Review and risk assessment of increasing vehicle length

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Introduction

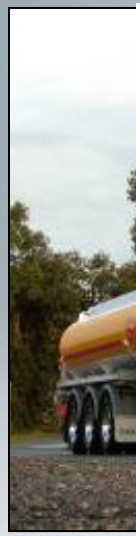
- Overall vehicle length is a primary driver of freight vehicle productivity, particularly for those vehicles with loads that are volumetrically constrained
- PBS aims to “match the right vehicles to the right roads”
- For the purposes of access and network classification, overall vehicles lengths are applied
  - What should those lengths be?
  - What criteria should be considered?

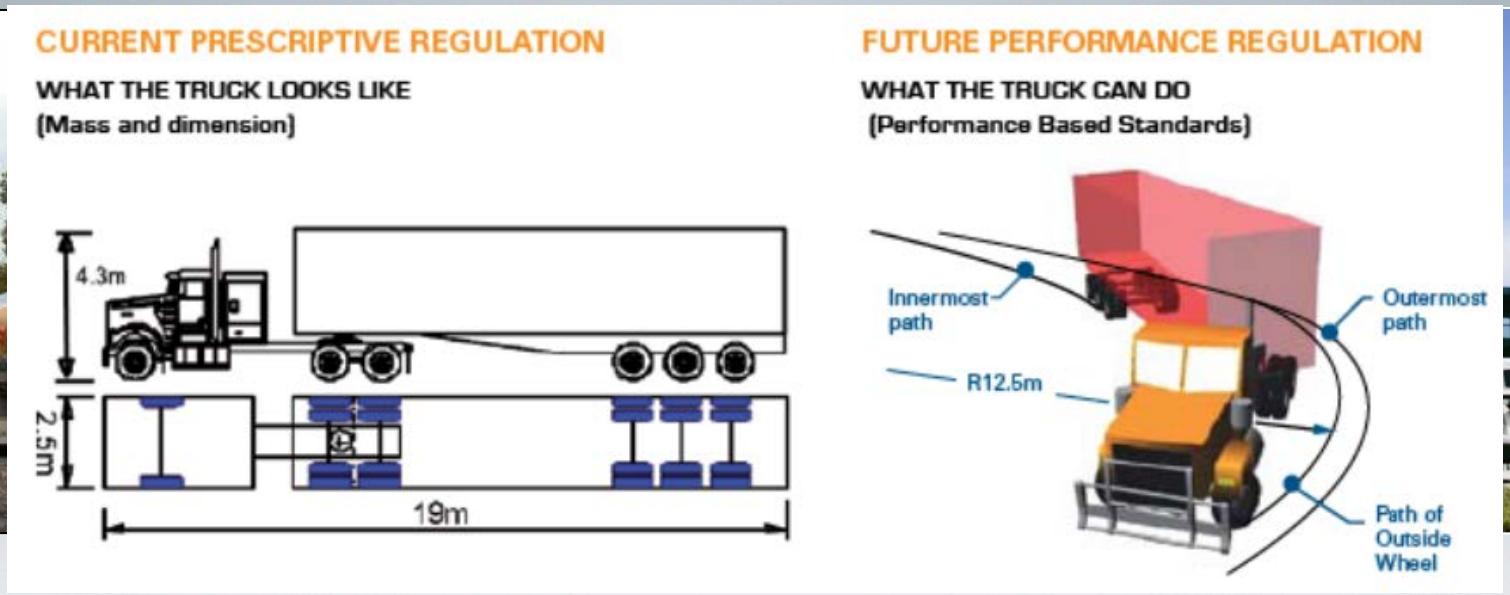
Project outline

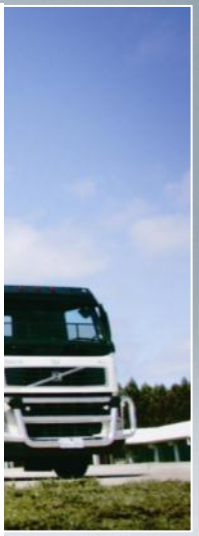
- Austroads project FS1675: “Performance Based Standards Lv 1 Length Limit Review”
- Objectives:
  - review the current PBS level 1 length limit;
  - determine the optimum length limit.
- Tasks consisted of:
  - Consultation with road owners
  - Development of risk-based assessment methodology
  - Initial network assessment
  - Refine methodology and extended network analysis to 55 sample sites (including Benefit-Cost Analysis)
  - Reporting

What is the PBS scheme?

- Performance Based Standards, established 2008
- Innovative scheme for innovative vehicles
- Focuses on what the truck can do, not what it looks like







- Network access is based on vehicle performance
- 16 safety standards and 4 infrastructure standards

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4

Current PBS de-facto length limits

Vehicle Performance Level	Network Access by Vehicle Length, L (m)	
	Access Class 'A'	Access Class 'B'
Level 1	L ≤ 20 (General Access*)	
Level 2	L ≤ 26	26 ≤ L ≤ 30
Level 3	L ≤ 36.5	36.5 ≤ L ≤ 42
Level 4	L ≤ 53.5	53.5 ≤ L ≤ 60

* General Access is subject to a 50 tonne gross mass limit, posted local restrictions and restrictions or limitations specified by the jurisdiction

Background

- When PBS was introduced, the Level 1 length limit was increased to 20 m, 1 metre greater than existing General Access limits
  - Provided some productivity benefit
  - Any increase in safety risk would be offset because PBS vehicles are inherently safer
  - 1 metre was a relatively minor increase
  - No cost benefit analysis of the trade-offs performed
- This project was commissioned to determine the optimum Level 1 length limit using a sample of high risk sites representative of the worst likely conditions across the network.

Assumptions

1) Current PBS Level 1 vehicle standards are unchanged and adhered to.
   - That is, a 24 m PBS vehicle would still need to meet the same swept path requirements as a 20 m long vehicle
2) Current rules on mass are unchanged
   - That is, an increase in length does not mean an increase in mass

Methodology

- A number of vehicle lengths to be investigated
  - 19 m to 26 m in 1 m increments
- Relative effects compared to the baseline 20 m vehicle to be examined
- 55 sample sites nationally to be assessed
- Risk-based approach to determine a base ‘score’ for each assessment criterion, multiplied by a severity factor for that criterion

Assessment methodology

- Based on the set of assessment criteria
- Relative Risk Factor (RRF) developed for each criteria
  - relative to the current 20 m length limit for PBS Level 1
  - based largely on the increase/decrease in requirements as vehicle length was changed (e.g. the number of extra seconds required for a longer vehicle to traverse an intersection)
- Severity Factor (SF) also developed for each criteria
  - represents severity of risk (consequence)

Assessment criteria

Issue	Number	Criteria	Severity of risk
Overtaking	1	Establishment sight distance	Low
	2	Continuation sight distance	Low
	3	Overtaking opportunities	Low
Intersections	4	Signal timings	Low-medium
	5	Intersection length and effects of grade	Medium
Railway crossings	6	Signal timings	High
	7	Crossing length and effects of grade	High-medium
Stacking distance	8	Stacking distance	High

- Based initially on the NTC's Network Classification Guidelines (2007)
- Criteria list and risk severity of risk revised by working group

Relative Risk Factors (RRF): Signal timings

Amount of time by which minimum green signal time is deficient (seconds)	Relative risk factor
0	0
0 - < 1.0	1
1.0 - < 2.0	2
2.0 - < 3.0	3
3.0 - < 4.0	4
4.0 - < 5.0	5
5.0 or greater	6

RRF: Stacking distance

Distance stacking distance is deficient	Relative risk factor
0 – < 0.5 lanes of opposing traffic	5
0.5 – < 1.0 lane of opposing traffic	10
≥ 1.0 lane of opposing traffic	20
0 – 1 railway line	30
Greater than 1 railway line	40

Application of methodology

- A weighted Criterion Score (CS) based on the traffic volumes entering each approach

$$CS_i = \frac{AADT_1}{\sum AADT} \times (RRF_1) + \frac{AADT_2}{\sum AADT} \times (RRF_2) + ... + \frac{AADT_n}{\sum AADT} \times (RRF_n)$$

where

CS_i	=	the Criterion Score: the average relative risk factor for each assessment criteria
$AADT_n$	=	is the AADT for each approach
$\sum AADT$	=	is the sum of the AADT for all approaches
RRF_n	=	the relative risk factor for the appropriate criterion for each approach.

Application of methodology

- Overall risk score is based on Criterion Score multiplied by the severity

$$RiskScore = SF_1 \times CS_1 + SF_2 \times CS_2 + ... + SF_i \times CS_i$$

Severity of risk	Severity Factor
Low	0.4
Low-medium	0.6
Medium-low	0.8
Medium	1.0
Medium-high	1.2
High-medium	1.4
High	1.6

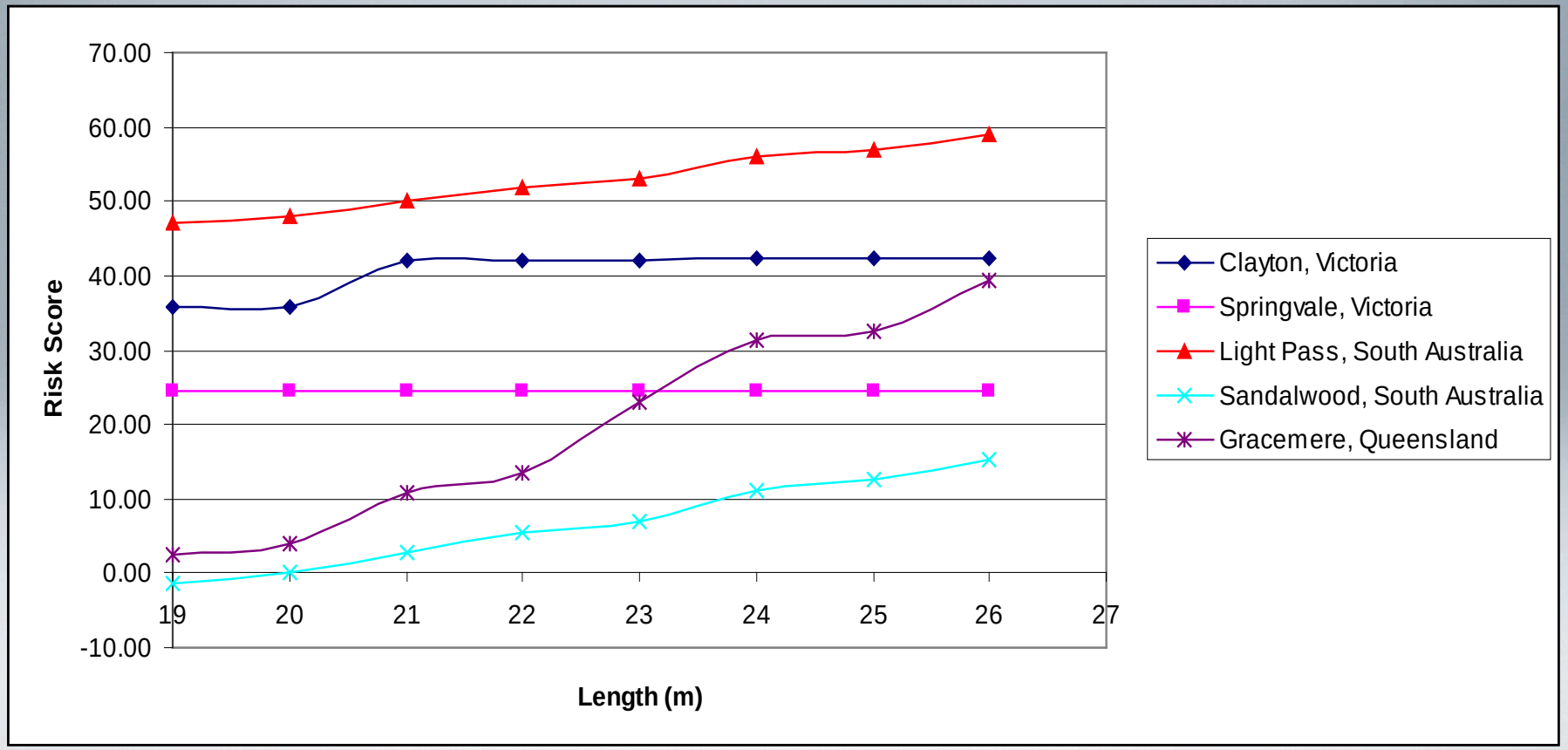
Sample site

Sample sites Criterion Scores

Issue	Criteria	Severity factor	Level 1 length limit (m)							
			19	20	21	22	23	24	25	26
Overtaking	Establishment sight distance	0.4	0	0	0	0	0	0	0	0
	Continuation sight distance	0.4	0	0	0	0	0	0	0	0
	Overtaking opportunities	0.4	0	0	0	0	0	0	0	0
Intersections	Signal timings	0.6	2.2	2.2	2.2	2.2	2.2	2.8	2.8	2.8
	Intersection length and effects of grade	1.0	0	0	0	0	0	0	0	0
Railway crossings	Signal timings	1.6	0	0	0	0	0	0	0	0
	Crossing length and effects of grade	1.4	0	0	0	0	0	0	0	0
Stacking distance	Stacking distance	1.6	21.5	21.5	25.5	25.5	25.5	25.5	25.5	25.5

Sample risk scores

- Risk score is generated for each vehicle length at each site



Banding outputs

- Risk score themselves don't really mean anything
- Banding was introduced to convey more meaning and provide visual cues

Risk band	Definition	Example
Low	Risk scores less than or equal to 10	Extra intersection signal timing is required
Medium	Risk scores greater than 10, but less than 20	Extra time is needed to cross railway lines
High	Risk scores equal to or greater than 20	Stacking distance issue where a longer vehicle may be encroaching into oncoming traffic

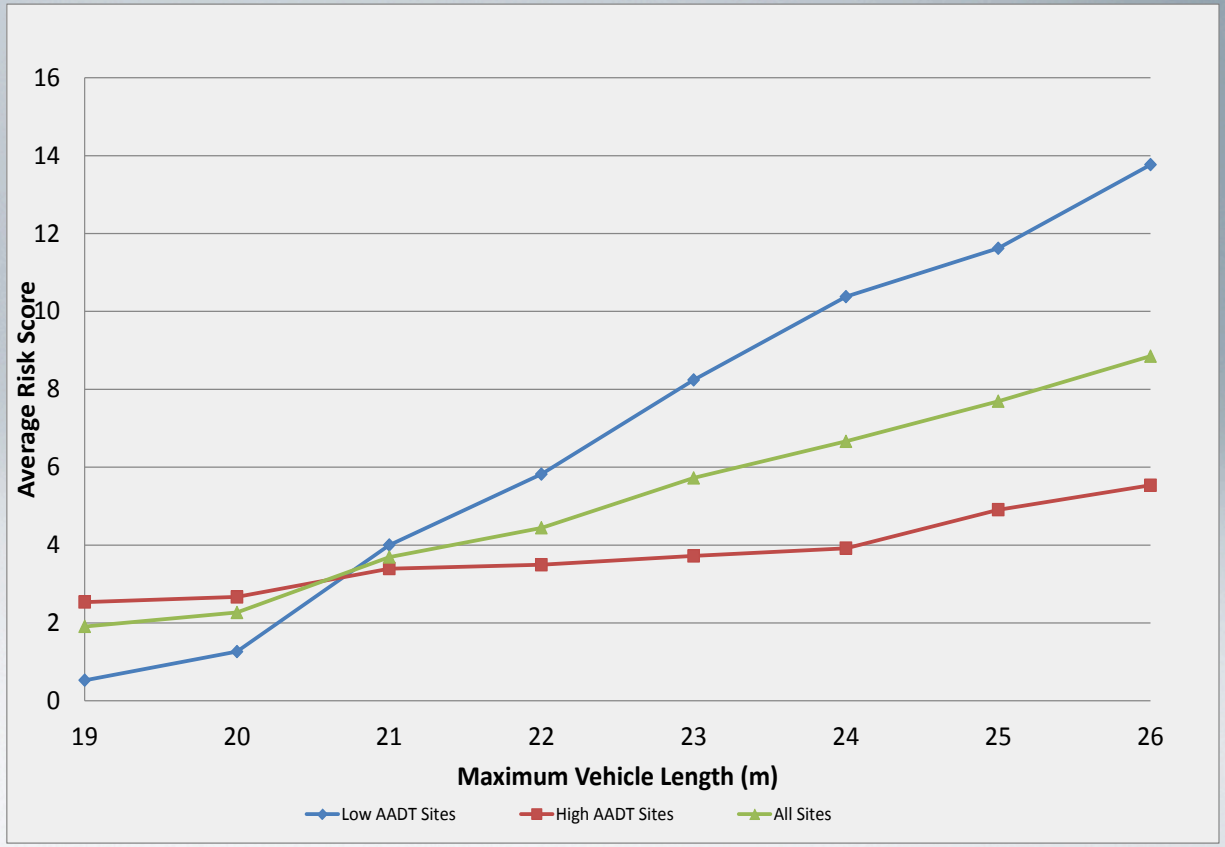
Sample site assessment results

Site ID	AADT band	Level 1 length limit (m)							
		19	20	21	22	23	24	25	26
RLX1330	Low	–1.4	0.0	26.8	29.6	47.0	51.2	52.6	63.4
RLX620	Low	24.0	24.0	24.0	32.0	48.0	48.0	51.2	52.8
3206	High	30.3	30.3	43.1	43.1	43.1	43.2	43.4	43.4
ID1763	High	6.6	8.0	10.8	13.6	31.0	35.2	36.6	39.4
041	High	2.6	6.0	11.3	13.4	16.9	19.7	22.7	26.0
840051	High	21.5	21.5	21.5	21.5	21.5	21.5	21.9	21.9
RLX144	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX496	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX510	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX650	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX671	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX678	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX923	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX929	Low	–1.4	0.0	2.8	5.6	7.0	11.2	12.6	15.4
RLX924	Low	–1.4	0.0	2.8	4.2	5.6	8.4	9.8	12.6
239	High	3.4	3.4	3.4	3.4	6.1	7.1	8.1	9.1
697	High	7.1	7.1	7.1	7.1	7.2	7.2	7.2	7.7
RLX30	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX32	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX34	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX40	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX91	Low	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX530	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX535	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX542	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX550	High	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
RLX977	Low	0.0	0.0	0.0	0.0	0.0	0.0	3.2	4.8
BRITTANIA	High	–0.6	0.0	0.6	1.4	2.0	2.7	3.3	4.0
1975	High	3.0	3.0	3.0	3.6	3.6	3.6	3.6	3.6
373	High	2.3	2.3	3.4	3.4	3.4	3.4	3.4	3.4
1127	High	2.7	2.7	3.0	3.0	3.0	3.0	3.0	3.0
4694	High	2.3	2.3	2.3	2.3	2.7	2.9	2.9	2.9
3142	High	0.6	0.6	1.8	1.8	1.8	1.8	1.8	2.9
472	High	2.2	2.2	2.2	2.2	2.2	2.6	2.8	2.8
1121	High	2.0	2.0	2.3	2.5	2.5	2.5	2.5	2.8

Low vs high traffic sites

- Average risk score determined for low (< 5000) and high (5000+) AADT sites

- 11 of 15 highest risk sites were low AADT
- 4 of 6 highest risk sites were high AADT
- Low AADT sites usually built to a lower design standard, and generally featured higher risk scores for longer vehicles



Conclusions

- Using this methodology, a maximum of up to 23 m could be considered for implementation
  - Approx 90% of sites examined remained in low risk range
- Stacking distance clearly the most influential factor in determining risk. Also the most difficult to quantify.
- A small number of sites were classified high risk for existing 20 m long vehicles
- Number of PBS Lv 1 vehicles longer than 20 m likely to be very small

Considerations for implementation

- What is acceptable for determining maximum length?
  1. Keep same risk level (maintain current access, potential small increase in productivity)
  2. Increase risk level (decrease access, net benefit in productivity)
- Level of acceptability needs to be determined
  - Some sites are currently high risk for existing 19 m and 20 m
  - Balance of accepting increased risk level against increased productivity

Considerations for implementation

- It was not possible to determine the degree of representation of the network for the examined sites
  - Distribution of ‘types’ of intersections
  - AADT distributions
- Sites would need to be individually assessed
  - Possibility to manage network by length restriction (similar to mass-restricted bridges)
- Vehicles currently operate under permit up to 25 m, though require additional controls and conditions
- Risk mitigation and treatments are possible
- Community concerns