Improving the safety of heavy vehicles in South Africa through a performance-based standards (PBS) approach to vehicle design

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CONTENTS

- PBS approach to vehicle design
- PBS pilot project in South Africa
- Pilot project monitoring results
Key Elements in Road Freight Transport

• Road infrastructure: roads, bridges, roadside furniture, signs, road markings, eToll gantries😊

• Vehicles: design, maintenance & operation

• Drivers: skill, health, fatigue
PBS Pilot Project Objectives

Investigate the Performance-Based Standards approach to heavy vehicles design and operations as researched and implemented specifically in Australia, Canada and New Zealand with a view to improving heavy vehicles operations in South Africa through:

- Reduced road wear (per tonne.km)
- Reduced vehicle trips i.e.
  - Reduced congestion
  - Reduced safety exposure risk
- Improved safety performance
- Improved transport productivity
- Reduced emissions (per tonne.km)
Problem statement
Problem statement
Problem statement
Problem statement
Problem statement
Performance-Based Standards

<table>
<thead>
<tr>
<th>Prescriptive Standards</th>
<th>Performance-Based Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>What the vehicle looks like</th>
<th>What the vehicle can do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governs <strong>mass and dimensions</strong></td>
<td>Governs actual <strong>on-road performance</strong></td>
</tr>
<tr>
<td><strong>Constrains productivity</strong></td>
<td><strong>Allows heavier and/or larger</strong> vehicles</td>
</tr>
<tr>
<td><strong>Constrains innovation</strong></td>
<td><strong>Promotes innovation</strong></td>
</tr>
</tbody>
</table>

Images courtesy of the Australian National Transport Commission
Australian Performance Standards for heavy vehicles

Performance-Based Standards Scheme – the Standards and Vehicle Assessment Rules
as at 10 November 2008 (incorporating all amendments consented to by the ATC up to the date)

Prepared by National Transport Commission
## Performance-Based Standards: Safety

<table>
<thead>
<tr>
<th>Manoeuvre/Test</th>
<th>Performance Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-speed 90° turn (5 km/h)</td>
<td>Low-speed swept path&lt;br&gt;  Tail swing&lt;br&gt;  Frontal swing&lt;br&gt;  Steer-tyre friction demand</td>
</tr>
<tr>
<td>High-speed lane-change (80 km/h)</td>
<td>Rearward amplification&lt;br&gt;  High-speed transient offtracking</td>
</tr>
<tr>
<td>Rollover</td>
<td>Static rollover threshold</td>
</tr>
<tr>
<td>High-speed pulse steer (80 km/h)</td>
<td>Yaw damping coefficient</td>
</tr>
<tr>
<td>High-speed on uneven road (90 km/h)</td>
<td>Tracking ability on a straight path</td>
</tr>
<tr>
<td>Various (driveability standards)</td>
<td>Startability&lt;br&gt;  Gradeability A&lt;br&gt;  Gradeability B&lt;br&gt;  Acceleration Capability</td>
</tr>
</tbody>
</table>
Low-Speed Offtracking

Standard Semi-Trailer
Low-Speed Offtracking

- Path followed by outside tractor tire
- Maximum width of swept path
- Path followed by innermost trailer tire
High Speed Transient Offtracking

PBS Lane Change Manoeuvre (SAE J2179)

Course and test specifications:
- 2.5 second period
- 24.5 m/sec (55mph)
- 61 m (200 ft) maneuvering section
- 1.46 m (4.8 ft) lateral displacement
- 0.15 g peak lateral acceleration

Traffic cone pairs
- 4.58 m (15 ft) stripes placed 0.6 m (2 ft) apart*

Preliminary straight start section, traffic cone pairs, 30.5 m (100 ft) spacing

Initial Straight section, 6.1 m (20 ft) spacing

"Maneuvering" section, 3 m (10 ft) spacing

Exit section, 6.1 m (20 ft) spacing

* not drawn to scale
High Speed Transient Offtracking
Rollover stability: Baseline (legal) vs PBS
Performance-Based Standards: Infrastructure

Infrastructure

- Pavements
- Bridges

Pavement Vertical Loading
Pavement Horizontal Loading
Tyre Contact Pressure Distribution

Bridge Loading
Road Wear Performance Standard
PBS in Africa ??? ....
New technology not always appropriate in Africa ....
PBS Pilot Project in South Africa

PBS VEHICLES IN OPERATION
× 282
136 073 256 km
TOTAL km TRAVELLED

www.csir.co.za
Performance-Based Standards (PBS) Strategy for Heavy Vehicles in South Africa

April 2007

Compiled by:
PBS Steering Committee
Contact Number: 012-841-3945

SMART TRUCK PROGRAMME

RULES FOR THE DEVELOPMENT AND OPERATION OF SMART TRUCKS AS PART OF THE PERFORMANCE-BASED STANDARDS RESEARCH PROGRAMME IN SOUTH AFRICA

April 2017

Compiled by: Smart Truck Committee and CSIR Built Environment
Access: Route assessments
Access: Route assessments
Forestry baseline and PBS vehicles

- 22.0 m, 56.0 tons
- 24.0 m, 64.1 tons
- 27.0 m, 67.5 tons
- 25.8 m, 67.5 tons
- 25.0 m, 70.0 tons
Buhle Betfu Rigid drawbar
Timber Logistics Services Rigid drawbar
Mining side-tipper
Unitrans B-Triple vs BAB Quad
Mining Road Train: Rearward Amplification
Barloworld Transport Sugar Bottom Dumper
SG Coal B-double
Unitrans Fuel Quad
Fuel Quad Case Study

**PBS COMBINATION**

- **PAYLOAD**
  - GCM: 38t
  - Mass Distribution: 68%
- **BASELINE COMBINATION**
  - **PAYLOAD**
  - GCM: 32t
  - Mass Distribution: 58%

**FUEL**

- **L/Tonne Payload/100km**
  - PBS: 1.2
  - Baseline: 1.4
  - 16.94% less fuel consumed by the PBS vehicle

**TRIPS**

- **TOTAL RETURN TRIPS**
  - PBS: 27
  - Baseline: 31
- **Savings**
  - R 2 076 323 saving per 1000 Tonne-Payload transported

**ROAD**

- **Roadwear/Tonne Payload**
  - PBS: 0.37
  - Baseline: 0.41
  - 9.5% less roadwear/Tonne-payload

**SAFETY**

- **Accidents/Million KM**
  - PBS: 1.37
  - Baseline: 2.24
  - 39% lower crash rate for PBS vehicles
  - R 261 000 accident cost saving/Million KM

**PBS COST SAVINGS PER 1000 TONNES**

- R 2 083 370
Beefmaster B-triple for cattle
SA Breweries PBS combination
### SA Breweries E. Cape PBS combinations: Efficiency improvements

<table>
<thead>
<tr>
<th></th>
<th>Kms Travelled</th>
<th>Kms Saved</th>
<th>Hours on the road</th>
<th>Hours Saved</th>
<th>Fuel Used (ℓ)</th>
<th>Fuel Saved (ℓ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec-16</td>
<td>33 250</td>
<td>13 253</td>
<td>621</td>
<td>248</td>
<td>23 940</td>
<td>3 962</td>
</tr>
<tr>
<td>Jan-17</td>
<td>74 642</td>
<td>29 720</td>
<td>1 477</td>
<td>588</td>
<td>55 059</td>
<td>7 558</td>
</tr>
<tr>
<td>Feb-17</td>
<td>63 854</td>
<td>25 519</td>
<td>1 245</td>
<td>497</td>
<td>46 564</td>
<td>7 060</td>
</tr>
<tr>
<td>Mar-17</td>
<td>82 108</td>
<td>32 349</td>
<td>1 614</td>
<td>636</td>
<td>60 497</td>
<td>8 117</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>253 854</strong></td>
<td><strong>100 841</strong></td>
<td><strong>4 957</strong></td>
<td><strong>1 969</strong></td>
<td><strong>186 060</strong></td>
<td><strong>26 697</strong></td>
</tr>
<tr>
<td>% Savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>12.5</strong></td>
</tr>
</tbody>
</table>
ZZ2 B-triple for tomatoes
Smart Truck Pilot Project: Impact

- **TOTAL TRIPS SAVED PER YEAR**: 85,923 trips (22%)
- **TOTAL FUEL SAVED PER YEAR**: 2.24 M Litres = $2.21 M (12%)
- **TOTAL km SAVED PER YEAR**: 14,207,336 km (22%)
- **GREENHOUSE GAS EMISSION**: 5,896 tons CO2 / year (12%)
- **ROADWEAR REDUCTION**: $2,000 per vehicle / year (13%)
- **CRASHES PER MILLION km**: 1.25 vs 2.10 for baseline vehicles (41%)

Note: Statistics are reported as at June 2018
* Fuel at R14.19 per litre
Smart Truck Pilot Project: Baseline vs PBS vehicles

PBS
- Level 1: 80%
- Level 2: 12%
- Level 3: 2%
- Level 4: 2%
- Fail: 12%

Baseline
- Level 1: 28%
- Level 2: 3%
- Level 3: 13%
- Level 4: 3%
- Fail: 56%
Smart Truck Pilot Project: Baseline vehicles

Number of PBS Failures

- 1 Failure: 73%
- 2 Failures: 18%
- 3 Failures: 9%

Percentage of Baseline Vehicles Failing PBS assessment

- Static Rollover Threshold: 35%
- Rearward Amplification: 10%
- Yaw Damping Coefficient: 20%
Smart Trucks: Potential Gains

- Reduced vehicle trips i.e.
  - Reduced congestion
  - Reduced safety exposure risk
- Improved safety performance
- Improved transport productivity
- Reduced road wear (per ton.km)
- Reduced emissions (per ton.km)
- Improved performance of the SA heavy vehicle fleet
Thank you