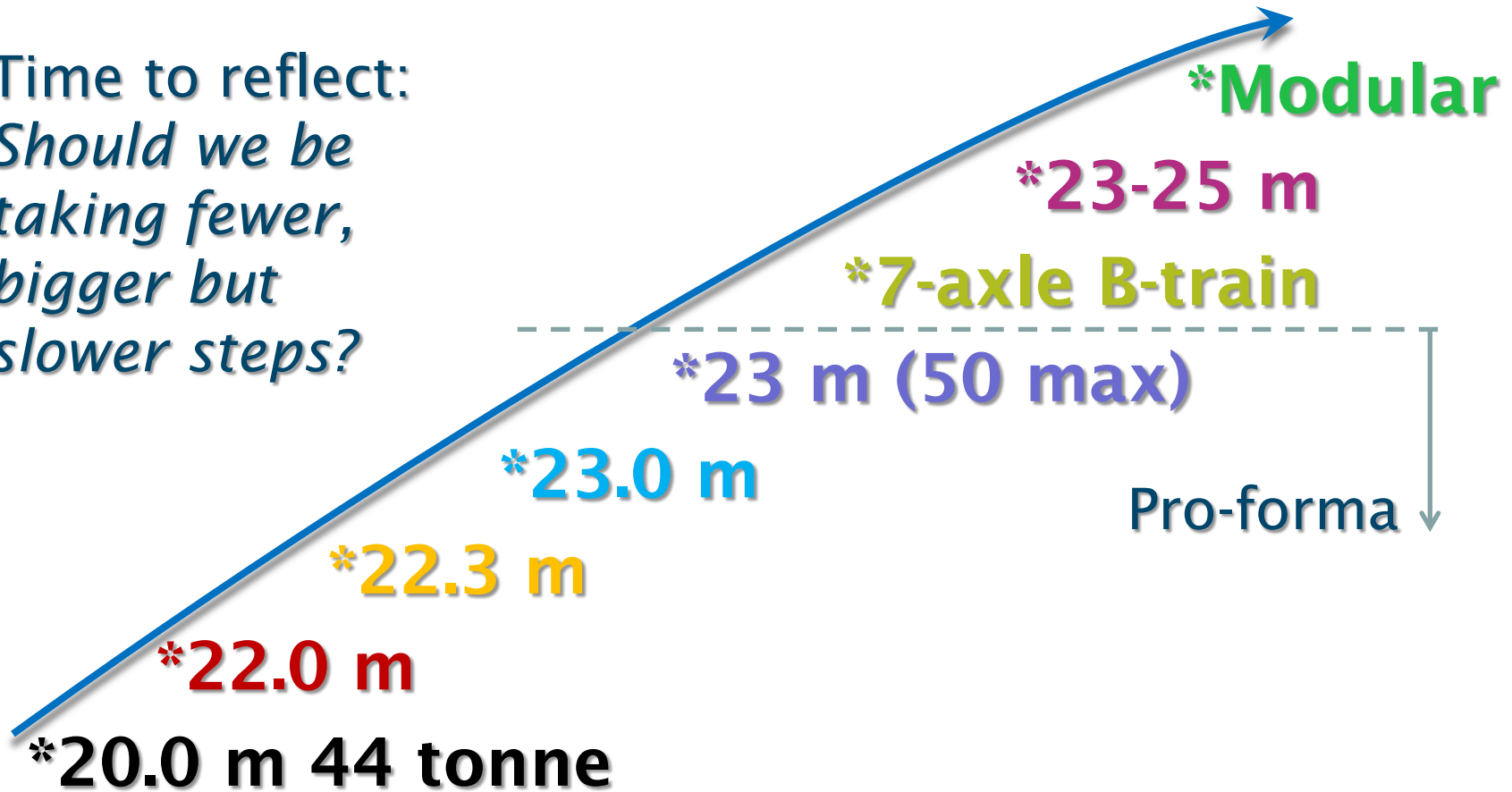
New Zealand PBS scheme:

- PBS designs are assessed by independent 3rd party assessors – there are 2
- Designs are approved by NZTA staff – significant reliance on assessor report
- PBS Standards formalised but still are draft
-
- Preference for longer dedicated combinations continues
- 11 ‘pro-forma’ designs plus one-offs such as 7-axle B-train
- 1000 vehicles since 2010



HPMV evolution (vehicle size)

Time to reflect:
Should we be taking fewer, bigger but slower steps?



NZ Transport Agency and Transport & Mechanical Consulting

Thank you for your attention

