Task 4 Rolling Resistance Testing:

California Energy Commission's Fuel Efficient Tire Program

Workshop on The Fuel Efficient Tire Program

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07December07

Smithers Scientific Services, Inc.

Rolling Resistance Testing:

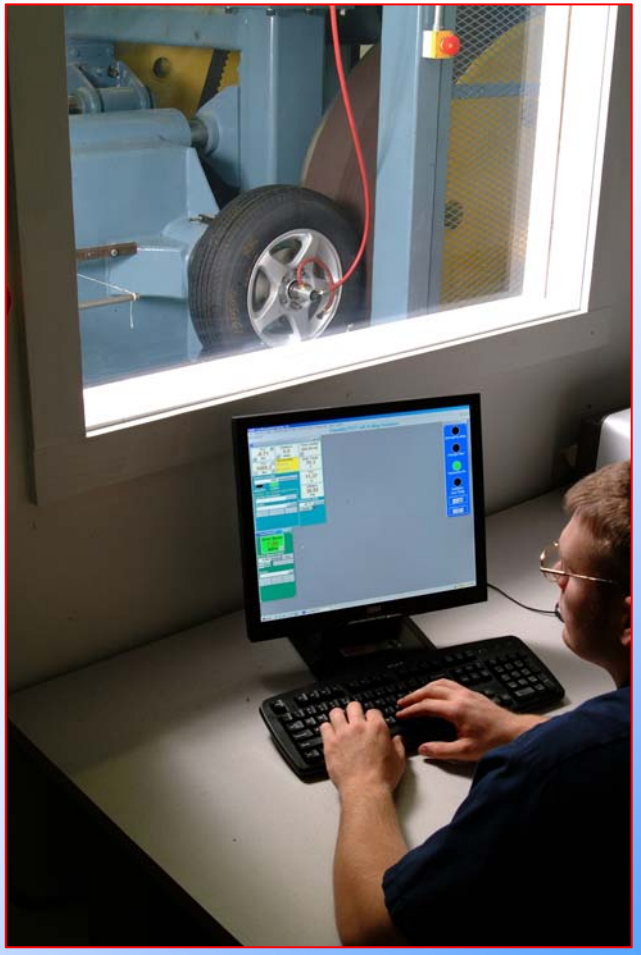
California Energy Commission's Fuel Efficient Tire Program

- **Discussion**

  → Task 2: Selection of Testing Protocol

  → Task 3: Tire Selections for Task 4

  → Task 4: Rolling Resistance Testing
    - Goals
    - Results
    - Tire Size Impact Study



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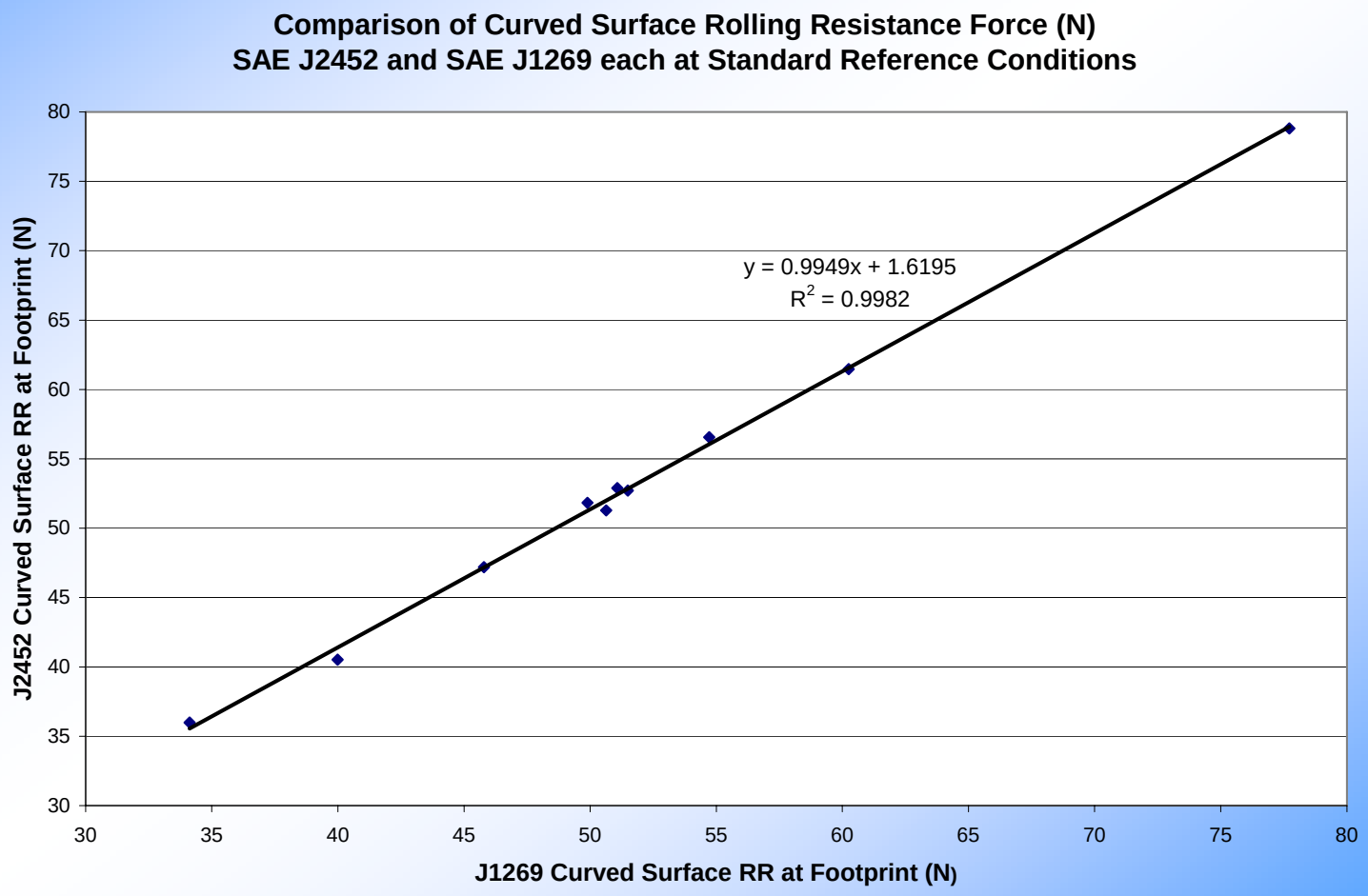
- **Task 2: Results**



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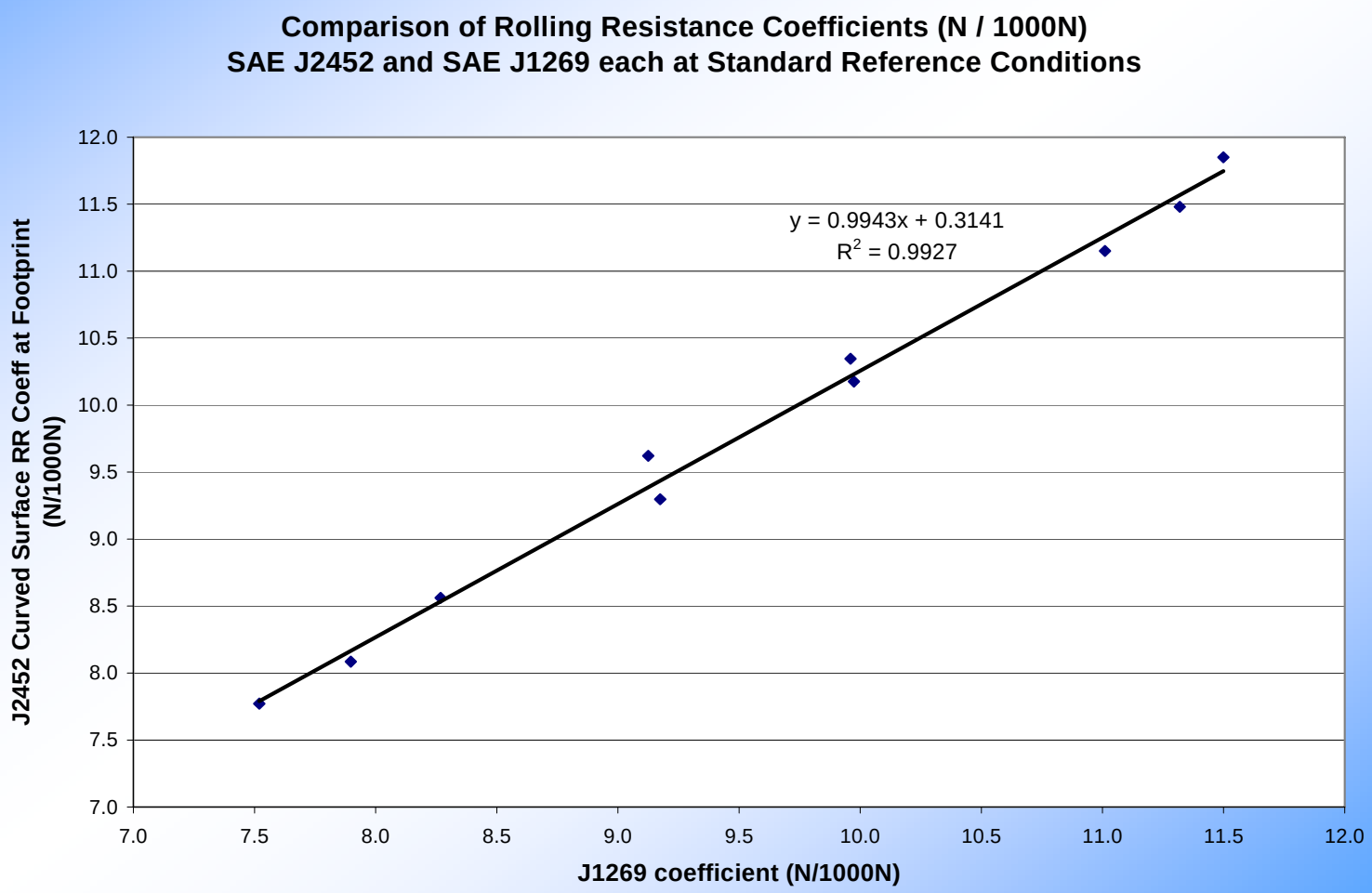

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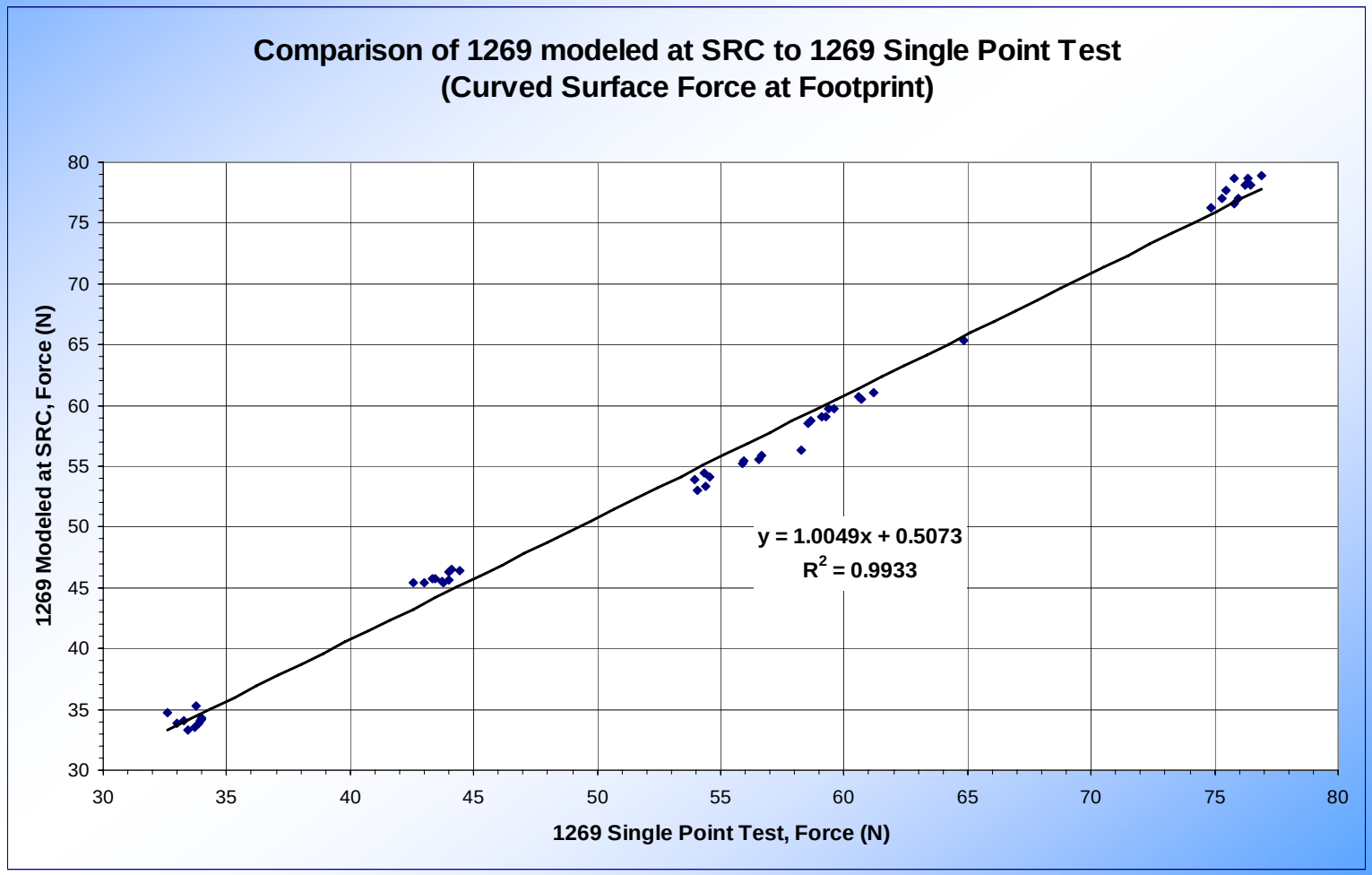

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- Task 2: Selection of testing protocol

  →Findings

  - The SAE J1269 and SAE J2452 results were well correlated for the populations of tires used for the subject study.
    - Rolling resistance forces correlated well between the two tests.
    - Calculated rolling resistance coefficients correlated well between the two tests.
  - Rolling resistance force values and rolling resistance coefficients did not mutually correlate for diverse tire populations. This finding was true for both SAE test protocols.
  - Test reproducibility, as based upon comparisons of coefficients of variations, indicated good reproducibility and similar levels of reproducibility between the two tests.

- Task 2: Selection of testing protocol

  → Findings (continued)

  - Within the confines of the design of the Task 2 test program, neither test revealed any key technically discriminating issues that would represent a deciding factor in its selection or rejection as the preferred protocol to be used in Task 4.
  - Both protocols offer the opportunity to narrow the procedure scope to standard reference conditions, which would allow significant test efficiencies to be achieved.
  - Decision: select single-point test guided by SAE J1269 for Task 4.

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- Task 3: Tire selection phase for Task 4 rolling resistance studies;

  Selection Criteria

  - regular production
  - OE and replacement
  - include all commonly-available speed ratings
  - include all commonly-available market types
    - touring
    - all season
    - high performance; etc
  - broad variety of manufacturers
  - U.S. and international manufacturers
  - two major sizes selected for 80% of Task 4 testing
  - tire size impact study criteria:
    - broad market replacement tires
    - standard all season
    - many sizes available

Rolling Resistance Testing:

California Energy Commission's Fuel Efficient Tire Program

- Task 3: Tire selection phase for Task 4 rolling resistance studies;

Test Plan Summary

→ Test Schedule: 740 Tires Total

- Size A: P195(195)/65R15
  - 76 groups of manufacturer/design combinations
  - 5 tires per group
- Size B: P265(265)/70R17
  - 44 groups of manufacturer/design combinations
  - 5 tires per group
- Tire size impact study
  - all primary sizes (28 sizes) from a single manufacturer
  - 5 tires per size

- Task 4: Rolling Resistance Studies

  → Goals

  - generate a broad rolling resistance data base representing two example sizes
  - provide direction for the question: "With the large number of tire designs available in the marketplace for a given size, what can be expected as a distribution of rolling resistance values?"
  - can the consumer relate basic, external tire characteristics (i.e. tire weight, outside diameter, UTQG treadwear ratings, tread depth, price) to rolling resistance?
  - how do original equipment (OE) vs. replacement market tires compare for rolling resistance?
  - how do size differences within a single manufacturer's product line compare for rolling resistance?

Rolling Resistance Testing:

California Energy Commission's Fuel Efficient Tire Program

- Task 4: Rolling Resistance Studies

  → Results

  - Histograms of Rolling Resistance Values
  - Histograms of Tire Characteristics
  - Rolling Resistance vs. Tire Characteristic Correlation Studies
  - Size Impact Study

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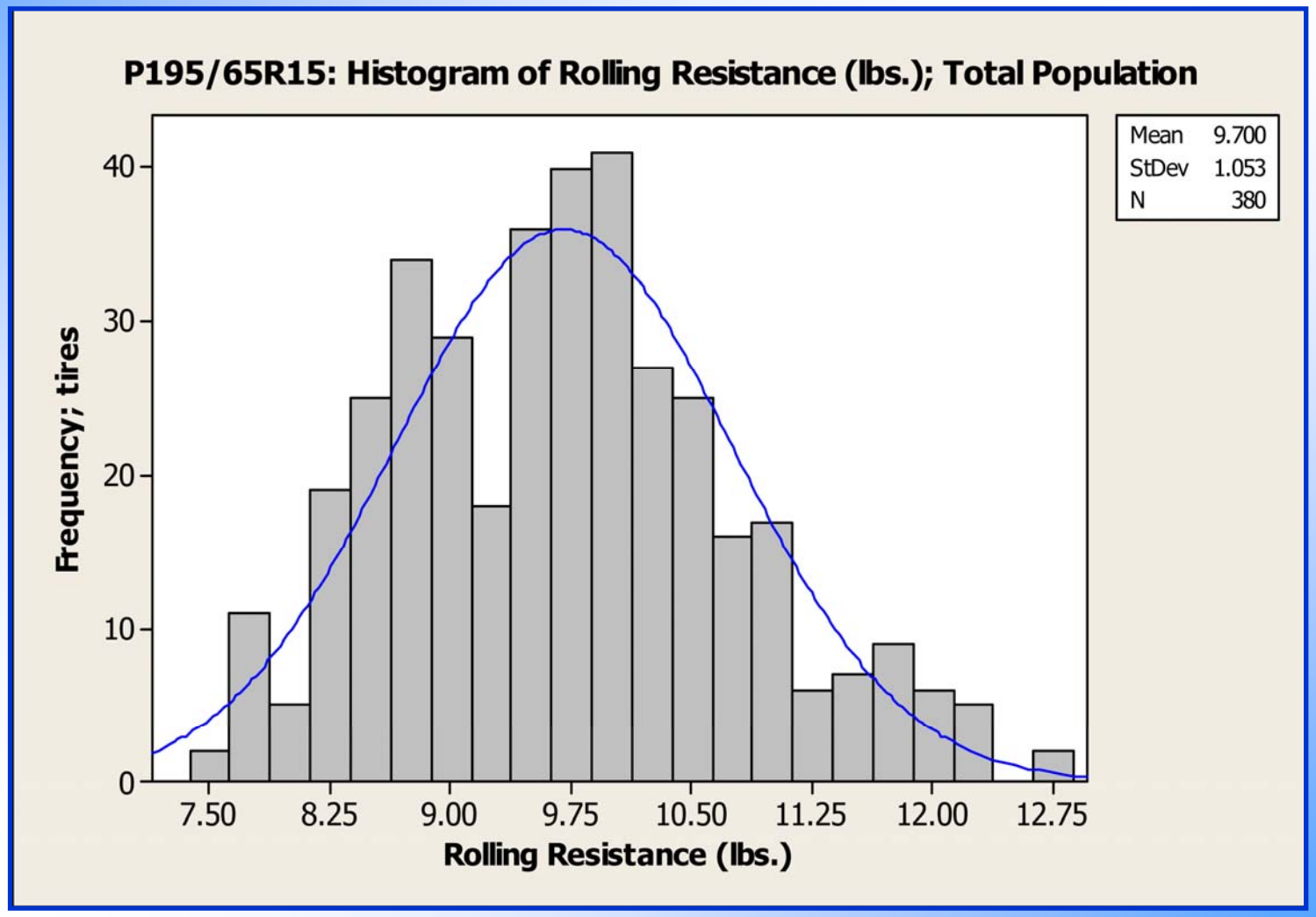
- **Task 4: Results- Histograms of Rolling Resistance Values**



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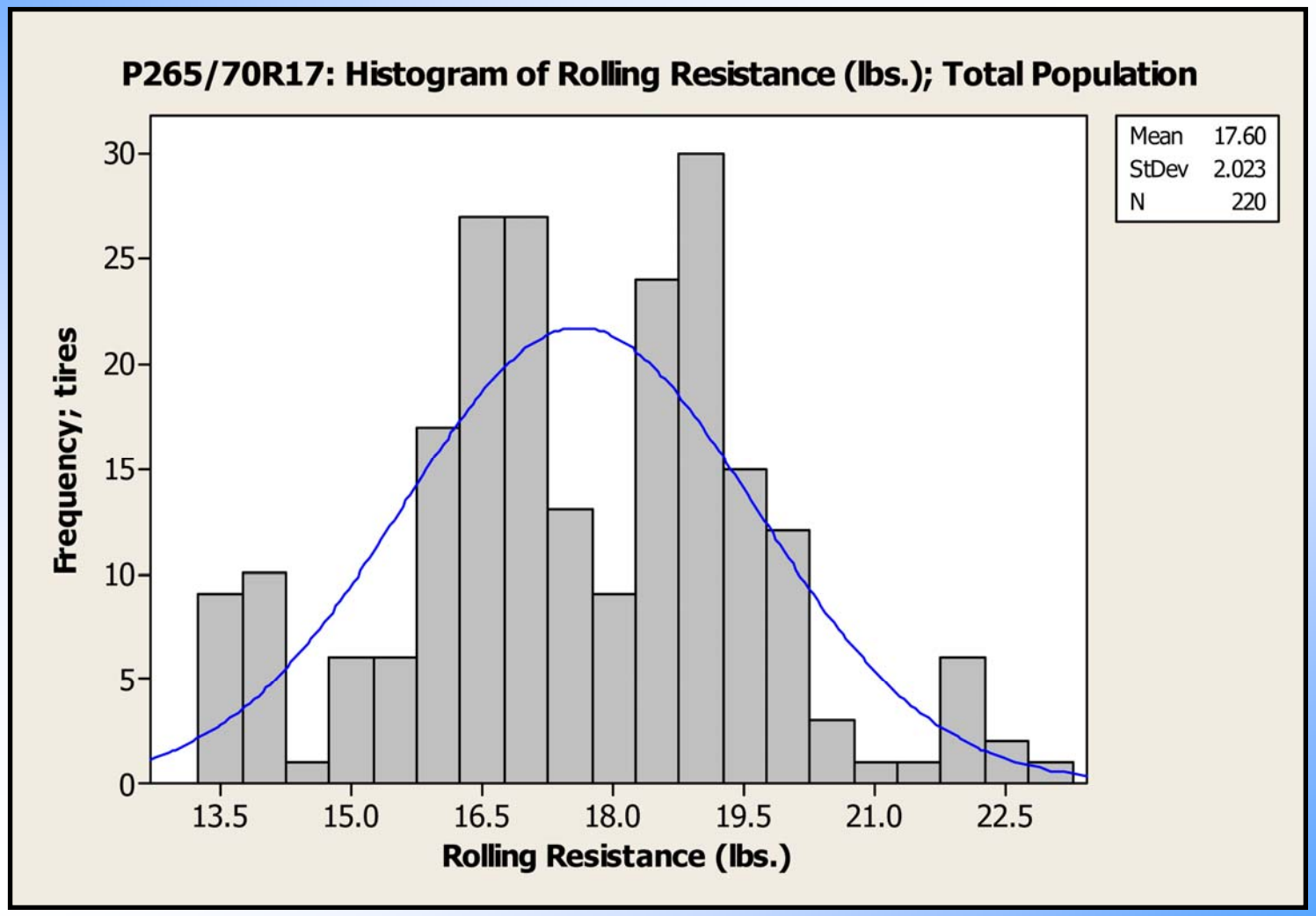

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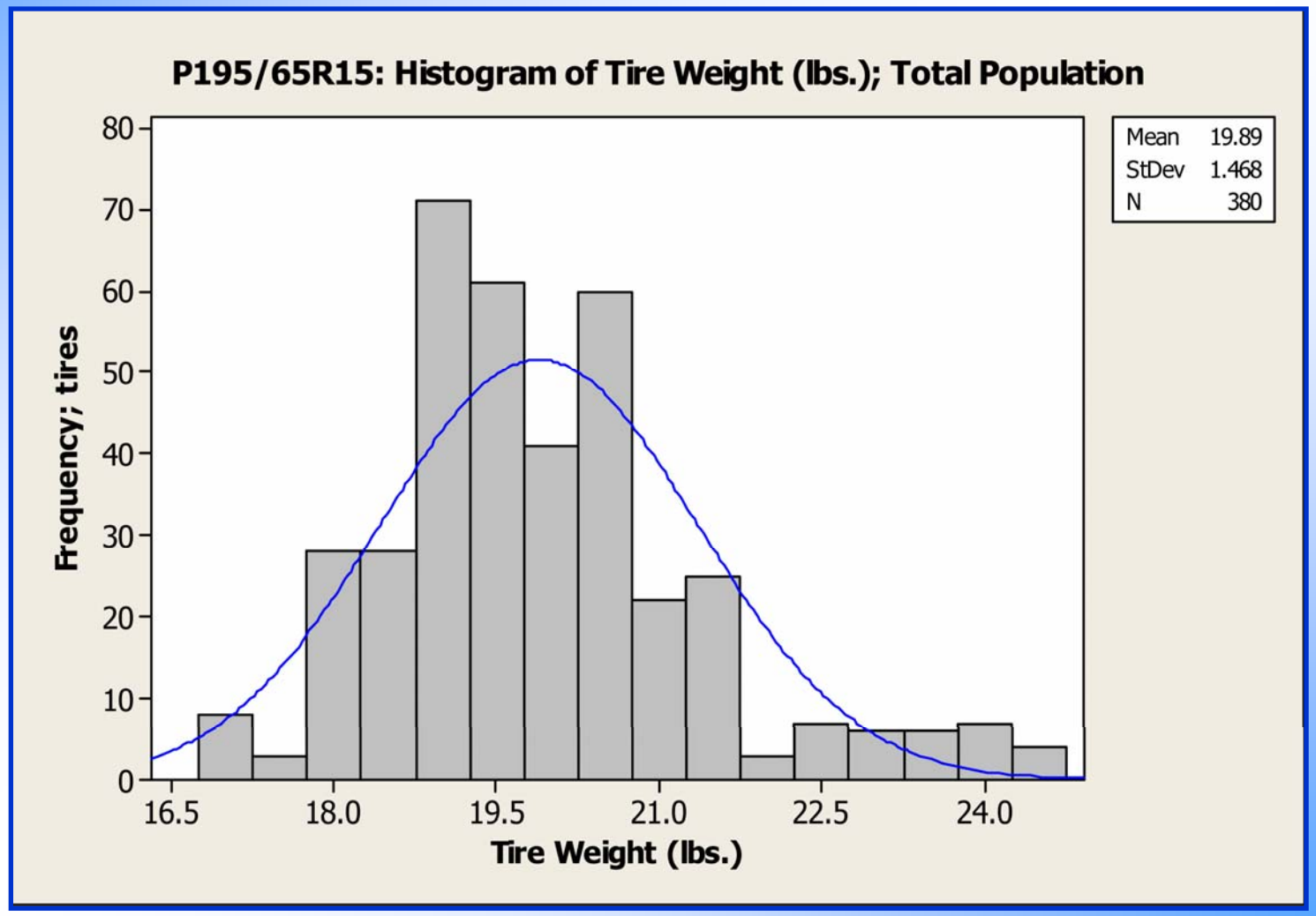

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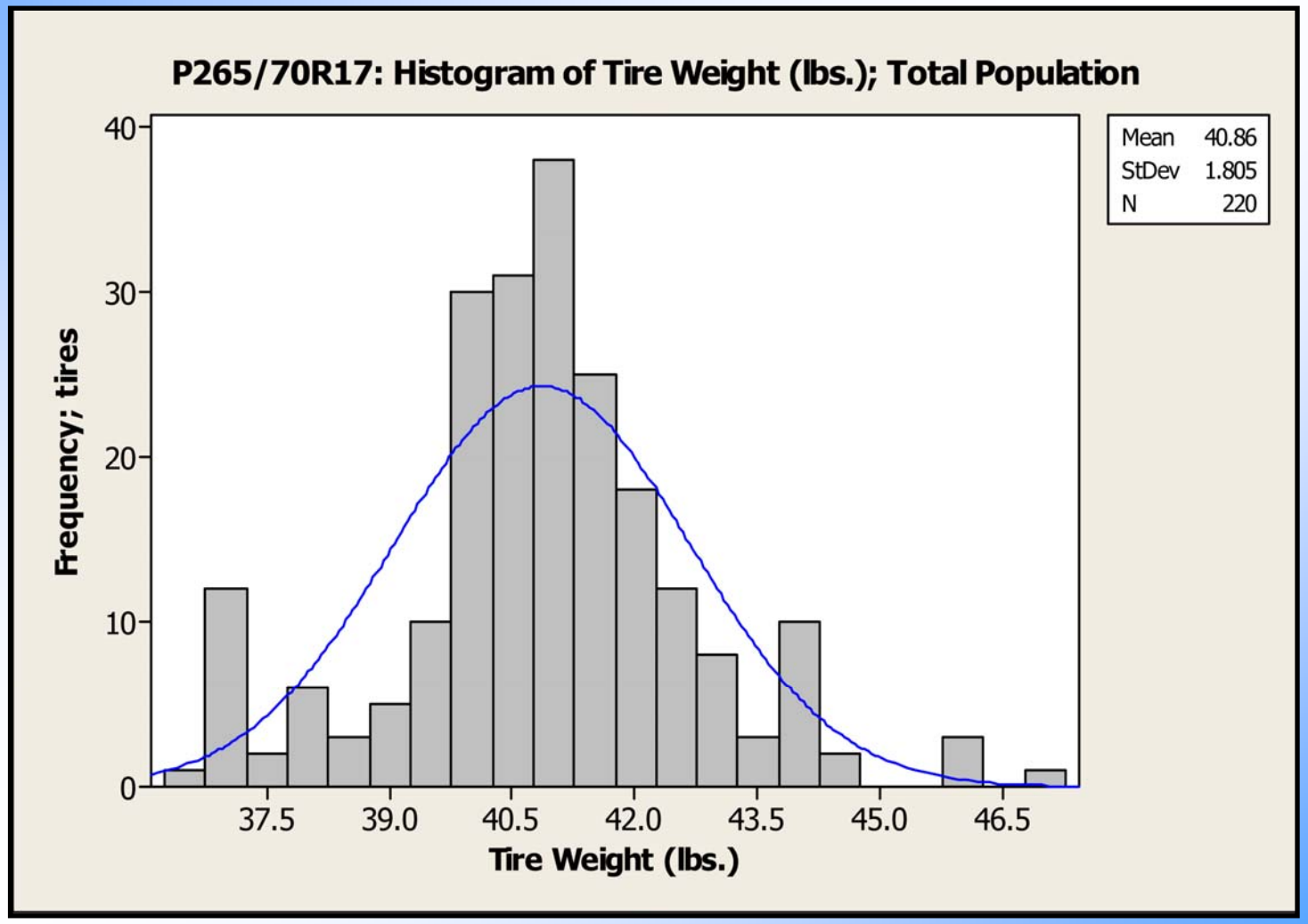

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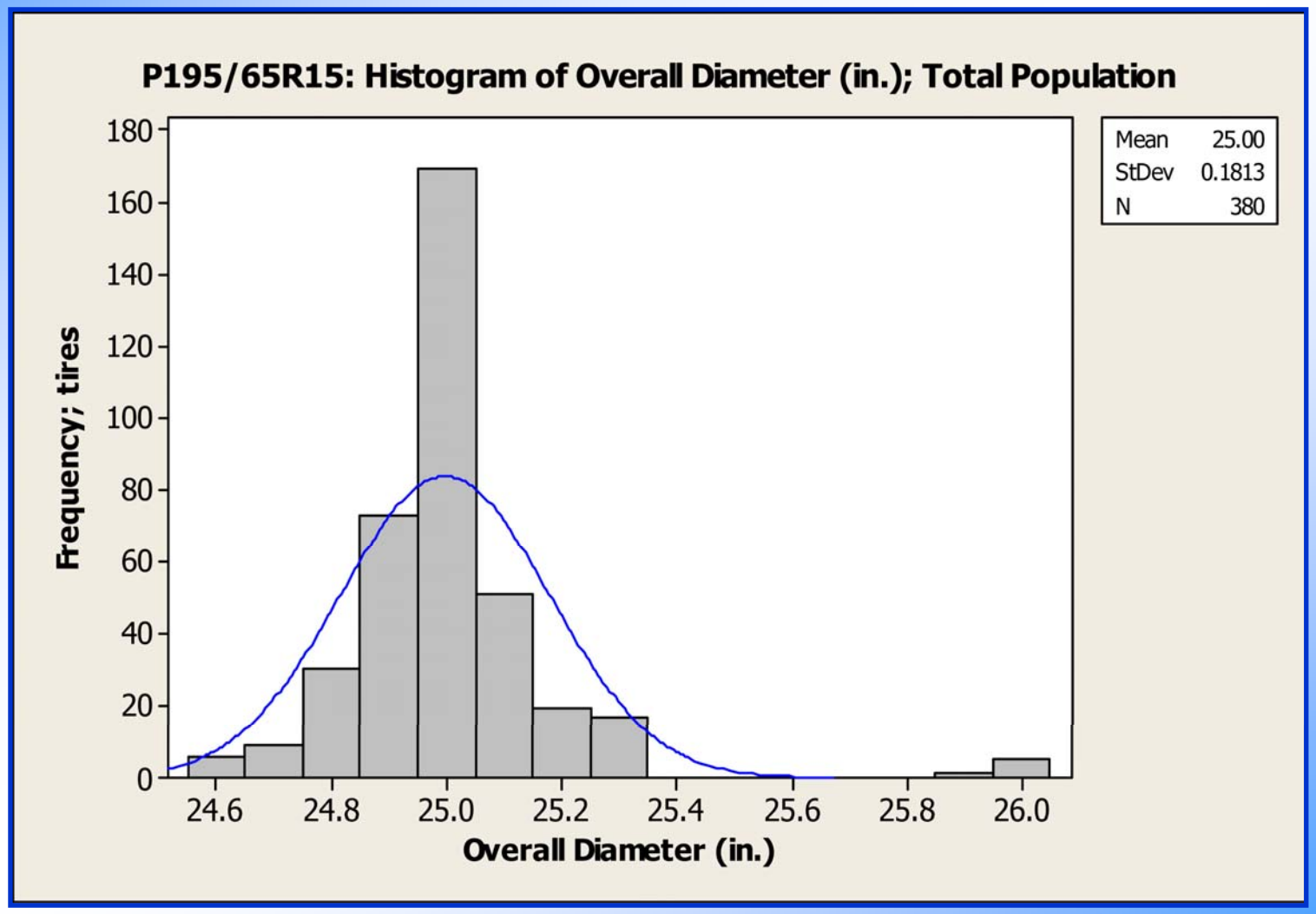

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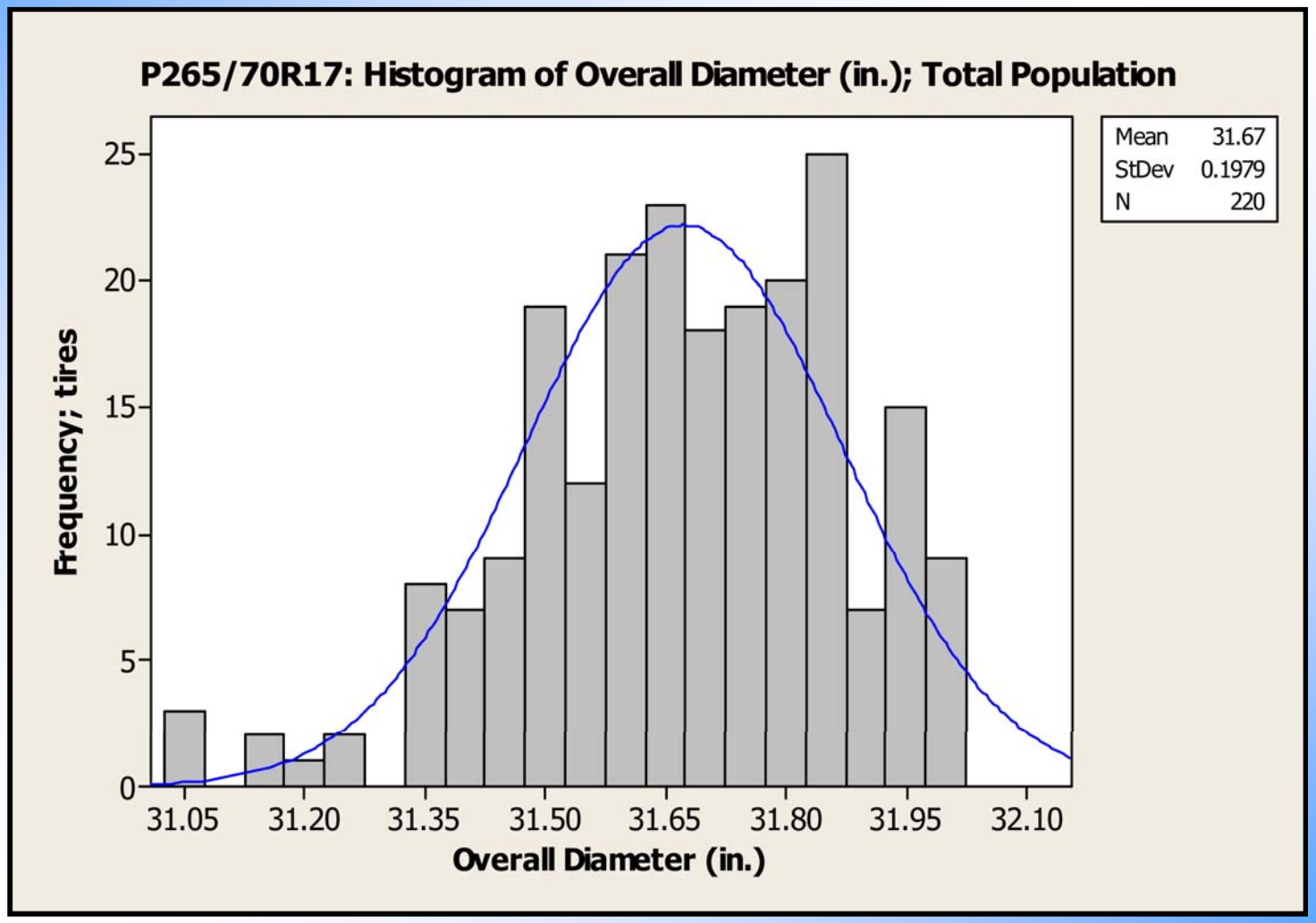

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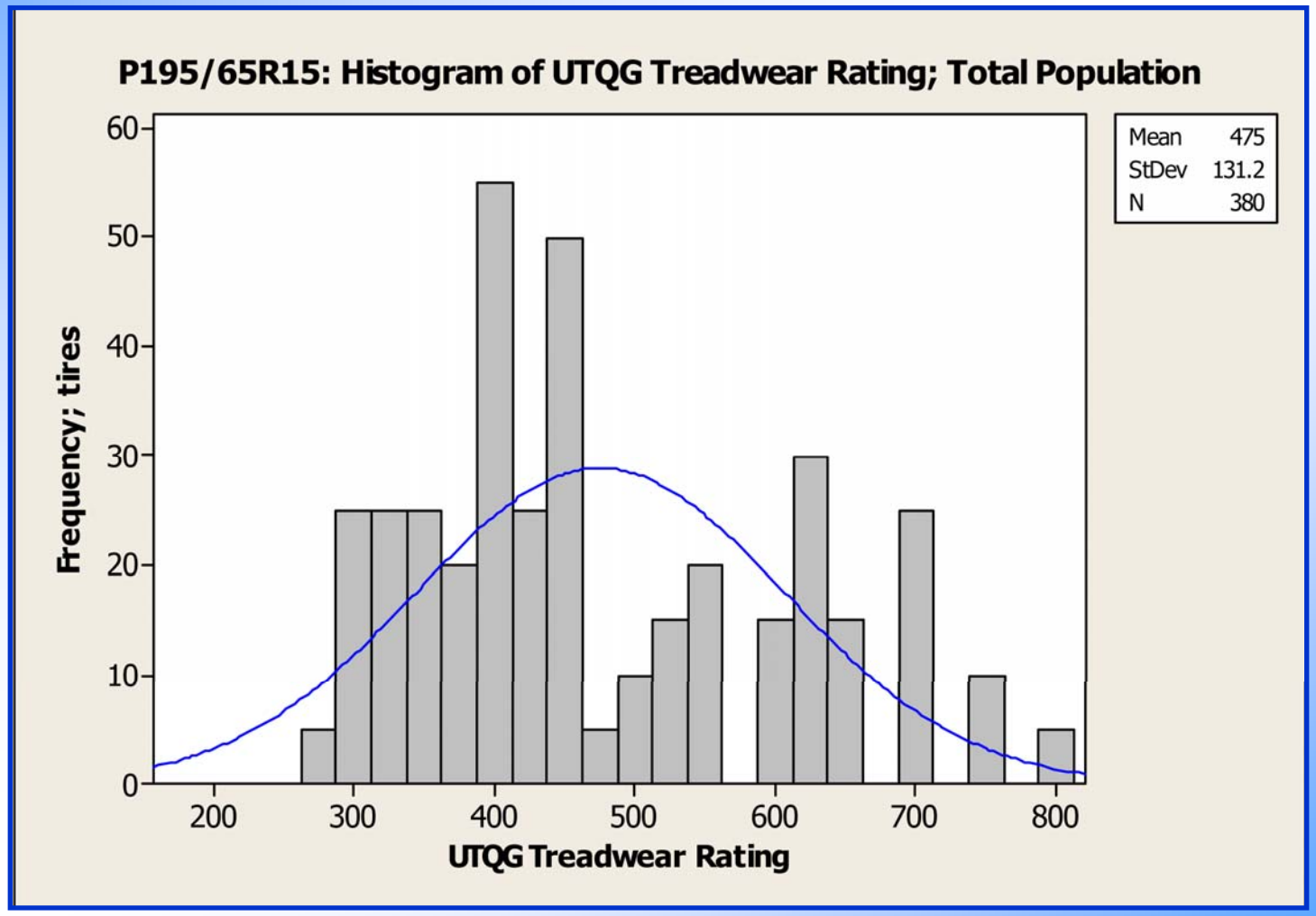

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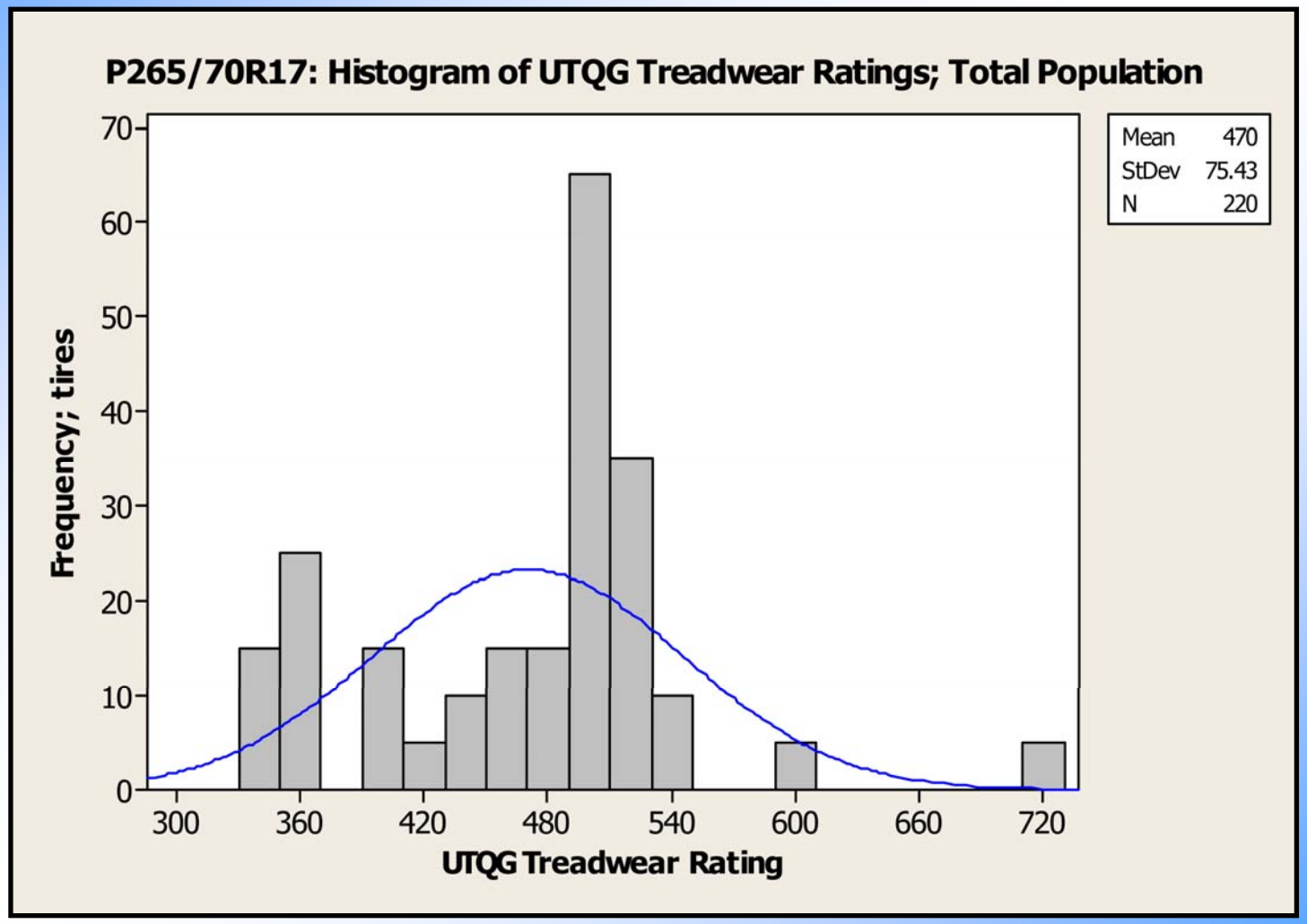

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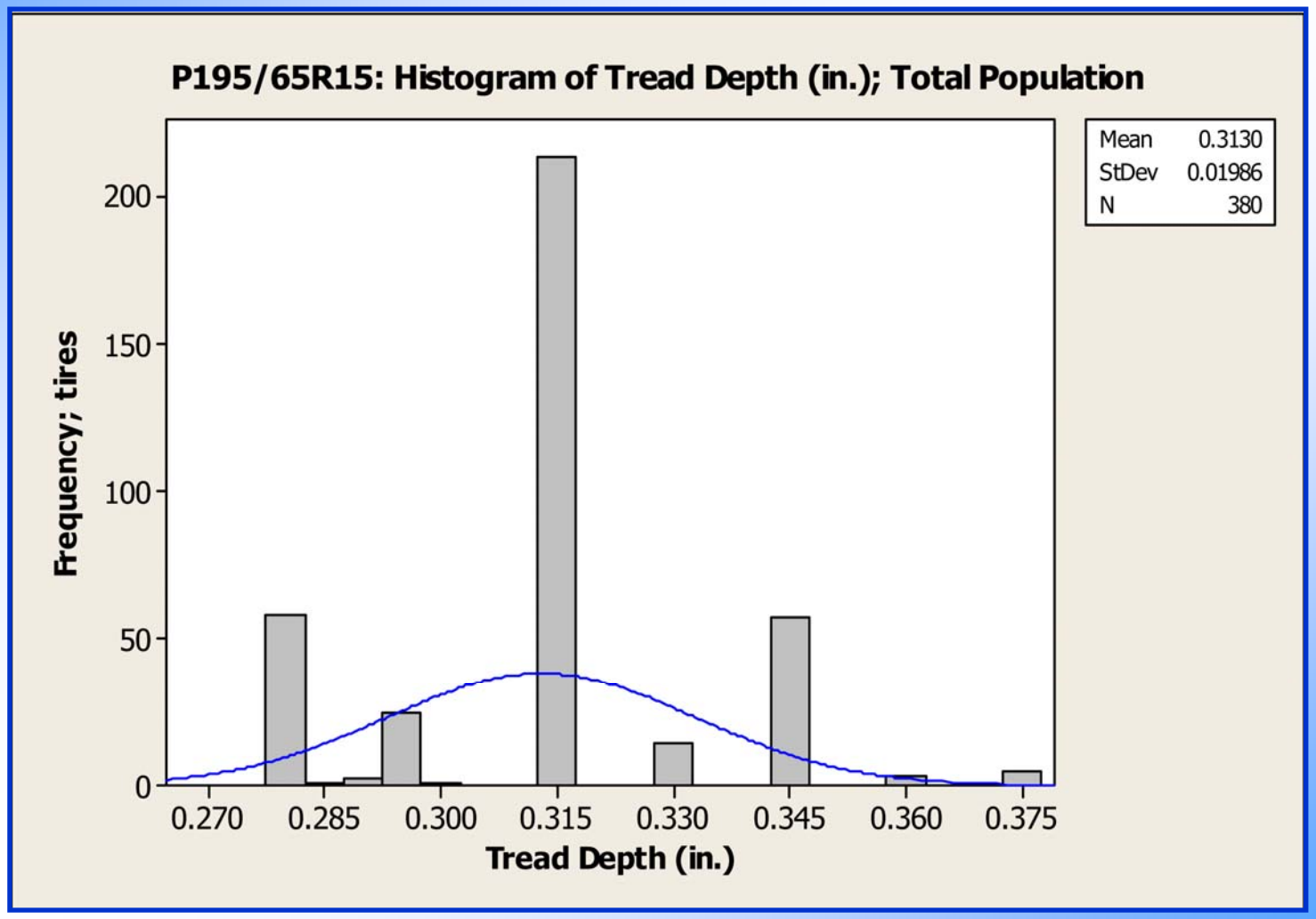

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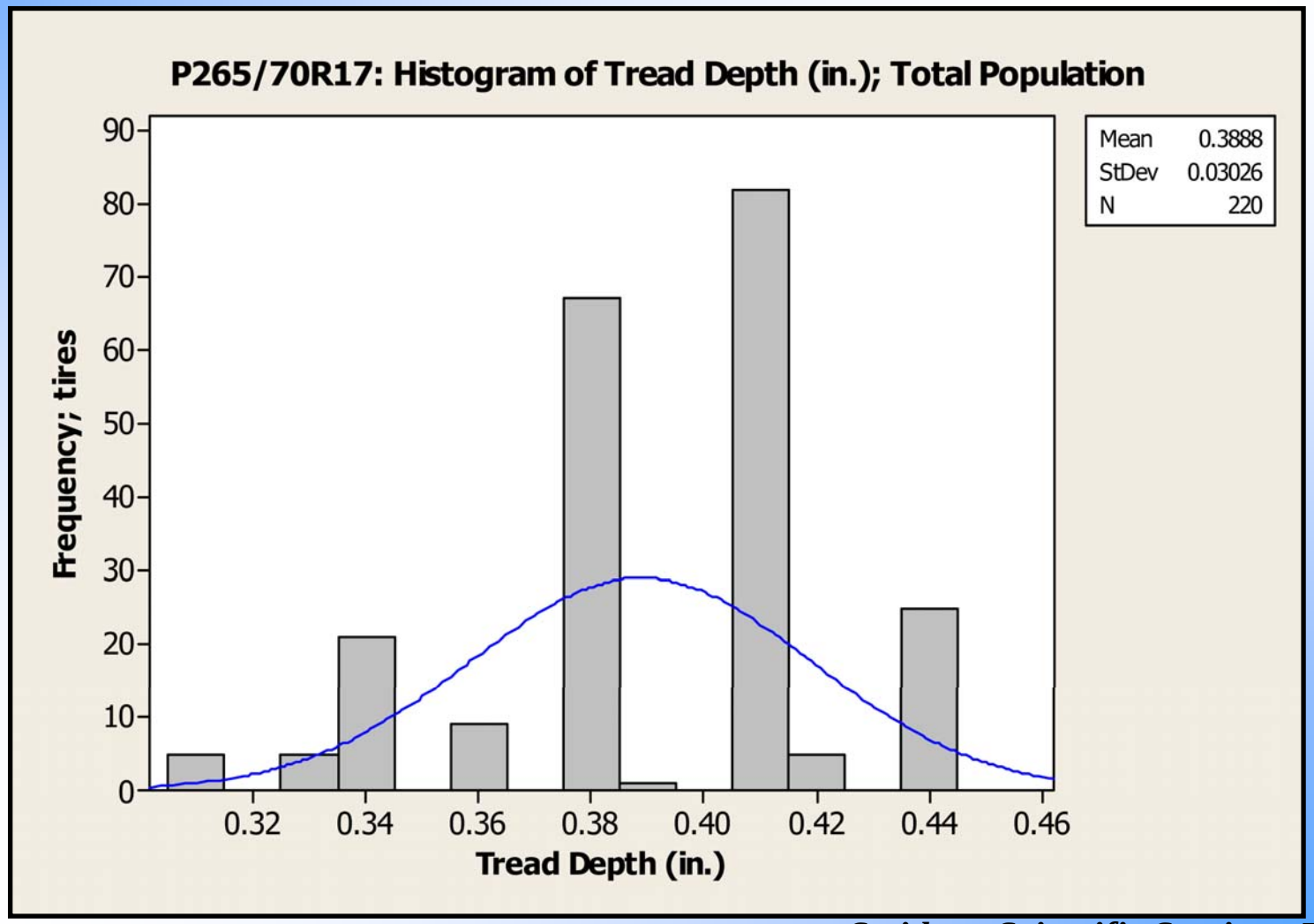

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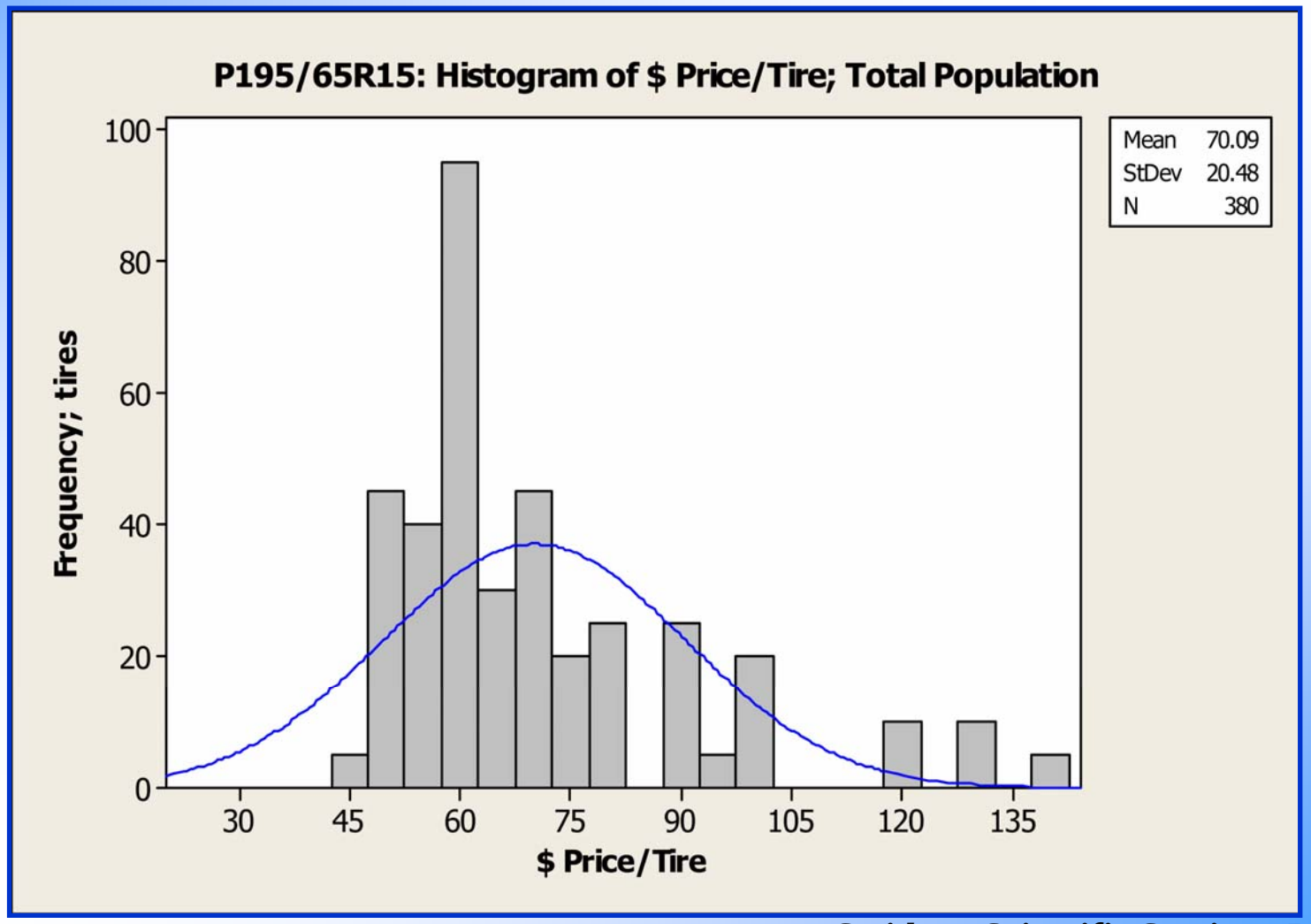

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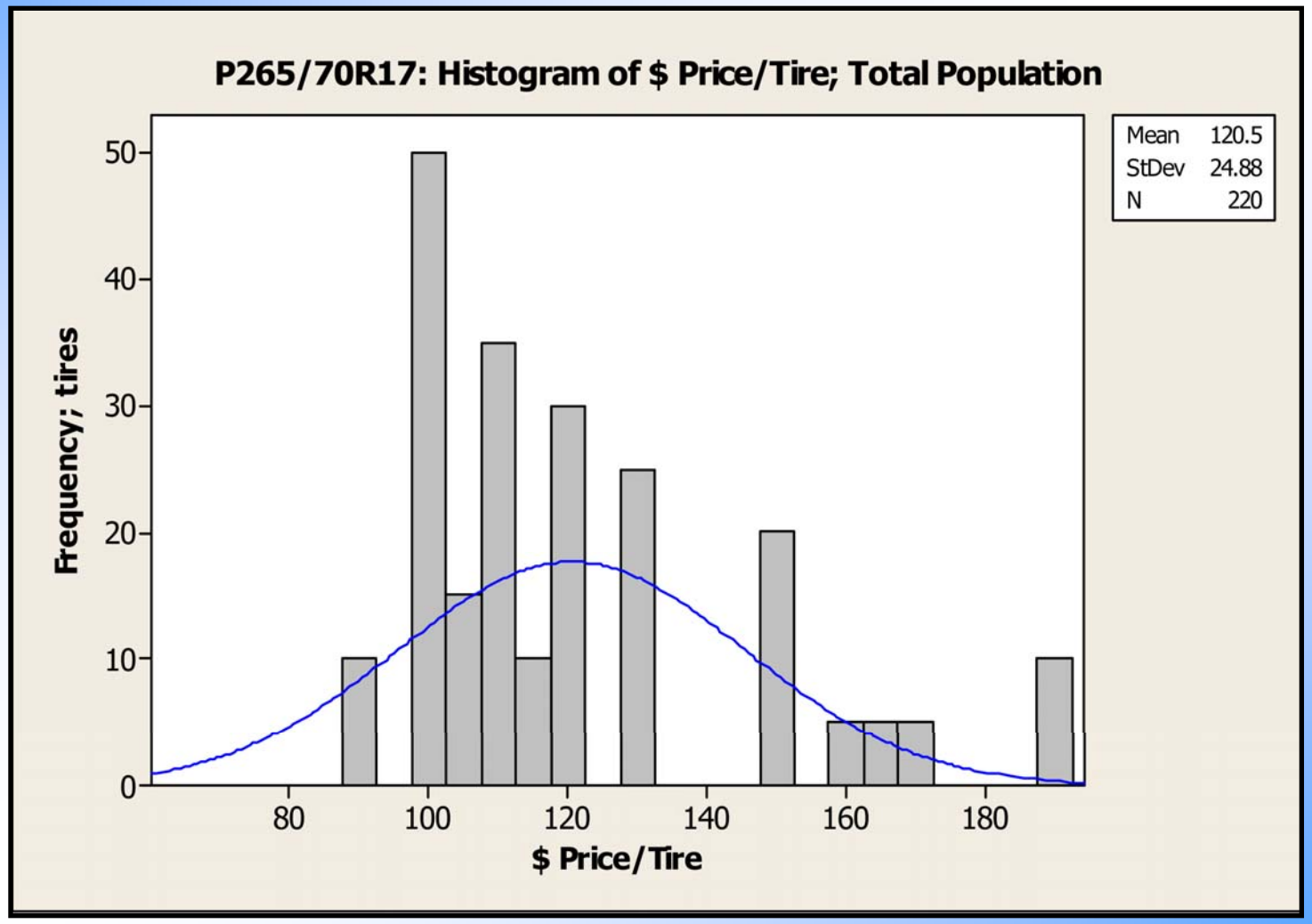

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- Task 4: Rolling Resistance Studies

  → Results
    - Rolling Resistance vs. Tire Characteristic Correlation Studies

Rolling Resistance Testing:

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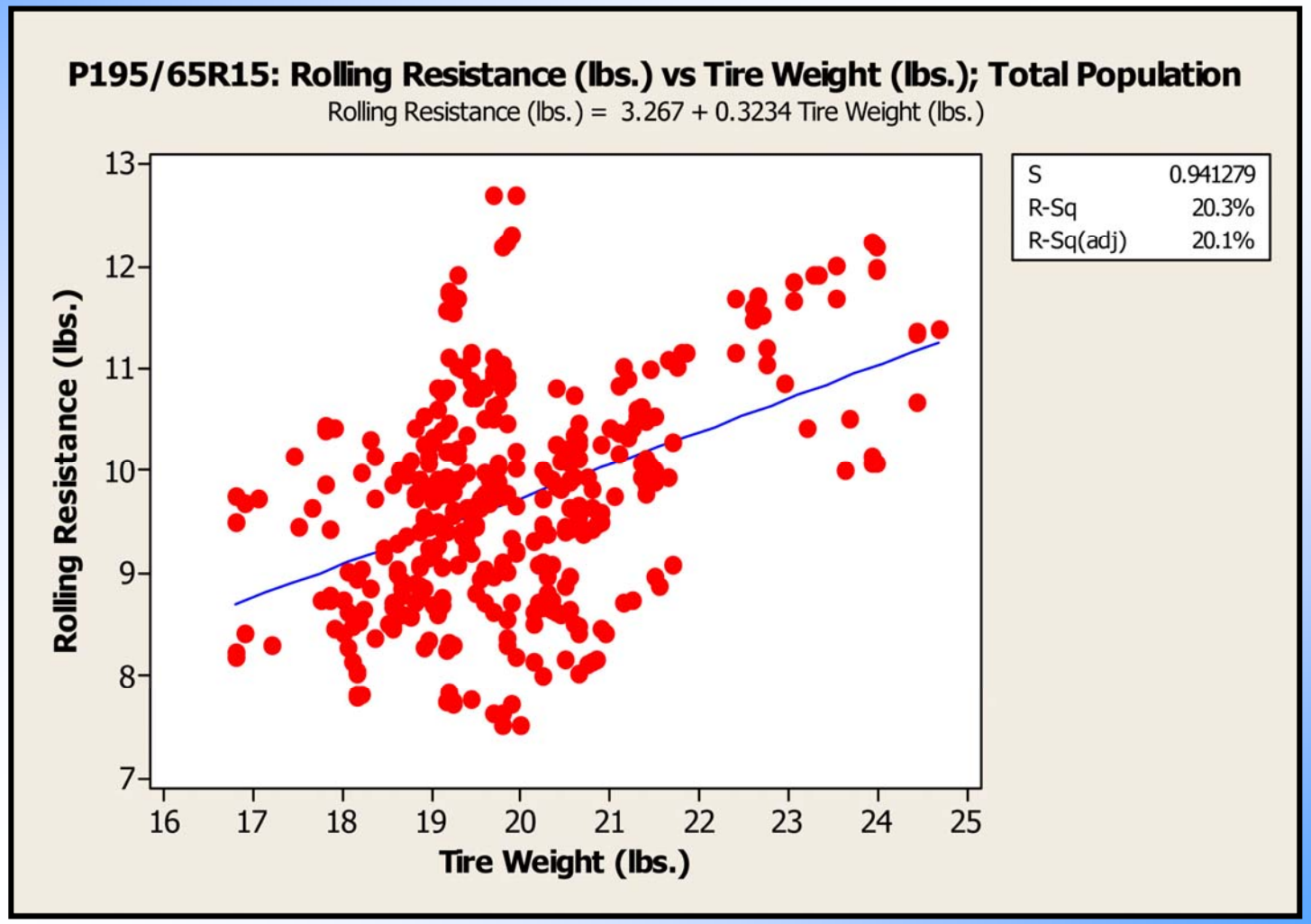
- **Task 4: Results- Rolling Resistance vs Tire Characteristics**



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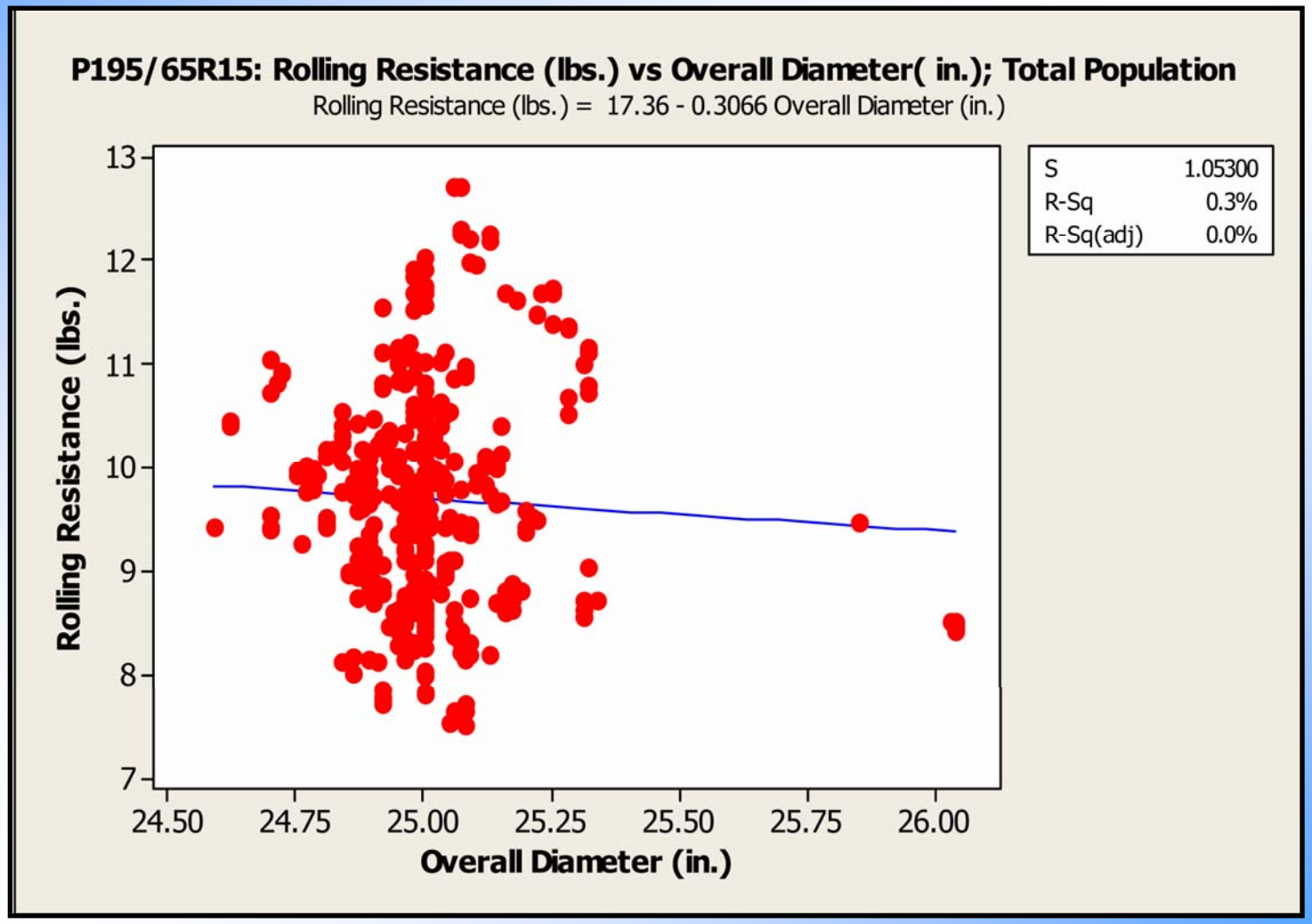

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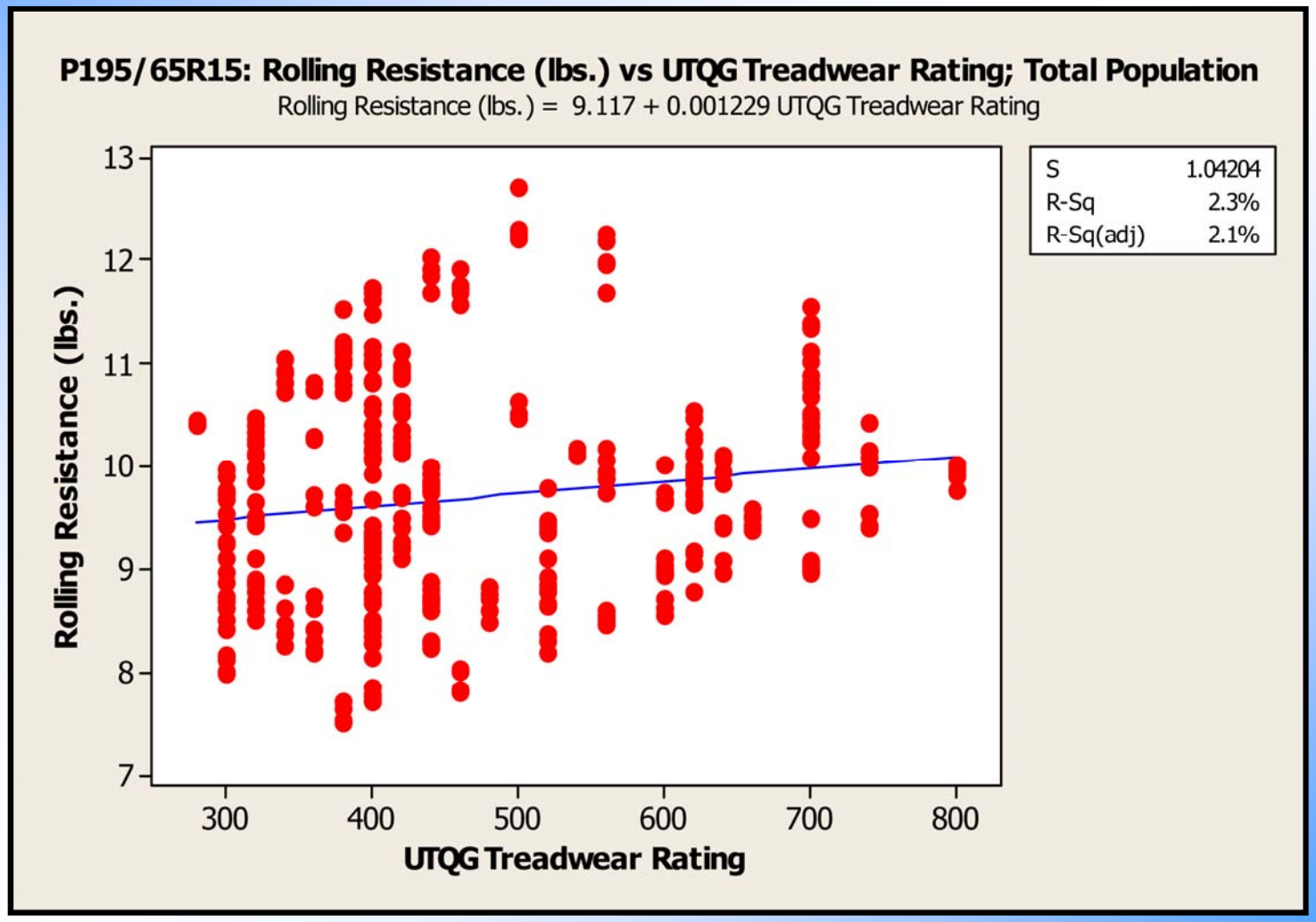

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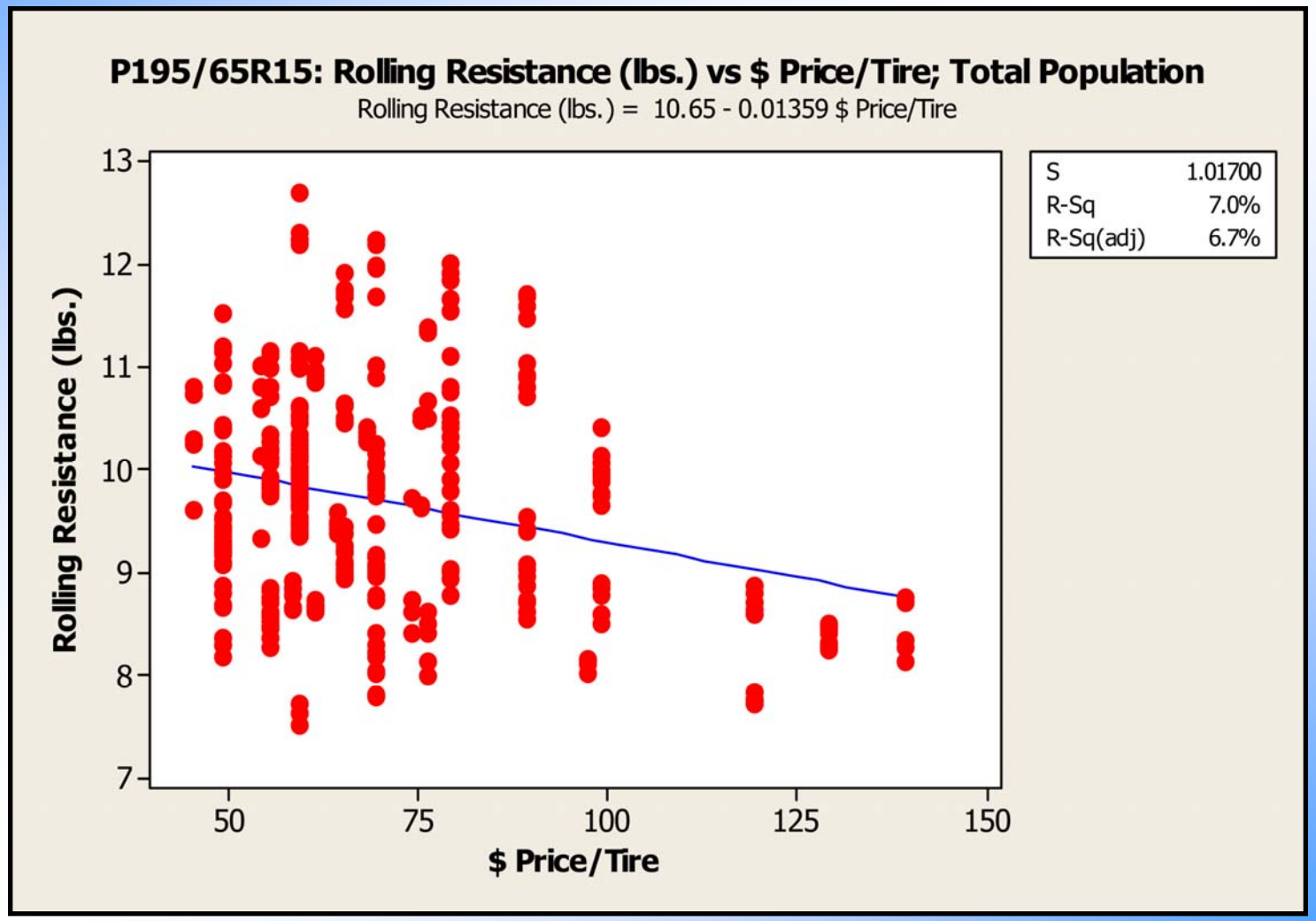

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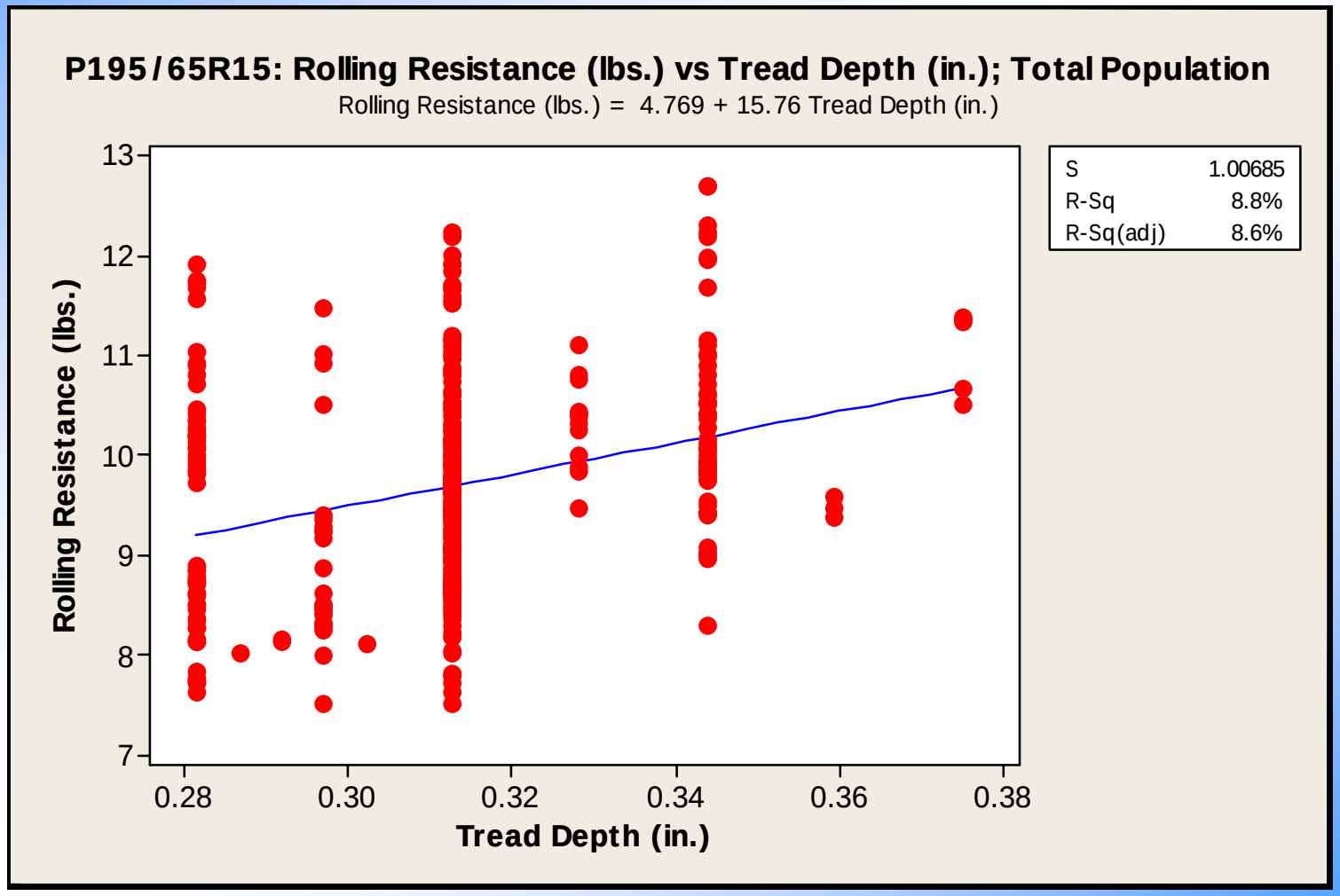

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- Task 4: Rolling Resistance Studies

  → Results

    - Size Impact Study

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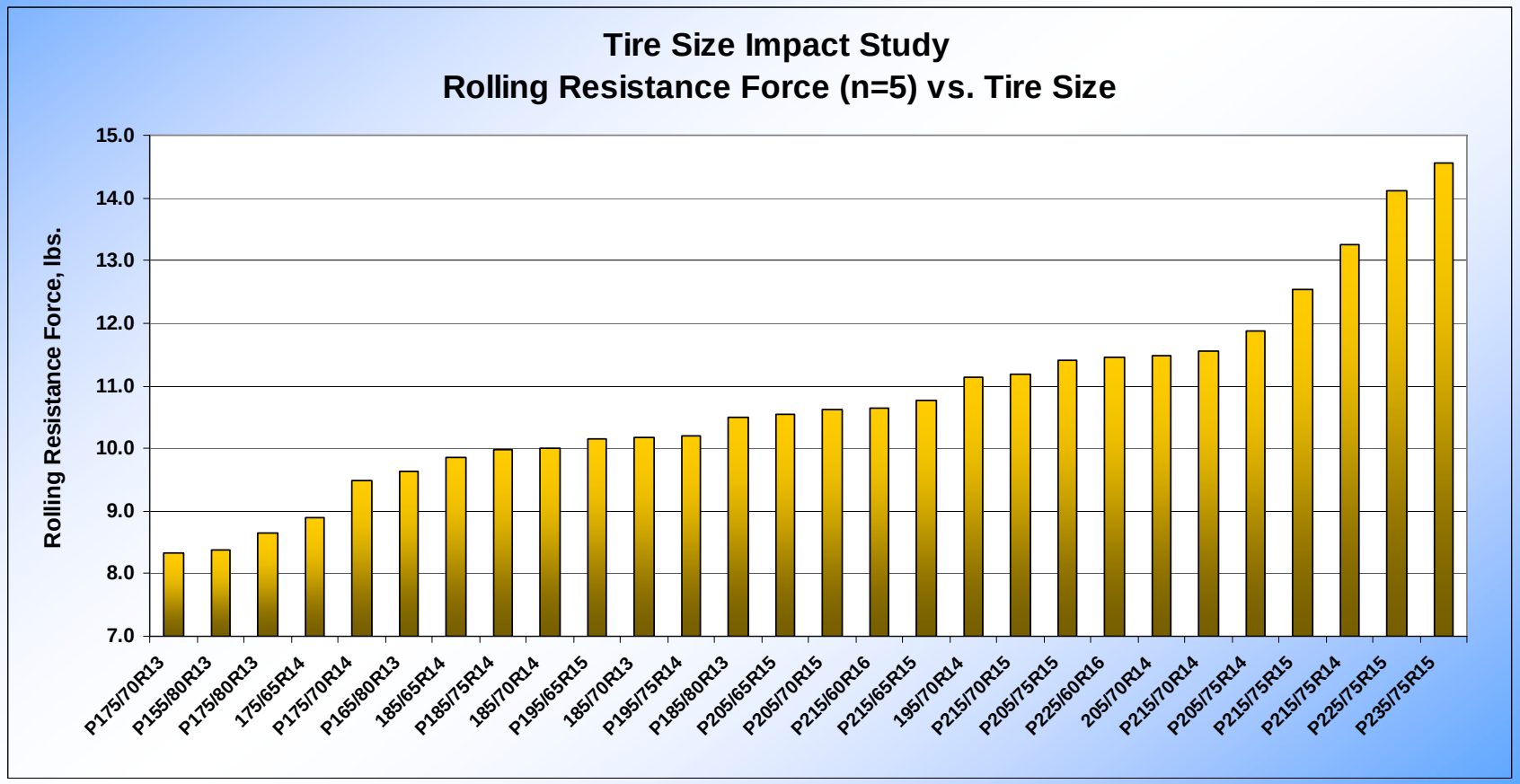
- **Task 4: Results – Tire Size Impact Study**



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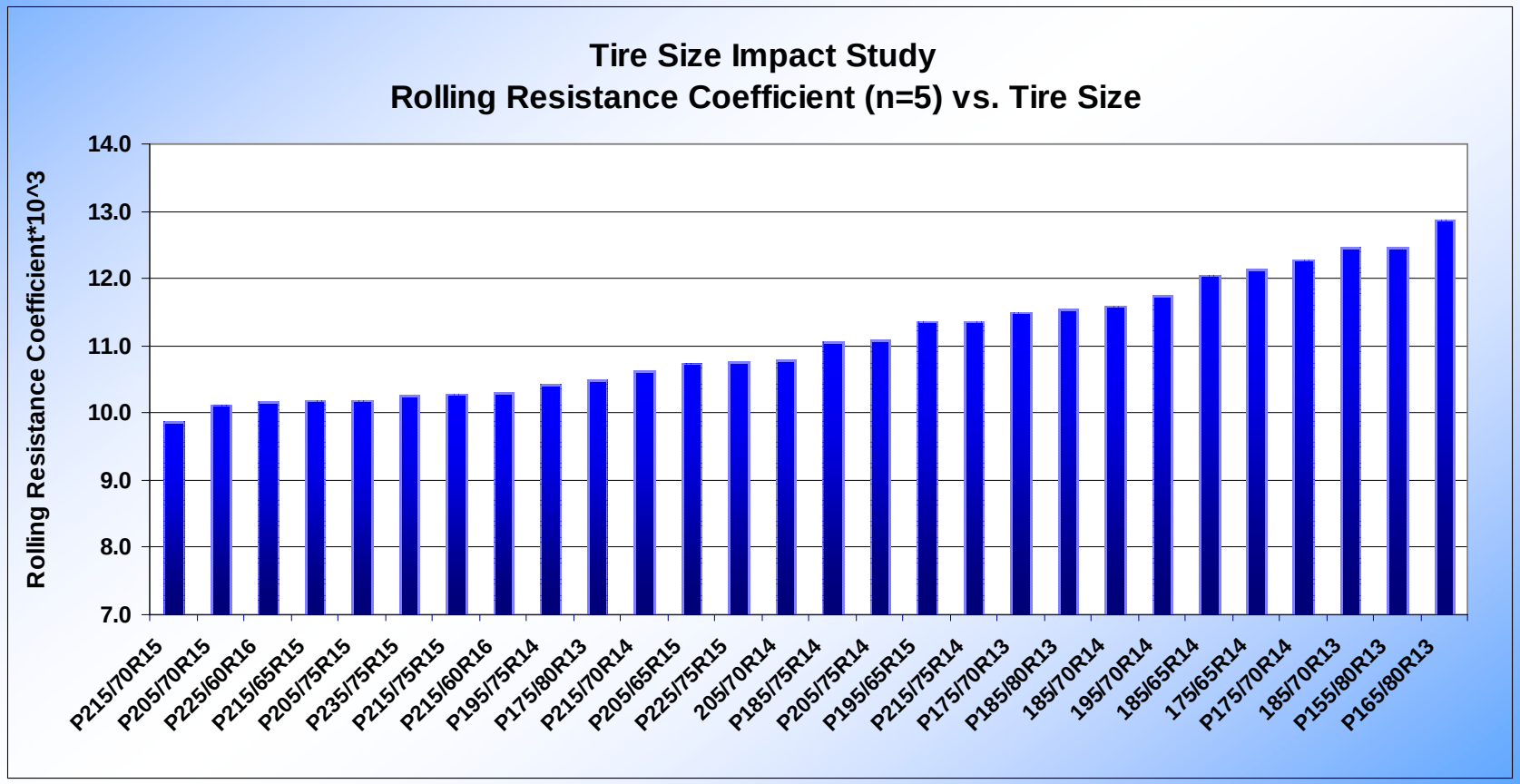

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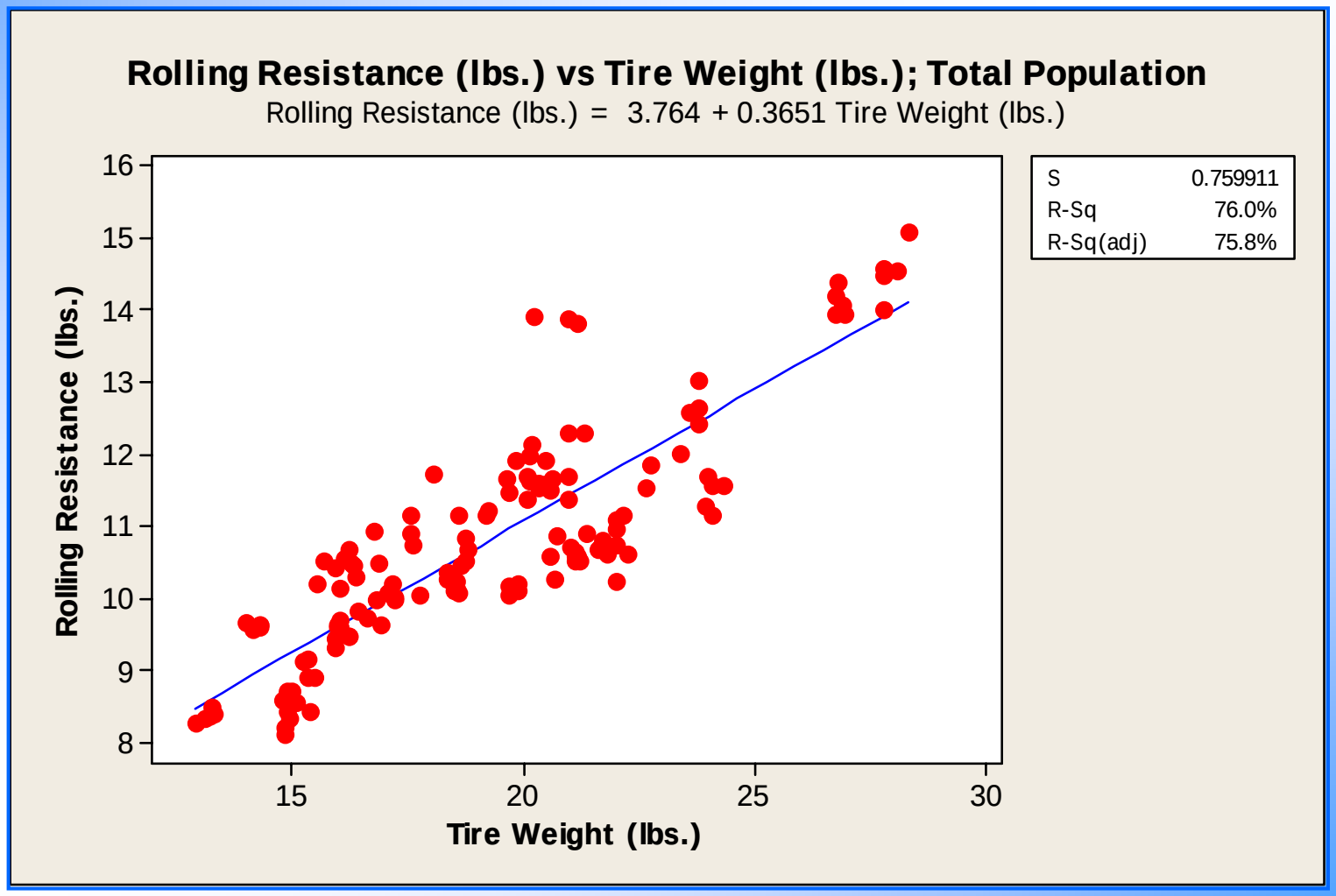

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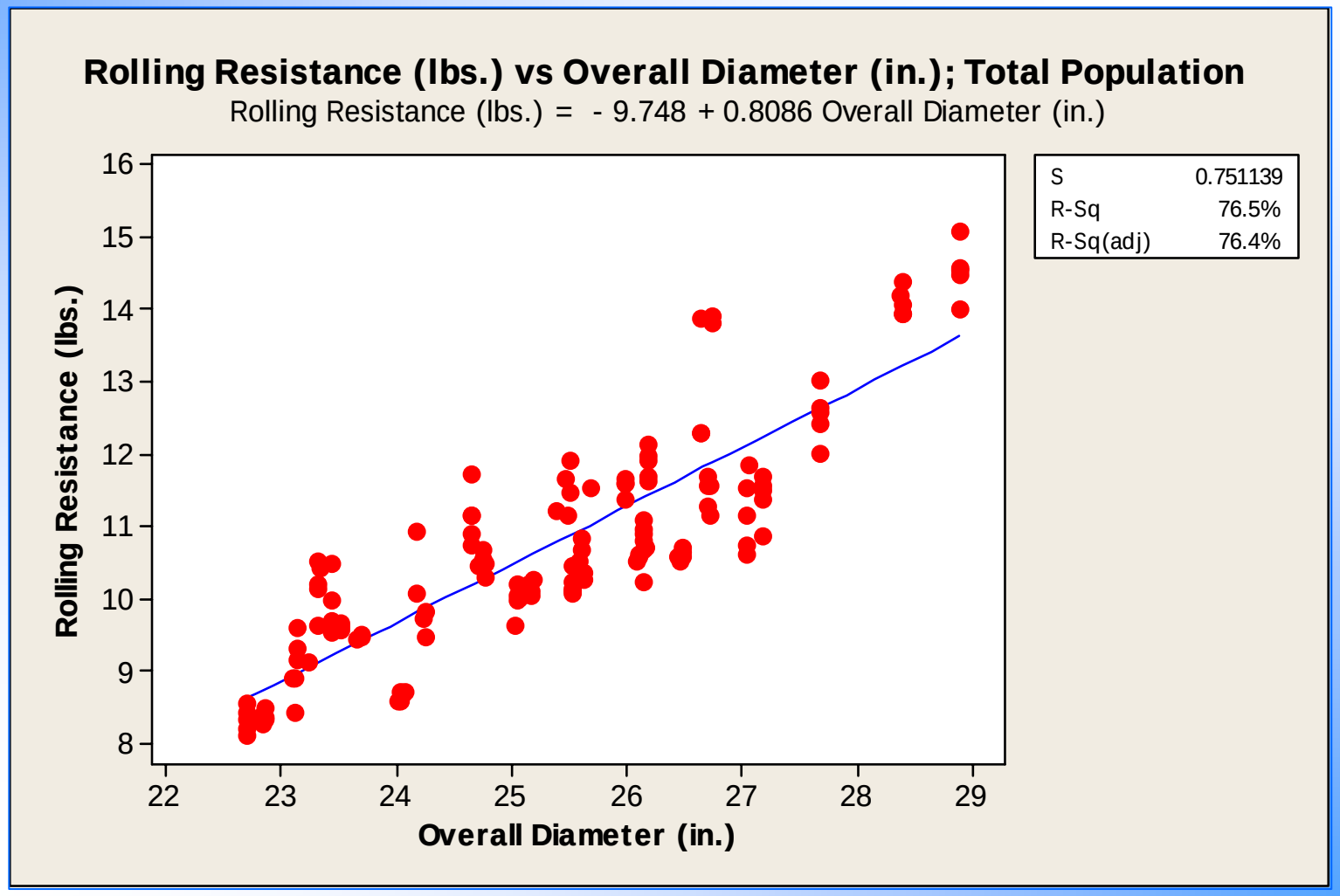

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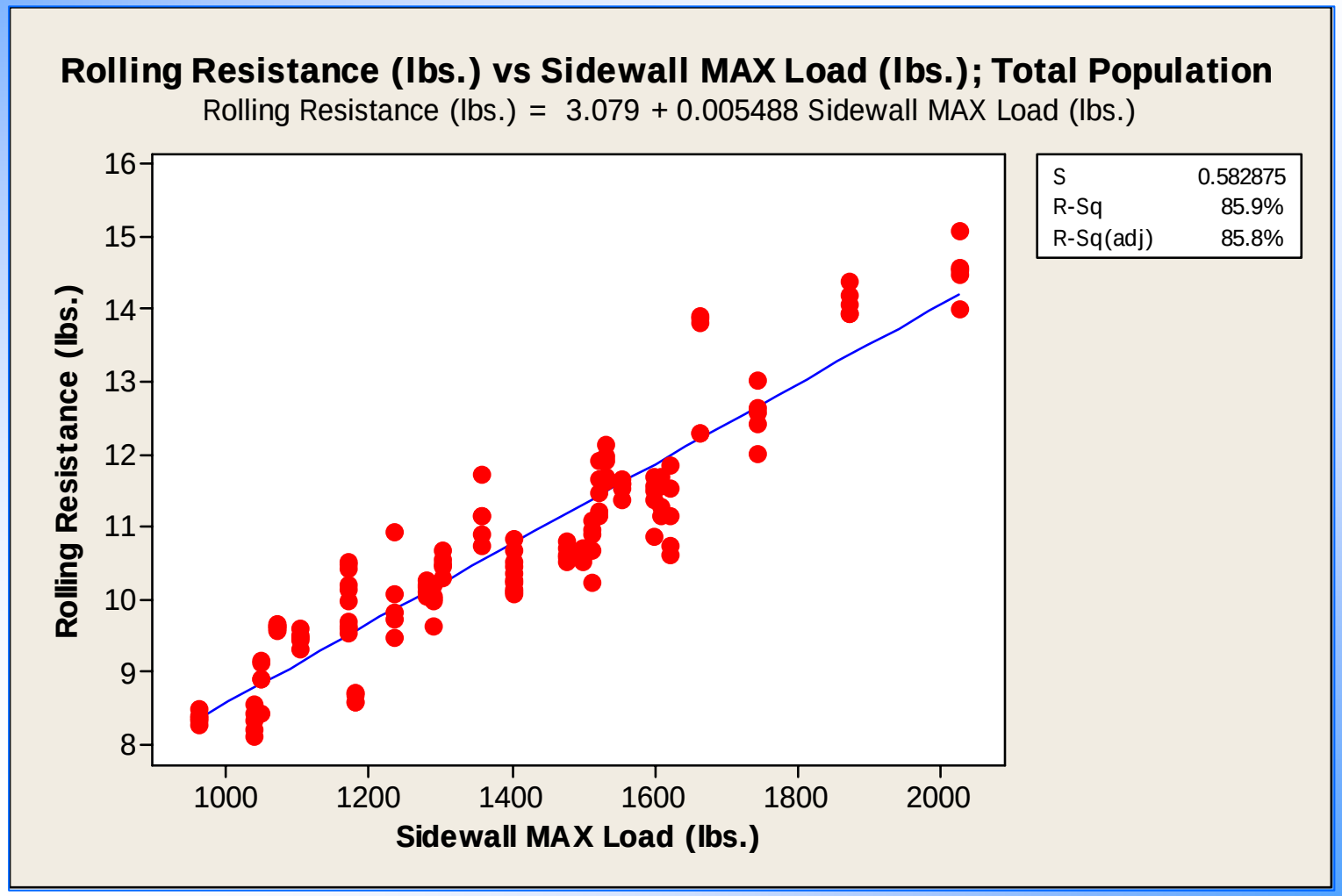

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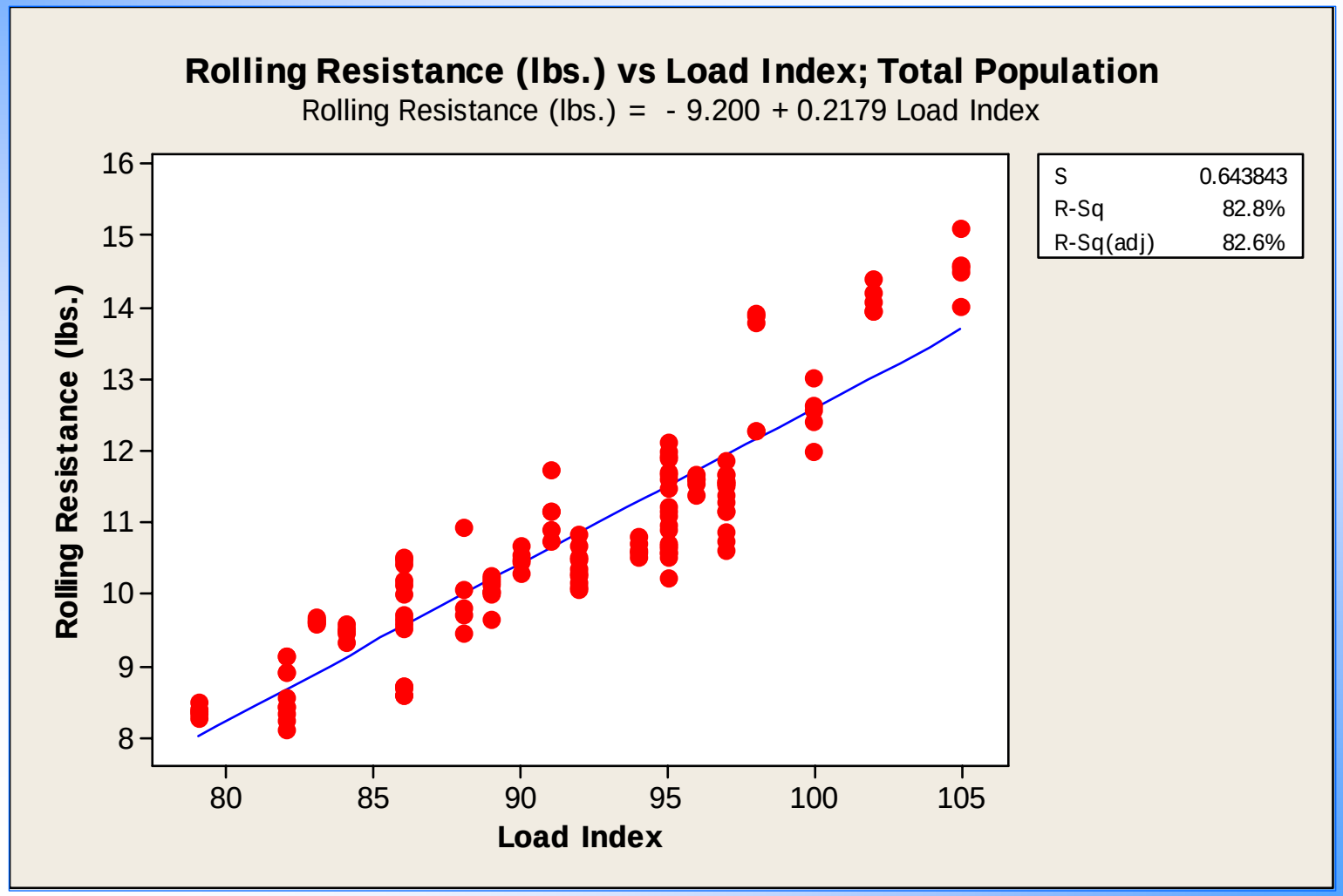


Task 4: Results – Tire Size Impact Study

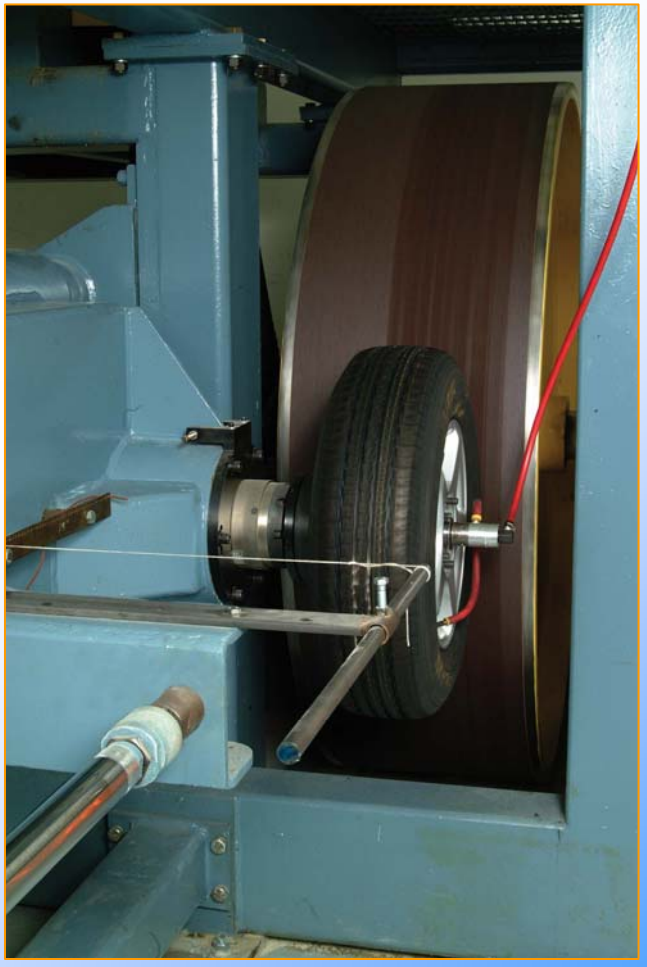
Correlation	R^2;%
Tire Weight and Rolling Resistance Forces	76.0
Tire Outside Diameter and Rolling Resistance Forces	76.5
Tire Load Indices and Rolling Resistance Forces	82.8
Tire Max. Sidewall Load Capabilities and Rolling Resistance Forces	85.9
Tire Weight and Rolling Resistance Coefficients	47.4
Tire Outside Diameter and Rolling Resistance Coefficients	55.8
Tire Load Indices and rolling Rolling Resistance Coefficients	53.6
Tire Max. Sidewall Load Capabilities and Rolling Resistance Coefficients	49.8

Rolling Resistance Testing:

California Energy Commission's Fuel Efficient Tire Program

- Task 4: Rolling Resistance Studies

  → Findings



Rolling Resistance Testing: California Energy Commission's Fuel Efficient Tire Program

- Task 4: Rolling Resistance Studies
  - → Findings
    - Examinations of the results from the P195/65R15 size tires indicated:
      - Rolling resistance responses were normally distributed and ranged from about 7.5 lbs. to 12.7 lbs. (rolling forces), which correlated to a range of rolling resistance coefficients of approximately 8.4x10-3 to 14.2x10-3.
    - Examinations of the results from the P265/70R17 size tires indicated:
      - Rolling resistance responses were normally distributed and ranged from about 13.3 lbs. to 22.8 lbs. (rolling forces), which correlated to a range of rolling resistance coefficients of approximately 7.5x10-3 to 12.9x10-3.

- Task 4: Rolling Resistance Studies

  → Findings

  - Linear correlation studies of rolling resistances with the basic parameters of tire weight, overall diameter, tread depth, and UTQG treadwear rating did not generate correlations that could be considered to represent useful tools to the consumer for predicting rolling resistance qualities of tires.
  - After subdividing into speed rating subcategories, linear correlation studies again failed to generate useful tools for predicting rolling resistances from the parameters measured.
  - The lack of quality linear correlations between rolling resistances and the basic parameters investigated suggested that if the researcher is investigating manufacturer/tire design differences within a tire size, other more complex aspects of the tire will need to be considered.

- Task 4: Rolling Resistance Studies

  → Findings

  - Results from the Tire Size Impact Study indicated the following:

    – Rolling resistance responses ranged from about 8.1 lbs. to 15.1 lbs. (rolling forces); rolling resistance coefficients ranged from approximately 9.4x10-3 to 12.9x10-3. Rolling resistance rolling forces and rolling resistance coefficients did not correlate.

Rolling Resistance Testing:

California Energy Commission's Fuel Efficient Tire Program

- Task 4: Rolling Resistance Studies
  - ➔ Findings (Tire Size Impact Study)
    - Linear correlation studies
      - Correlations of rolling resistance values with external tire characteristics yielded higher R^2 coefficients documented during for the Tire Size Impact Study
      - These stronger correlations were largely attributable to greater differences in tire weights and dimensions than observed during the within-size correlation studies. Within-tire characteristics not studied in this investigation, such as component hysteresis levels and tire architecture, were expected to be more standardized due to the single manufacturer/design constraint.