Overview of 6 X 2 Axle Systems and New Generation Wide Base Single Tires for Highway Tractors

Benefits and Issues Concerning Weight Regulations in Western States

WASHTO Meeting
September 10, 2014

Brad Hicks
Meritor, Inc.

Stan Lew
Michelin North America
Objective of Today’s Discussion

• Provide overview of new 6 x 2 Axle Technology, including features and benefits.

• Provide overview of Next Generation of Wide Base Single Tires (NGWBST), including features and benefits.

• Describe potential regulatory issue in several western states that restrict usage of these technologies.

• Discuss potential options for addressing this regulatory issue.
EPA/NHTSA Final Rule – Phase 1

GHG Emissions and FE Standards for Medium and Heavy-Duty Engines and Vehicles

<table>
<thead>
<tr>
<th>Class 2B</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Class 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5k</td>
<td>10k</td>
<td>14k</td>
<td>16k</td>
<td>19.5k</td>
<td>26k</td>
<td>33k</td>
</tr>
<tr>
<td>10k lb</td>
<td>14k lb</td>
<td>16k lb</td>
<td>19.5k lb</td>
<td>26k lb</td>
<td>33k lb</td>
<td>80k lb</td>
</tr>
</tbody>
</table>

- **Work**
  - Heavy-duty pickups and vans

- **Vocational (Truck, Tractor)**
  - Light, medium, and heavy heavy-duty

- **Tractors**
  - Combination

**Vehicle examples**

- CREW VAN
- WALK-IN VAN
- CONVENTIONAL VAN
- CITY DELIVERY
- LARGE WALK IN
- LARGE WALK IN
- BUCKET
- TREE SPECIALIST
- BOTTLED GAS
- SINGLE AXLE VAN
- BOTTIER
- MEDIUM CONVENTIONAL
- HOME FUEL
- TRASH
- FIRE ENGINE
- LOW PROFILE COE
- MEDIAN AXLE VAN
- INTERCITY BUS
- TANDEM REUSE
- CEMENT
- REETER
- HEAVY CONVENTIONAL
- HEAVY TANDEM CONVENTIONAL
- HEAVY TANDEM CONVENTIONAL SLEEPER

**Meritor Wabco**

Safety Strong. Efficiency Smart.
Overview of 6x2 Axle Systems

6x4 Configuration

• 6 Wheel Ends
• 4 Wheel Ends Provide Drive
• Most Common Linehaul Setup

“Live Tandem” (6x4) – 2 Driving Axles

6x2 Configuration

• 6 Wheel Ends
• 2 Wheel Ends Provide Drive
• 1 Single (Larger) Drive Axle

6x2 Tandem – 1 Driving Axle
Why is Fleet Interest in 6x2’s Increasing?

• **Significant Weight Savings**
  - Eliminates one drive carrier
  - Eliminates inter-axle driveline
  - **371 lb.** vs. a 6x4 Tandem

• **More Efficient versus 6x4**
  - Use of newer, “high efficiency” carrier designs
  - Fewer Gearset Meshes
    » A source of energy loss
  - Less Lubricant Churning Losses
    » One sump vs. two

---

Churning Losses as gear rotates through Sump are significant at high speeds

2-4.6% fuel efficiency improvement
Performance Concerns about 6x2’s

• Past Concerns have limited usage of 6x2 vehicles
  - Significant concerns about traction, especially in adverse weather
    ▪ A smaller percentage of the total combination weight is on the driving axle, so available traction is reduced:

<table>
<thead>
<tr>
<th>Configuration</th>
<th>GCW (kg)</th>
<th>% Total Load on Drive Axles</th>
</tr>
</thead>
<tbody>
<tr>
<td>6x4 Configuration</td>
<td>36,000</td>
<td>42.8%</td>
</tr>
<tr>
<td>6x2 Configuration</td>
<td>36,000</td>
<td>21.4%</td>
</tr>
</tbody>
</table>

• Newer 6x2 Axle Systems have overcome these issues while providing additional benefits
System Operation - Load Transfer and Diff-lock

Inputs
- Wheel Speed
- Vehicle Speed
- Mode Selected
- Spring Pressures
- ABS & Eng. Retarder Info

Pneumatic Control Unit (PCU)

Air Pressure

Air Spring
- 60psi
- 75psi

Air Spring
- 60psi
- 45psi

34k lbs.

20k lbs.

17k lbs.
Traction Performance of Advanced 6x2

Split-mu Traction Event
80,000 lbs Maximum Line Haul
20% Grade
18 Wheelers to 10 Wheelers

New Generation of Wide Base Single Tires (NGWBST)

- 2000 – present *
- Used by hundreds of fleets and thousands of drivers.
- Savings of > 150 million gallons of fuel.
- Reduction of > 1.5 million metric tons of CO$_2$ equivalent GHG

* Based on industry standard rolling resistance testing of comparable tires and retreads.

18 wheels
- 275/80R22.5
- 295/75R22.5
- 11R22.5

10 wheels
- 445/50R22.5
- 455/55R22.5
- (~800 lbs. weight reduction)
New Generation Wide Base Single Tires (NGWBS)

• 1908 - paired or dual tires to increase load capacity
• 1980’s – “Super Singles” (385, 425/65R22.5)
• 2000 - NGWBS technology introduced
  - 445/50R22.5 or 455/55R22.5
• 8 manufacturers
  » Michelin
  » Bridgestone
  » Yokohama
  » Continental
  » Goodyear
  » Double Coin
  » Hankook
  » Linglong
Average USA = 19%

5 – axle heavy vehicles on USA highways with at least 1 NGWBS-fitted axle group (2Q13) ➔ 13% to 32% (regional variations).

• NGWBS application on 5-axle vehicles based on a highway survey of 2974 vehicles.
2014 Status

New Generation Wide Base Single Tires (NGWBS)

• US permit-issued operation (O/S, O/W, LCV)
  - 8 states - KS, MN, MT, NY, SD, UT, WA, NV.
    » “... each axle (non-steering) must have 4 tires ...”
    » “... two tires at each end of each axle ...”
    » “. tandem axle shall have tires of the same size and construction .”
    » “… 500 lpi …”
  » WASHTO "Guide for Uniform Laws and Regulations Governing Truck Size and Weight Among the WASHTO States"
    - WASHTO Guide Section 9.08 - 2010 COHT ballot/survey approval
      - "Axes previously equipped with four tires may use two wide-base tires as replacement, providing existing axle weight regulations and tire manufacturer ratings are not exceeded.".
      - “NGWBS” tire definition vs “Super Single WBT” already adopted into WASHTO Guide Chapter 1.
“Advanced” 6x2’s and NGWBST – A Great Combination

• It is no surprise that fleets attracted to the benefits of Advanced 6x2’s are also interested in WBST:

  **Weight Savings**
  
<table>
<thead>
<tr>
<th></th>
<th><strong>6x2</strong></th>
<th><strong>NGWBST</strong></th>
<th><strong>Total Savings:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>371 lb.</td>
<td>800 lb.</td>
<td>1171 lb.</td>
</tr>
<tr>
<td>Plus easier maintenance, inspection and inflation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

  **Fuel Savings**
  
<table>
<thead>
<tr>
<th></th>
<th><strong>6x2</strong></th>
<th><strong>NGWBST</strong></th>
<th><strong>Total Savings:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-14.6%</td>
<td>5-10%</td>
<td>7-14.6%</td>
</tr>
</tbody>
</table>

  **Expected Market Growth**
  
<table>
<thead>
<tr>
<th></th>
<th><strong>Today (available since 2013)</strong></th>
<th><strong>5 Year Projection</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;5%</td>
<td>15%</td>
</tr>
</tbody>
</table>
The Regulatory Issue

Max Permitted Loading
Of Axle with NGWBS
(based on 500 lb per inch)

17,200 lb.
Drive Axle

17,200 lb.
Tag Axle

“Advanced” 6x2 - Nominal

17,000 lb.
Drive Axle

17,000 lb.
Tag Axle

“Advanced” 6x2 – Load Transfer

20,000 lb.
Drive Axle

14,000 lb.
Tag Axle

During load transfer event, load on drive axle exceeds 17,200 lb., and WBST loading exceeds 500 lb. per inch.
Regulatory Issue – Key Points to Consider

• The duration of a load transfer event is short. (Meritor’s system times out at 80 sec; Meritor WABCO system restores equal split above 25 mph).

• The frequency of such load transfer events is low, less than 3% of the time or 3% of distance traveled.

• The maximum load on the drive axle during a load transfer event does not exceed single axle load limits imposed by state (NGWBS tire load per inch limit is temporarily exceeded).

• Loading during load transfer event is well within design limits for WBST.

• The improved traction and mobility offered by these advanced systems provides improved safety and vehicle stability.
Regulatory Issue: Key Points to Consider

• Benefits to Fleets
  - Greater Fuel Efficiency (approximately 7-15% combined when WBST are used on 6x2 vehicles)
  - Reduced Weight – Nearly 1200 lb. savings combined. Improved fuel economy and/or allows greater payloads.

• Benefits to the States and the General Public
  - Reduced Vehicle Emissions – 10% Fuel Savings ~ 10% Reduction in Greenhouse Gas Emissions
  - Truck maintenance and inspection with NGWBS tires is simplified over duals (eliminates concerns about tire pressure differentials and unmatched sizes that affect tire load sharing).
  - More Productive Fleets = Increased business, revenues, and a more robust economy.
Request to Regulatory Authorities
(in states that impose 500 lb per in. limit on NGWBS tires)

We respectfully request that you consider some means of acknowledging the compliance of these “advanced” 6x2 systems equipped with NGWBS tires. This can be accomplished by:

- An instruction
- A “waiver”
- An exception
- Adoption of a less vigorous interpretation of the regulations
- A footnote to the current regulation exempting WBST installed on “advanced” 6x2’s with electronically controlled air suspensions from the 500 lb. per in. limit.
- A formal change to the regulations
Thank You!

Brad Hicks
Meritor, Inc.
Bradford.Hicks@meritor.com

Stan Lew
Michelin North America
Stan.Lew@us.michelin.com