Tire Rolling Resistance
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Tire Testing and Data Analysis

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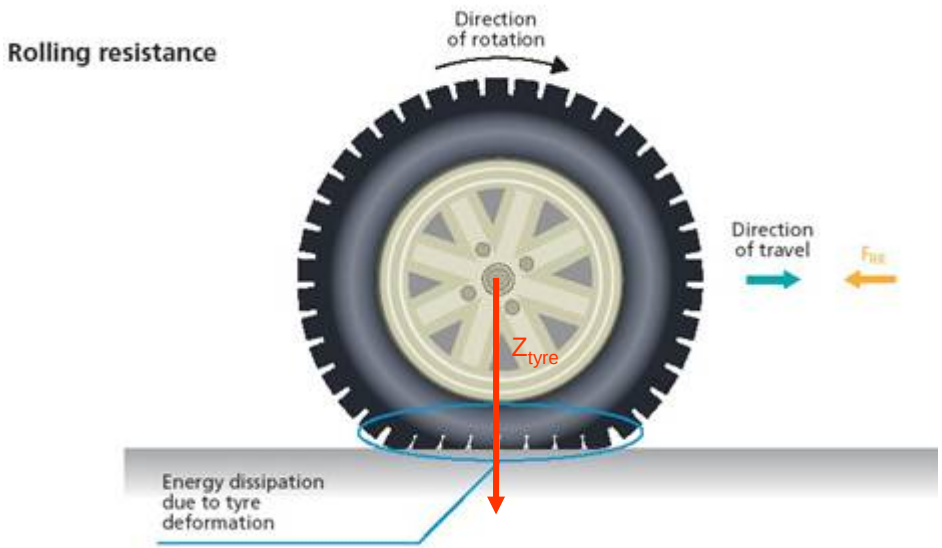
Engineering Terminology

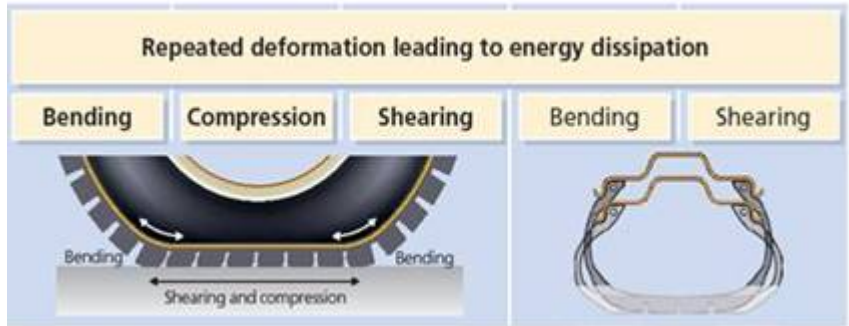
F_R or Fr = Rolling Resistance Force: Rolling resistance of the free-rolling tire is the scalar sum of all contact forces tangent to the test surface and parallel to the wheel plane of the tire. RRF also has been used in some published documents

C_R or Cr = Rolling Resistance Coefficient: Rolling resistance coefficient is the ratio of the rolling resistance to the load on the tire. RRC also has been used in some published documents

Definition of Tire's Rolling Resistance

- As tires roll under the vehicle's weight, their shape is being deformed and their visco-elastic compounds, which are also designed to ensure traction and comfort, dissipate energy that turns into heat





- As rubber conductivity is low, the heat is not easily evacuated towards outside and the tire is warming-up

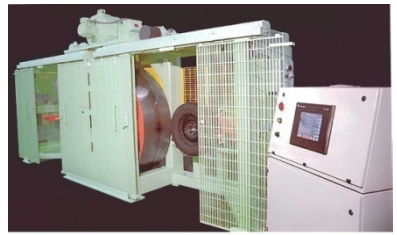
- Tire's rolling resistance is defined as the energy dissipated by a tire per unit of distance traveled (rolling resistance force F_R) and can be characterized by a coefficient C_R expressed in kg/t or ‰

Measurement Methods

Current Standards/Practices to Consider:

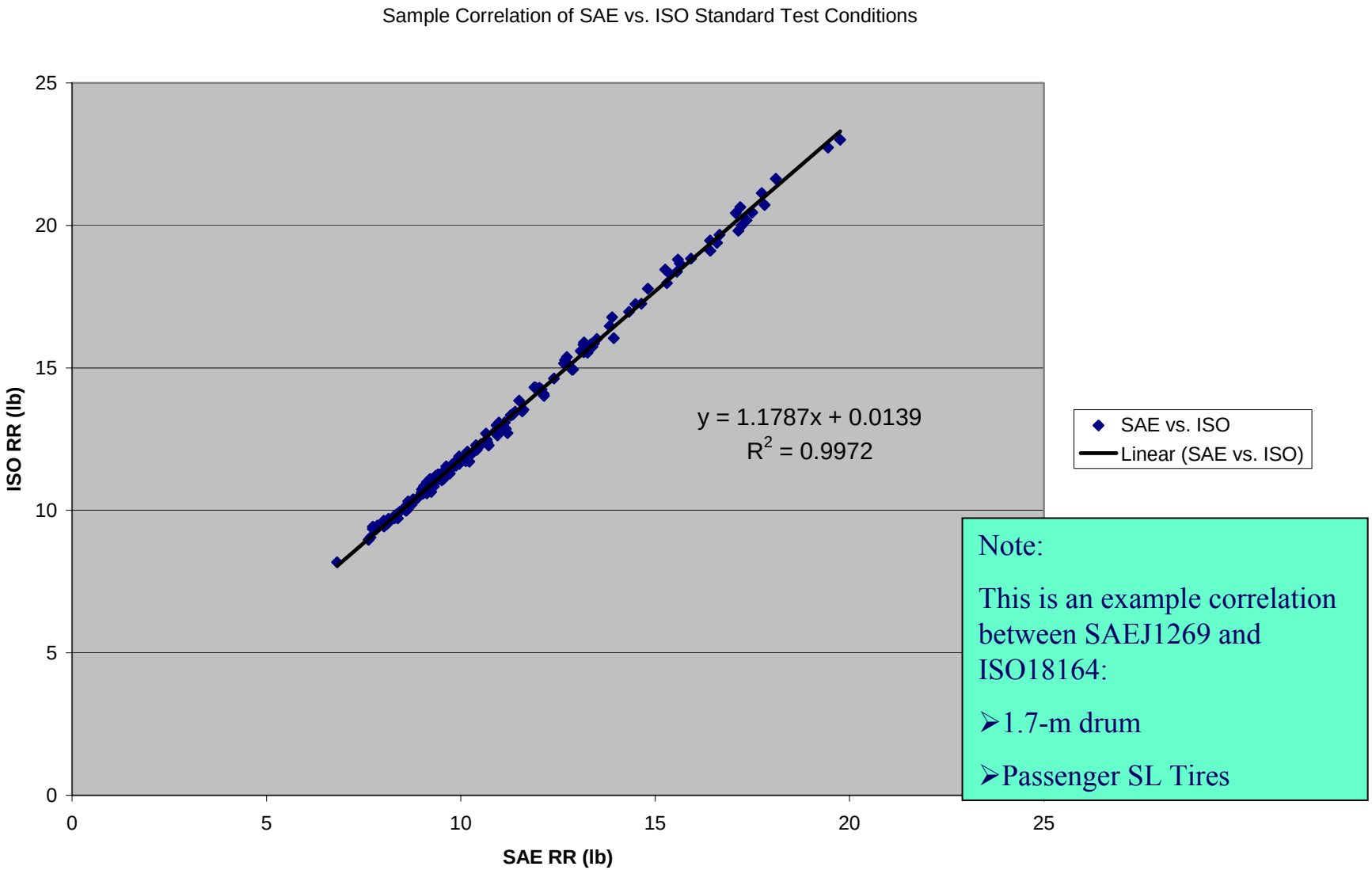
- SAE J1269 USA Historical multi-point and single point test
  - Commonly used today for tire characterization comparisons
- ISO 18164 Global Standard single point test
- ISO 28580 Global Standard in Development single point test
  - New standard for tire characterization comparisons, including a testing machine alignment procedure

Test Comparison



	Current: **SAE J1269** **Single Point**	**Current:** **ISO 18164** **Single Point**	**Future:** **ISO 28580** **Single Point**
Test Drum Diameter:	≥1.5m smooth or 80 grit Ref: 1.7m	≥1.5m smooth or 80 grit Ref: 1.7m	≥1.7m smooth or 80 grit Ref: 2.0m
Thermal Environment:	24° C	25° C	25° C
Test Speed:	80km/h	80km/h	80km/h
Test Load: % of Max Load Capacity	70	80	80
Test Inflation Pressure:	260 kPa Regulated; SL 300 kPa Regulated: XL	210 kPa Capped; SL 250 kPa Capped: XL	210 kPa Capped; SL 250 kPa Capped: XL
Data Correction	Temperature Only	Temp. & Drum Dia.	Temp & Drum Dia.
Lab Alignment Procedure:	NO	NO	**YES**

Sample Correlation Between ISO and SAE J1269:



Note:

This is an example correlation between SAEJ1269 and ISO18164:

- 1.7-m drum
- Passenger SL Tires

- **Correlation Equation: ISO STC RR = 1.18*SAE STC RR**
- **Range of all tires used for this example: ISO = 1.13*SAE to 1.22*SAE**

ISO/TC 31 N 000

2008-03-31

ISO/CD 28580

ISO/TC 31/WG 6

Secretariat: ANSI

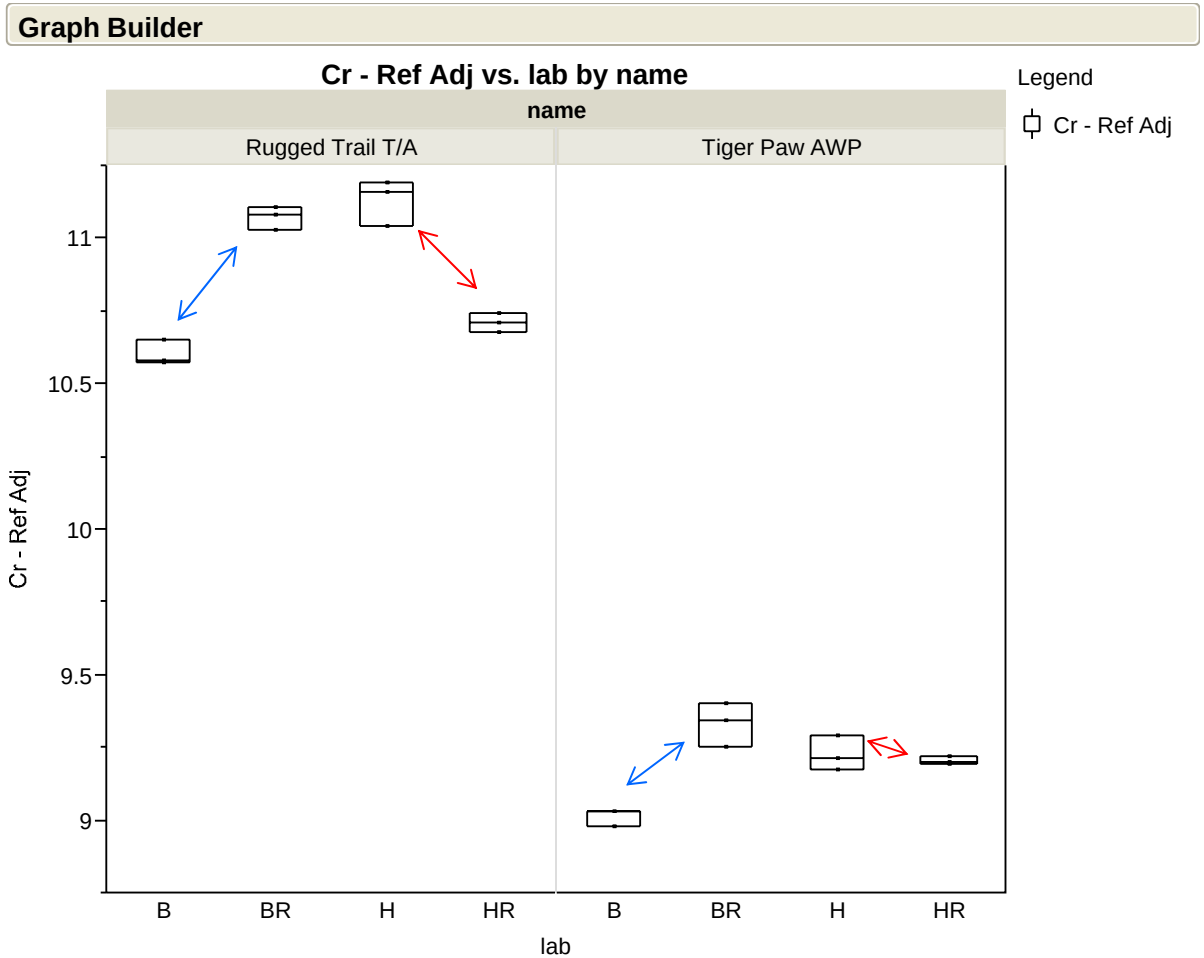
Tyre Rolling Resistance measurement method – single point test and measurement result correlation – designed to facilitate international cooperation and, possibly, regulation building.
Passenger Car, Truck and Bus

Proposed Alignment Method from ISO 28580

- Reference Lab (Lab R) Creates Two Groups of Alignment Tires
  - Reference lab machine repeatability must be less than or equal to 0.050 kg/t
  - Two tire groups must have C_R values and tire LI range specified
- Candidate labs (Lab A,B...) Measures Each Alignment Tire
  - Repeatability of three measurements must be below 0.075 kg/t
  - If repeatability is above 0.075, then additional repeats must be done to get below 0.075 kg/t
- Alignment is derived by each candidate lab to the reference lab (formula $y = a*x + b$)
- Testing results of all candidate tires must be transformed using the formula to produce aligned results for reporting C_R

Sample Lab to Lab Alignment Tire Testing

One Tire Tested 3 Times Per Model Name At Each Lab



$\sigma_{\text{Machine R}} \leq 0.050$

$\sigma_{\text{Machine B \& H}} \leq 0.075$

Alignment Using Two Points

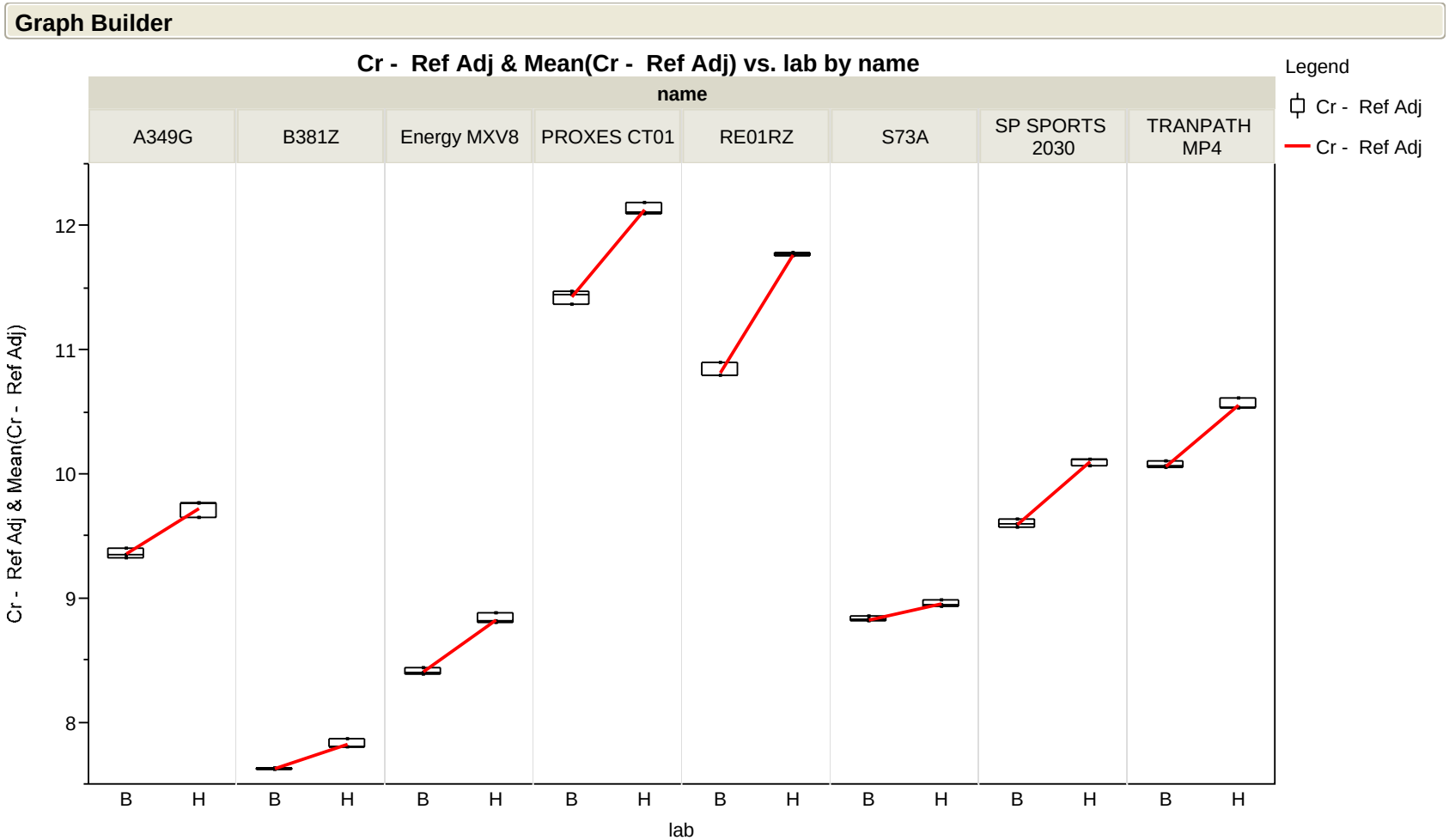
Cr= A (X) + B

A = Gain between labs

B= Offset between labs

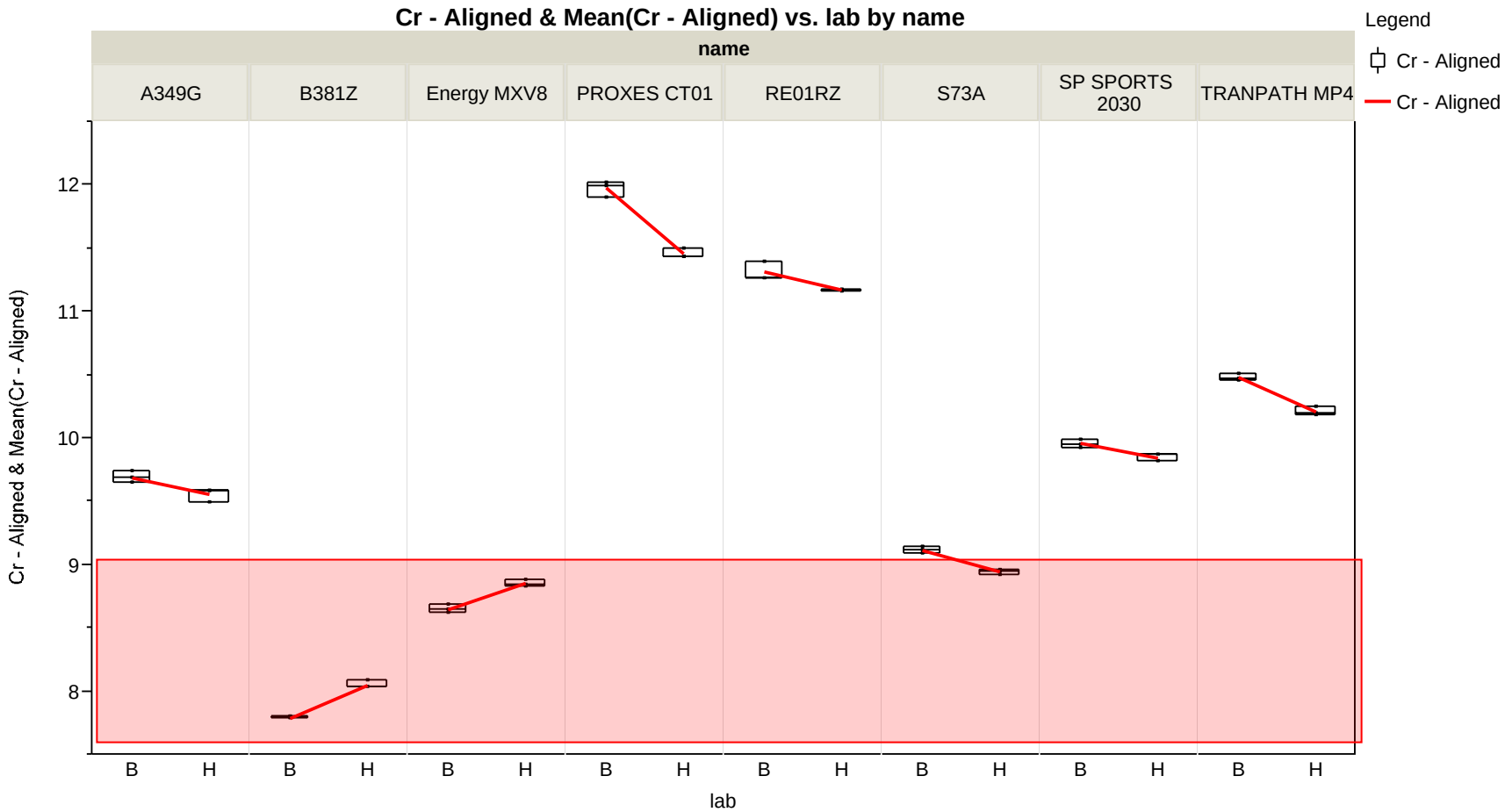
Sample Lab to Lab Testing Not Aligned

Same 3 Tires Per Model Name Tested At Each Lab



Sample Lab to Lab Testing Aligned

Graph Builder



UNCERTAINTY = Absolute Value (δ_{Mean}) + 1.96 * σ_{Global}
0.56 = 0.08 + 1.96 (0.244)

Min Bin Width = UNCERTAINTY * 5/1.96
1.39= 0.56*5/1.96

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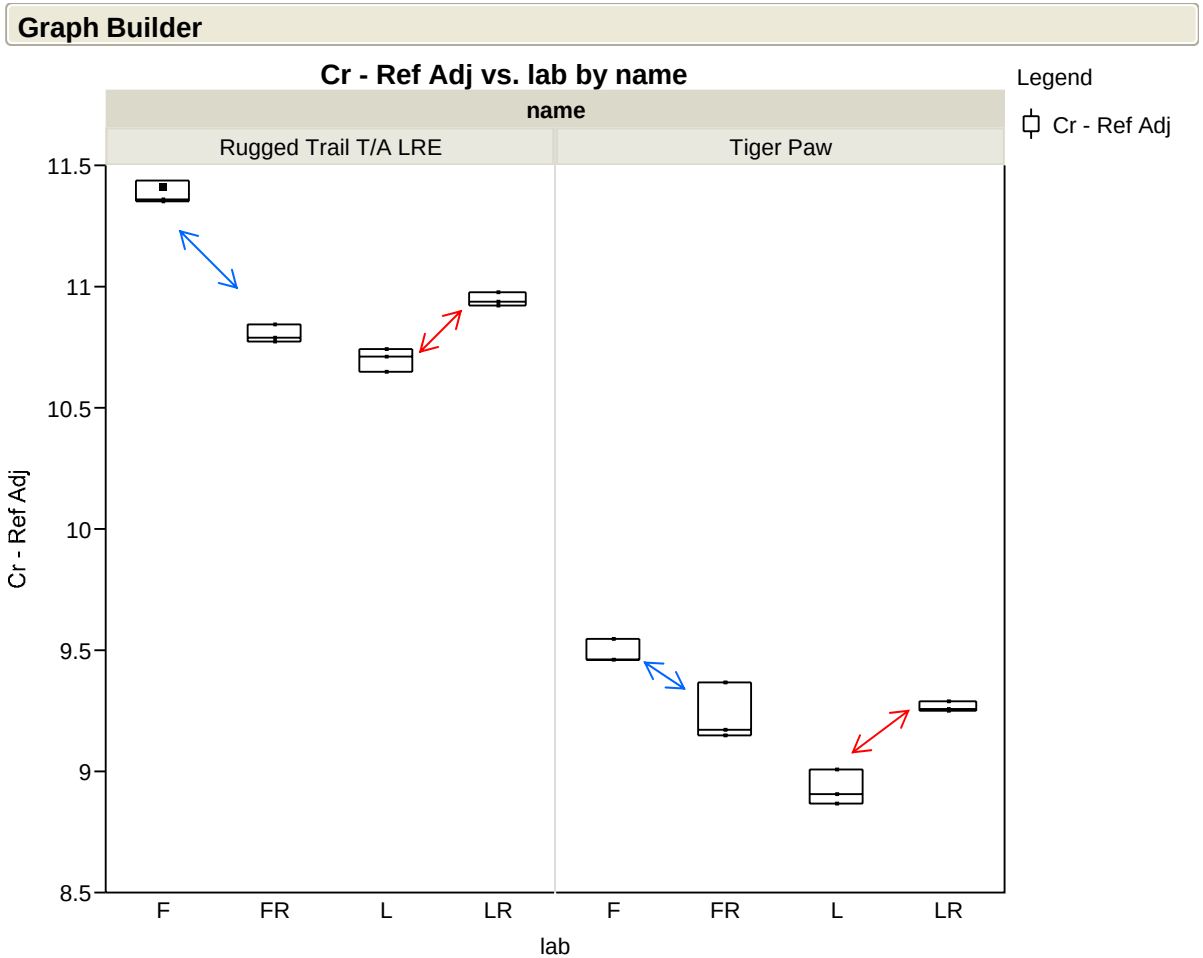

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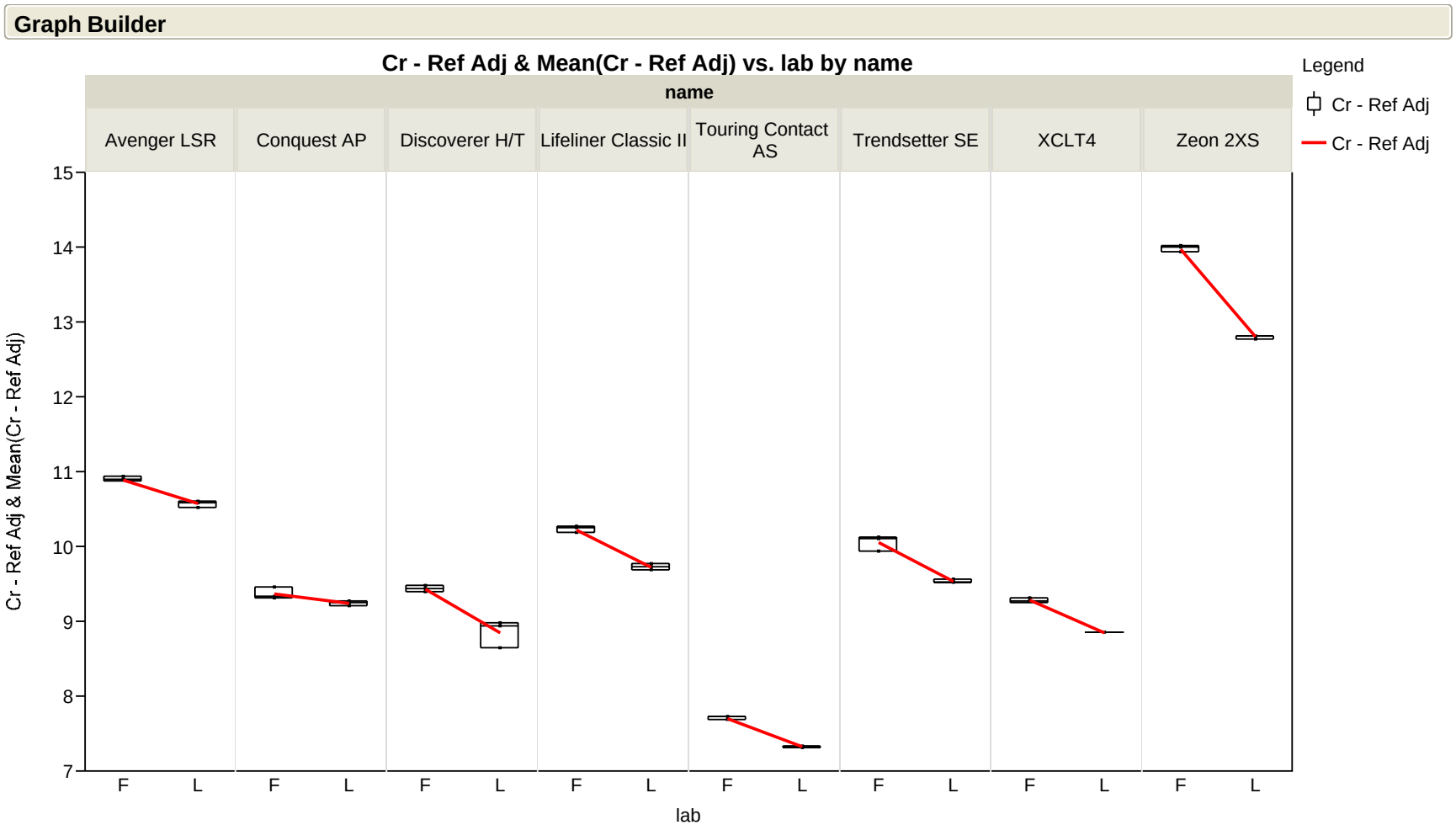

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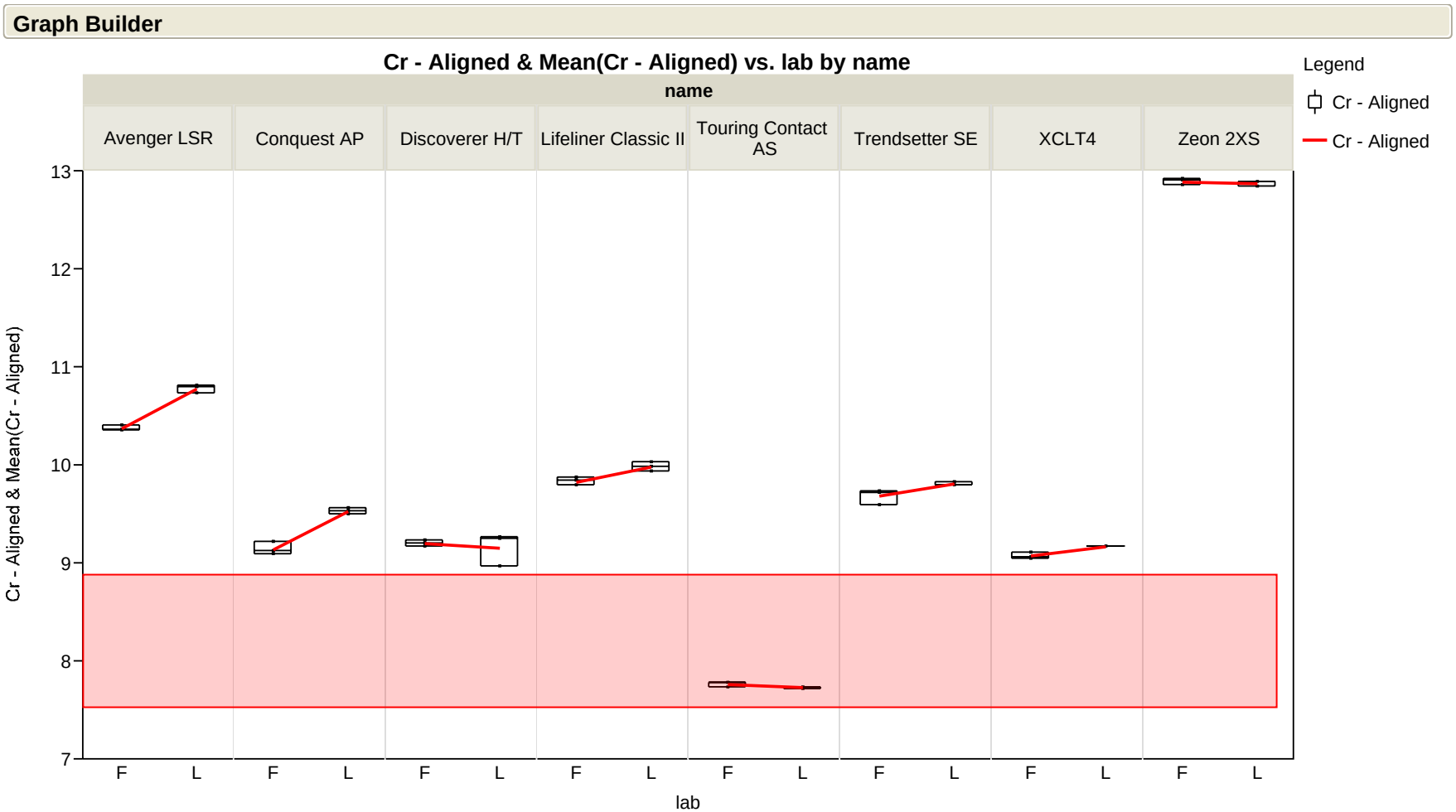

UNCERTAINTY = Absolute Value (δ_{Mean}) + 1.96 * σ_{Global}
0.51 = 0.18 + 1.96 (0.17)

Min Bin Width = UNCERTAINTY * 5/1.96
1.28= 0.51*5/1.96

Summary Of Key Points

- Cr is an appropriate characteristic to analyze and categorize tire rolling resistance information.
- IS28580 provides an effective methodology for lab to lab alignment and requires that Cr results are "Aligned" results.
- Some amount of "Variation" lab to lab and within lab remains after alignment and creates "Uncertainty" for any aligned results comparisons.
- "Categorical Ratings" are an effective way of dealing with the uncertainty attached to all aligned results.
- Presentations that follow will demonstrate that Categorical ratings effectively avoid consumer confusion and potentially inappropriate tire selections.
- Questions? And Thank You For Your Time Today!