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*Cardinal Scale Manufacturing Co.*



## **Axle Load Weighing NIST Vehicle Scale Training Session**

**September 2003**

**Commercial Vehicle Enforcement Weighing**

# Highways form the foundation for a good part of the economic system





## **Reasons for Weighing Axles**

- **Reduce road damage**
- **Monitor overloads**
- **Safety**
- **Minimize wear**

# Means of Weighing Axles



- In-motion scales
- Axles load scales
- Full-length truck scales
- Multi-platform truck scales

# In-Motion Scales

- **Quick and easy**
- **Affected by road and truck characteristics**
- **Lower accuracy**
- **Cannot be used for enforcement weighing**



# Axle Load Scales

- Requires more time
- Less expensive than full-length scale
- Affected by approach to scale
- Should not be used for enforcement weighing



# Full-length Truck Scales

- **Requires more time**
- **Can be used to measure total weight**
- **Affected by approach to scale**



# Multi-platform Scale

- **Quick (<10 sec)**
- **Unaffected by approach**
- **Accurate**
- **Can be used for enforcement weighing**
- **Best solution for enforcement weighing**







# Typical Legal Load Limits for Truck Scales

**Single Axle - 20,000 lb**

**Tandem Axle - 34,000 lb**

**Axle Groups - See FHWA  
table**



# Short Test Truck Weights

<b><u>Position</u></b>	<b><u>Scale 1</u></b>	<b><u>Scale 2</u></b>	<b><u>Scale 3</u></b>	<b><u>Total</u></b>
<b>1</b>	<b>00</b>	<b>12360</b>	<b>34040</b>	<b>46400</b>
<b>2</b>	<b>00</b>	<b>12280</b>	<b>34120</b>	<b>46400</b>
<b>3</b>	<b>00</b>	<b>12260</b>	<b>34140</b>	<b>46400</b>
<b>4</b>	<b>12840</b>	<b>33560</b>	<b>00</b>	<b>46400</b>
<b>5</b>	<b>12860</b>	<b>33580</b>	<b>00</b>	<b>46440</b>
<b>6</b>	<b>12780</b>	<b>33640</b>	<b>00</b>	<b>46420</b>

# Short Test Truck

**Change in Steering Axle Weight  
– 600 lb**

**Class IIIIL Tolerance – on  
steering axle**

**+/- 40 lb Maintenance**

**+/- 20 lb Acceptance**

**Change in total weight – 40 lb**



# Long Test Truck Weights

<u>Position</u>	<u>Scale 1</u>	<u>Scale 2</u>	<u>Scale 3</u>	<u>Total</u>
<b>1</b>	<b>00</b>	<b>12020</b>	<b>41820</b>	<b>53840</b>
<b>2</b>	<b>00</b>	<b>12000</b>	<b>41860</b>	<b>53860</b>
<b>3</b>	<b>00</b>	<b>11960</b>	<b>41880</b>	<b>53840</b>
<b>4</b>	<b>12020</b>	<b>41800</b>	<b>00</b>	<b>53820</b>
<b>5</b>	<b>12000</b>	<b>41840</b>	<b>00</b>	<b>53840</b>
<b>6</b>	<b>12000</b>	<b>41860</b>	<b>00</b>	<b>53860</b>



# **Long Test Trucks**

**Change in Steering Axle  
Weight – 60 lb**

**Change in Total Weight –  
40 lb**



# Scale Comparison

<b>Scale</b>	<b>Steering Axle</b>	<b>Drive Axle</b>	<b>Change in Gross Weight</b>
<b>Brand X</b>	<b>120</b>	<b>140</b>	<b>40</b>
<b>Brand Y</b>	<b>120</b>	<b>60</b>	<b>80</b>
<b>Brand Z</b>	<b>60</b>	<b>80</b>	<b>60</b>

# Scale Comparison

<b>Scale</b>	<b>Steering Axle</b>	<b>Drive Axle</b>	<b>Trailer Axles</b>	<b>Change in Gross Weight</b>
<b>A</b>	<b>30</b>	<b>75</b>	<b>40</b>	<b>20</b>
<b>B</b>	<b>45</b>	<b>76</b>	<b>31</b>	<b>102</b>

# Weight Change – Brakes On

<b>Scale</b>	<b>Steering Axle</b>	<b>Drive Axle</b>	<b>Trailer Axles</b>	<b>Change in Gross Weight</b>
<b>A</b>	<b>135</b>	<b>197</b>	<b>84</b>	<b>37</b>
<b>B</b>	<b>144</b>	<b>346</b>	<b>264</b>	<b>98</b>



# Standard Deviations of Weights

<u>Scale</u>	<u>Brakes</u>	<u>Steering</u>	<u>Drive</u>	<u>Trailer</u>	<u>Total</u>
A	OFF	17	9	14	14
A	ON	121	145	63	27
B	OFF	40	43	10	44
B	ON	121	350	200	38

# Conclusions

- **No significant difference among the scales tested.**
- **Application of truck brakes shift weight between axles without affecting total weight.**
- **Suspension effects require further study.**



# Conclusions (cont.)

- **Scale provides accurate measurement of axle weights at one point in time.**
- **Axle weights change continuously with truck movement:**
  - Acceleration**
  - Grade**
  - Centrifugal force**
  - Shifting loads**
  - Suspension**
  - Braking**

# Recommendations

- **Keep this phenomenon in mind when checking axle weights on a single vehicle**
- **Establish appropriate allowances on over-weight axles in enforcement weighing.**
- **Consider further study of axle weight variance.**





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