A / C Effects in MOBILE6

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MOBILE6 Workshop
October 1, 1997

Outline

- Model Structure
- Emission Characterization
  - » EPA Testing
  - » Correlation with Full-Usage Condition
  - » Stratification
- Activity
  - » Intermediate Conditions
  - » Heat Index Approach
- SFTP Control

Model Structure

- Model incorporates full-usage (100% AC) emission factor for each pollutant by:
  - » Strata (e.g. vehicle class, emitter level)
  - » Speed and facility if appropriate (running)
  - » Soak duration if appropriate (start)

- Full-usage emission factor scaled down based on temperature and humidity inputs

EPA Testing

- 25 vehicles at NVFEL, 12 at ATL/Ohio
- Inventory cycles, LA92, NYCC, ST01 (cold)
- A/C On: 95^{o} F, driver window down
- A/C Off: 75^{o} F without 10% loading factor

Full-Usage Condition

- Proposal:
  - » SFTP test conditions = 100% A/C loading (95^{o}, 40% RH, 850 W/m^2 solar load)
  - » Full-usage emission factors based on these conditions
- Need to establish correlation between EPA/ATL and SFTP conditions to determine appropriate full-usage dataset

Correlation

- Sample-average AC-On / AC-Off compared with industry testing under SFTP conditions
- Industry results vary significantly - will focus on individual vehicles
- ATL lower than EPA
- Correlation vehicle will be tested at EPA, ATL and possibly an industry environmental cell

A / C Factor Stratification

- NOx
  - » Speed, Vehicle Class appear significant
  - » Facility, Standard?
- HC and CO
  - » Emitter level appears significant
  - » Speed, Class, Technology, Standard (HC)?
- Start impact appears less than running

Activity

- Usage: SFTP In-Use A/C Survey
  - » Phoenix August-October 1994
  - » 20 vehicles
  - » Time/date stamp, A/C & compressor on/off
  - » Hourly weather information linked
- Market Penetration: Ward's/AAMA

Intermediate Conditions

- Factor needed to scale down full-usage emission factor for intermediate conditions
- EPA not aware of emission data at intermediate conditions
- Proposal:
  - » Scaling factor = A/C compressor-on %
  - » Compressor-on % modeled from Phoenix
  - » Temperature and humidity only

Heat Index Approach

- Heat Index (HI) combines temperature and humidity into “effective temperature” - good surrogate for driver discomfort.

- Proposed approach:
  - » MOBILE computes HI based on temperature and humidity inputs
  - » HI used to calculate compressor-on %
  - » Emission Factor = Full-usage emission factor scaled down by compressor-on %

SFTP Control

- SFTP Benefit Analysis:
  - » NOx design target based on 50% reduction
  - » HC/CO - US06 control assumed to reduce
- Proposal:
  - » NOx: 50% reduction in Emission Factor
  - » HC: 100% reduction
  - » CO: 100% reduction + loading effect (CO2)

Open Issues

- Full-usage dataset (correlation)
- Stratification (including speed, start/running)
- Heat Index methodology
- Intermediate soaks
- SFTP control on starts
- Market penetration projections

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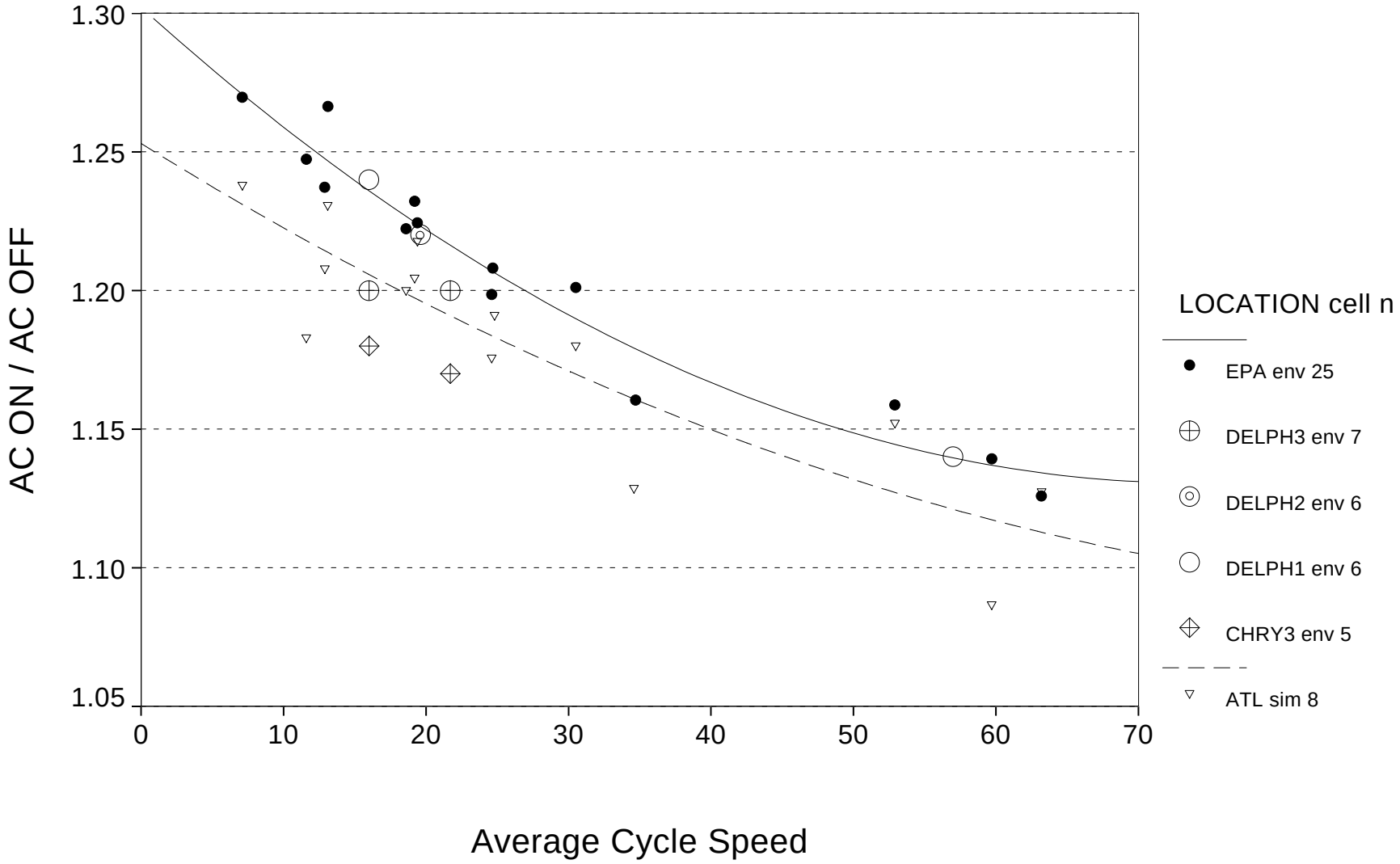
A/C CO2 Factor Correlation

Running Cycles



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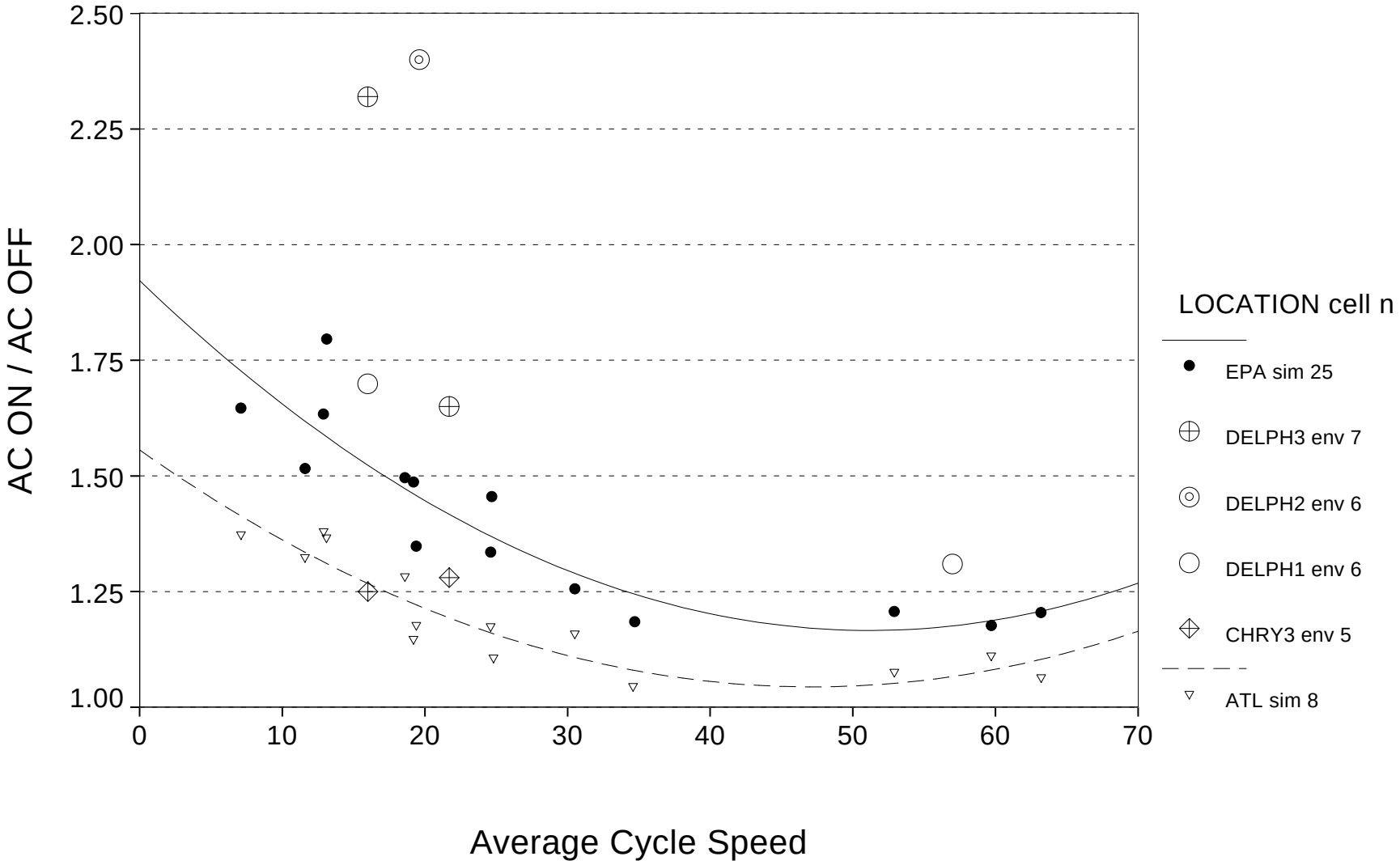
A/C NOx Factor Correlation

Running Cycles



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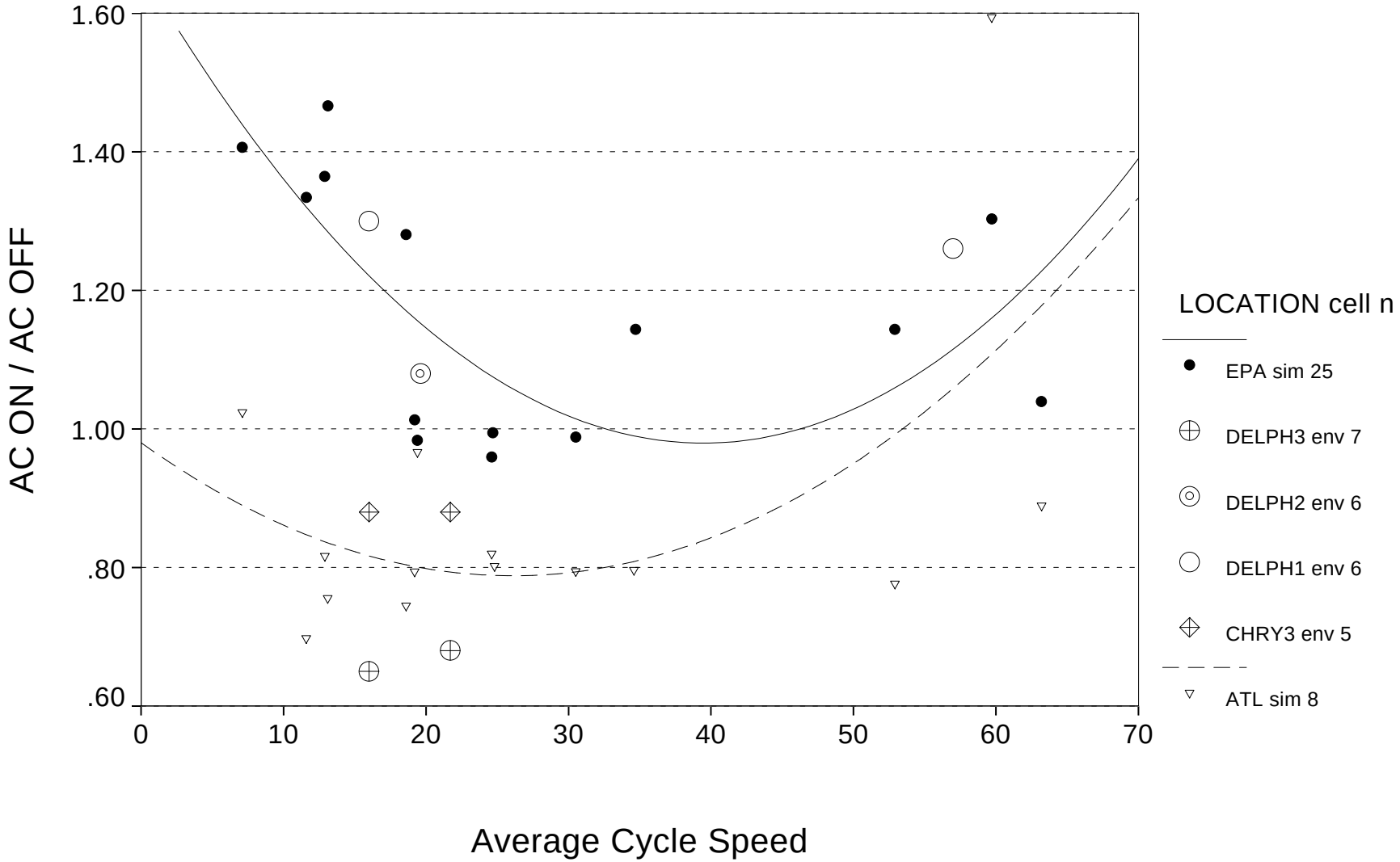
A/C HC Factor Correlation

Running Cycles



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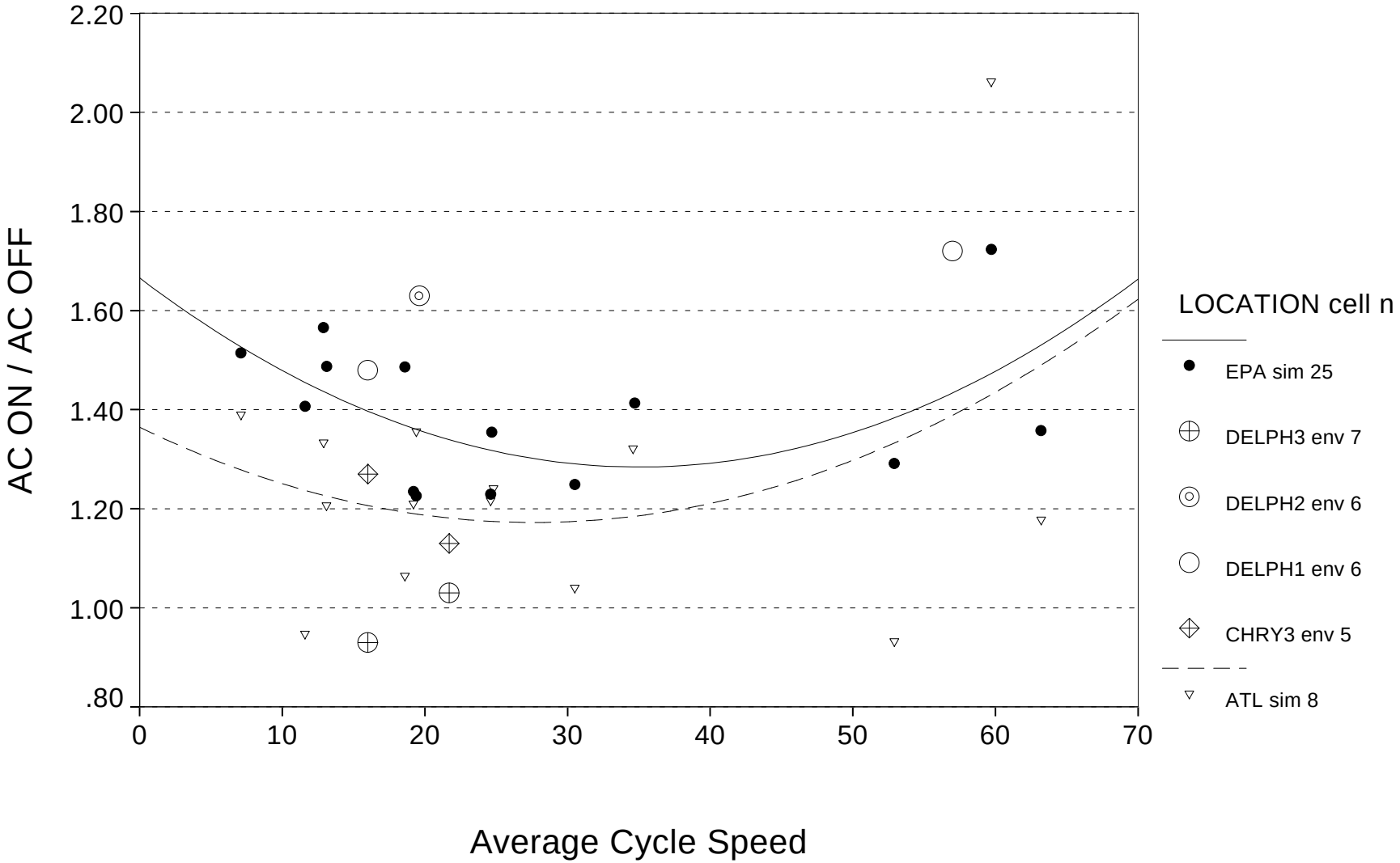
A/C CO Factor Correlation

Running Cycles



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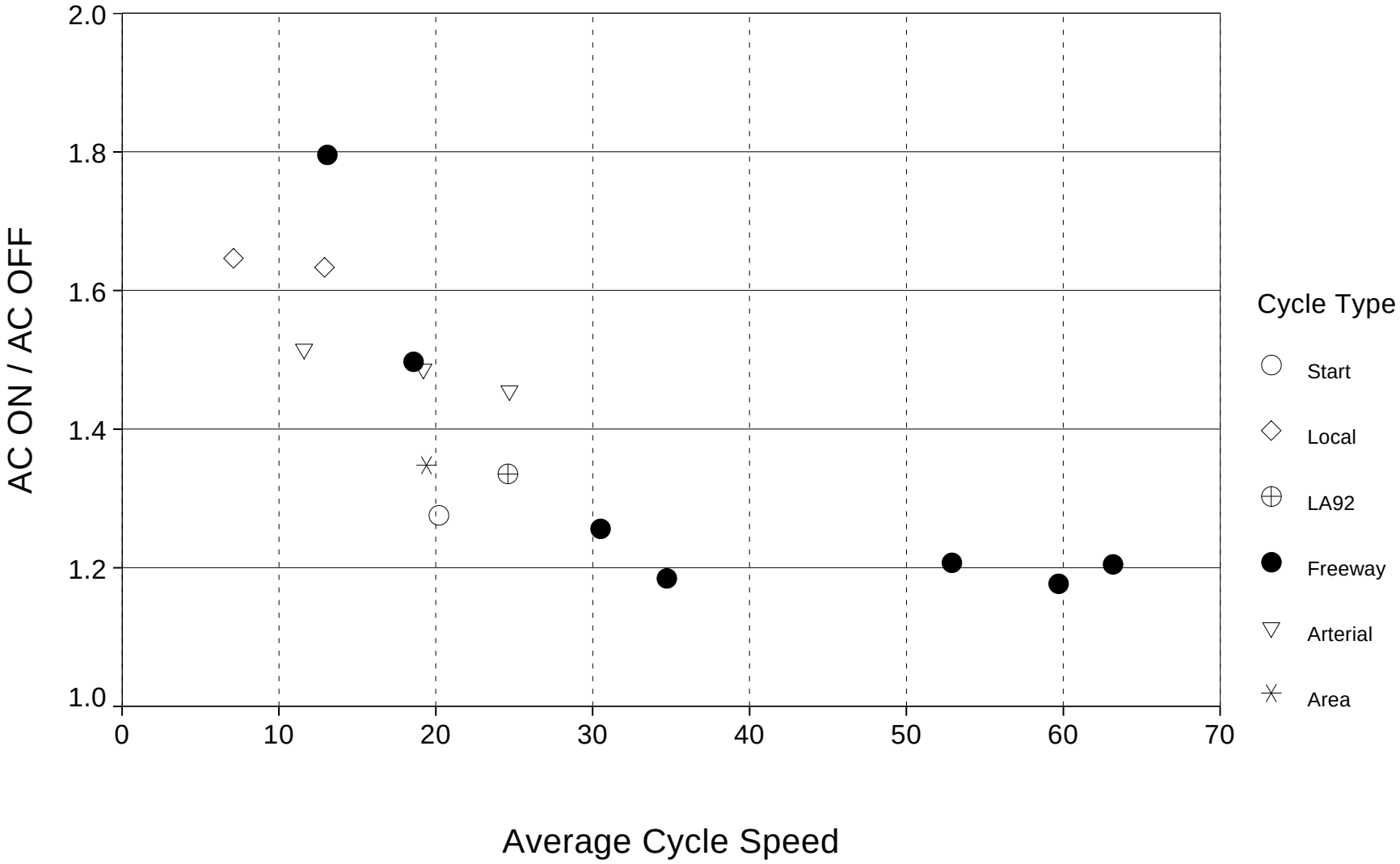
A/C NOx Factor by Cycle Type

EPA Bag - All Vehicles



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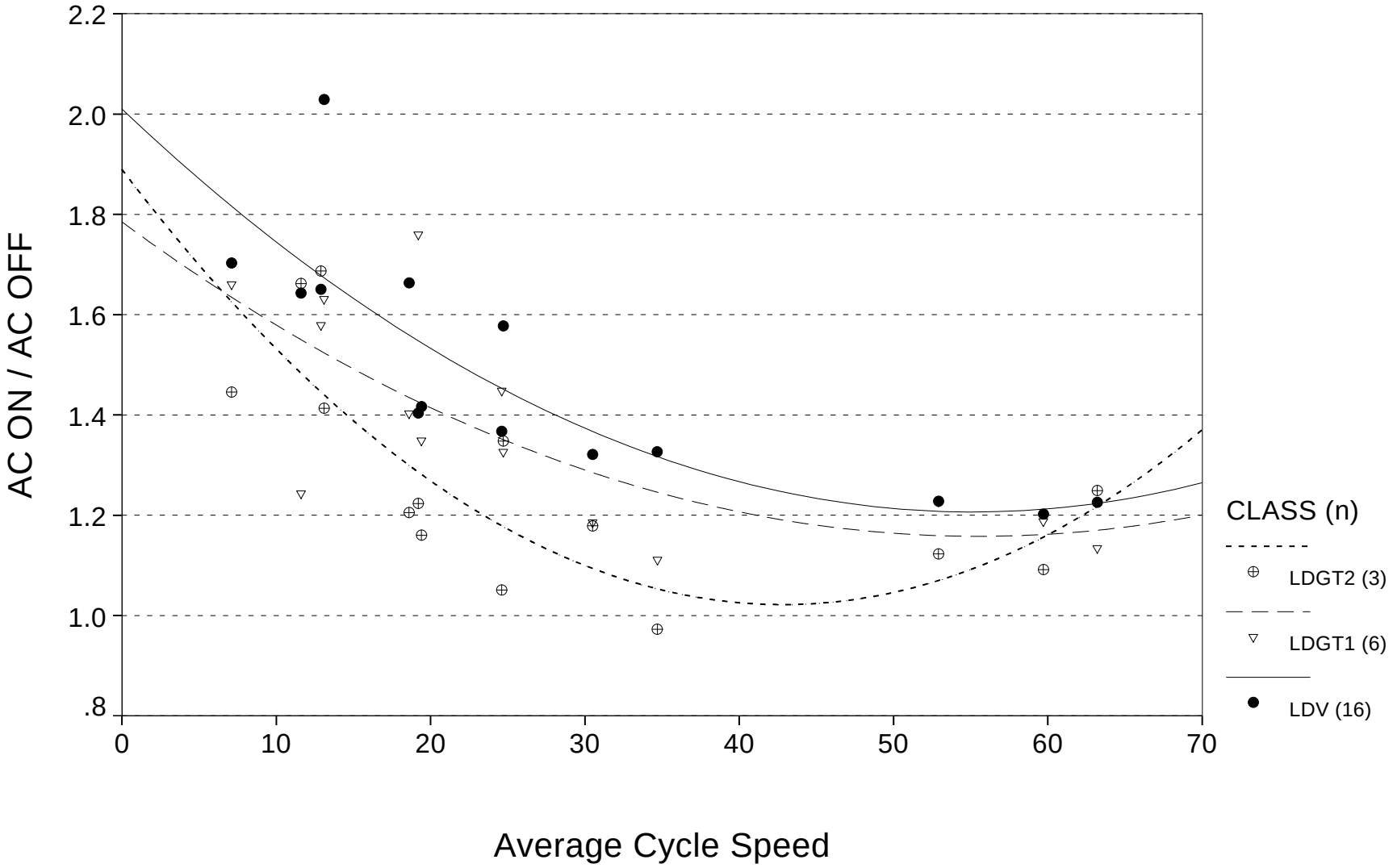
A/C NOx Factor by Vehicle Class

EPA Bag - All Vehicles, Running Cycles



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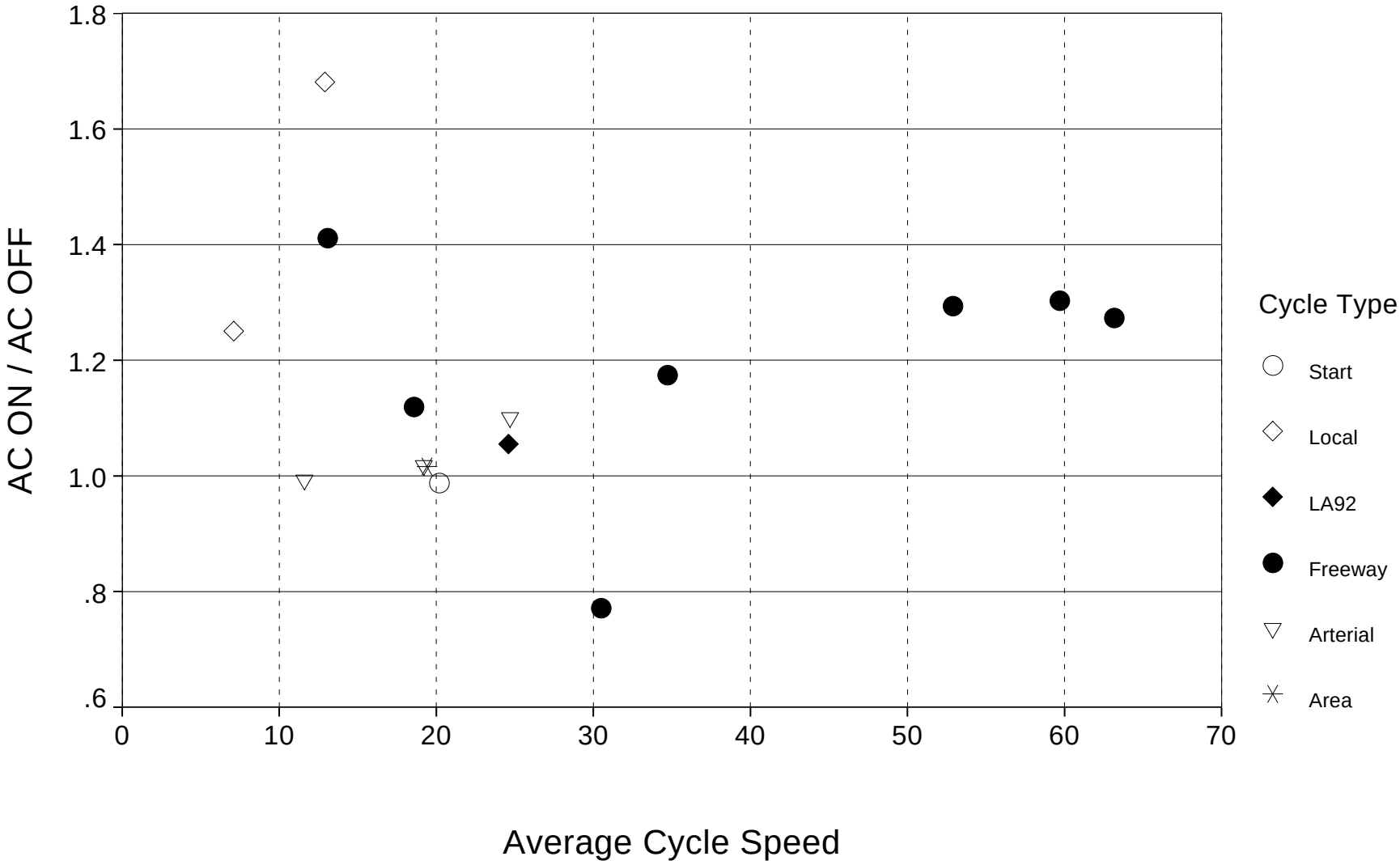
A/C HC Factor by Cycle Type

EPA Bag - Vehicle 219 Excluded



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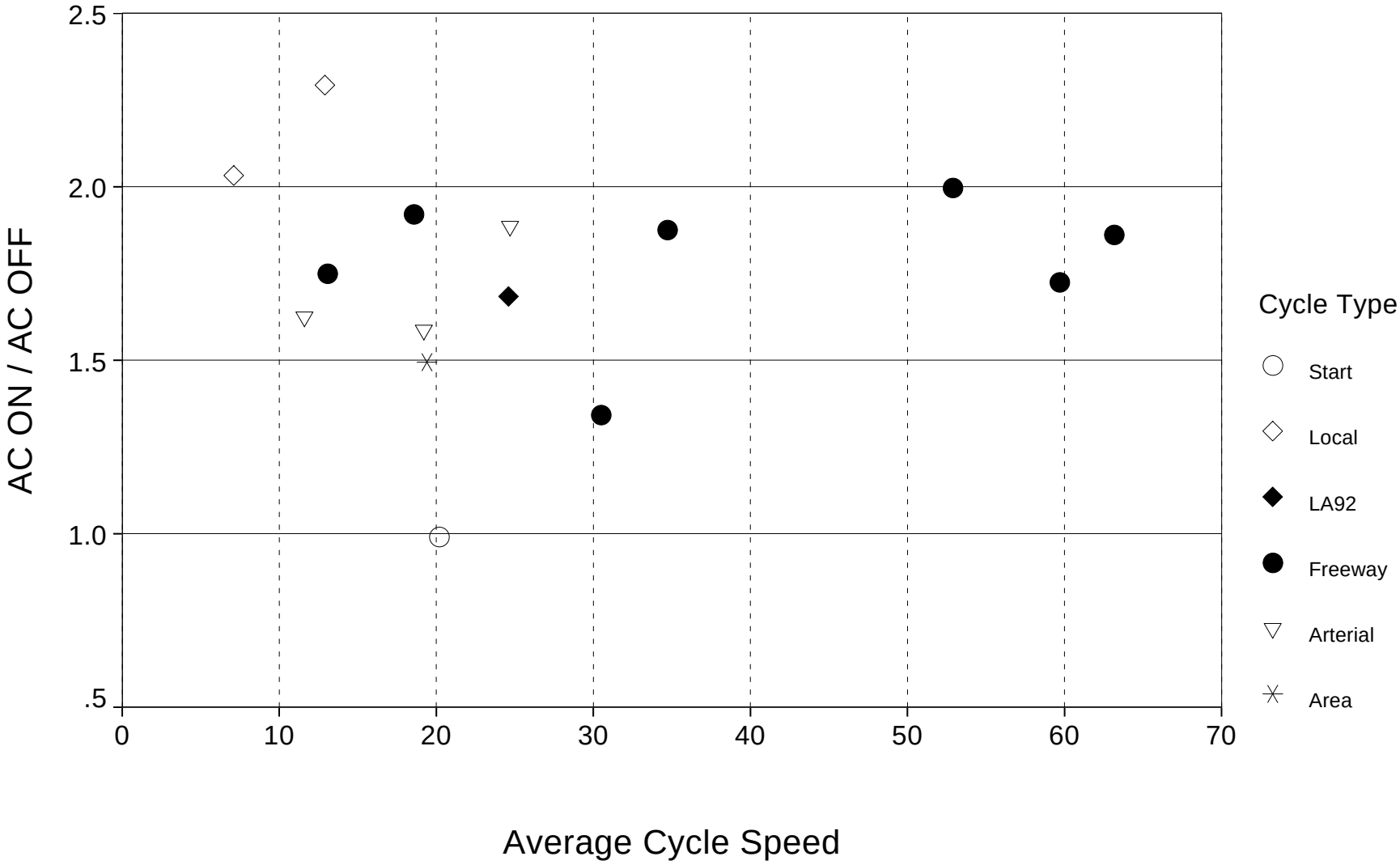
A/C CO Factor by Cycle Type

EPA Bag - Vehicle 219 Excluded



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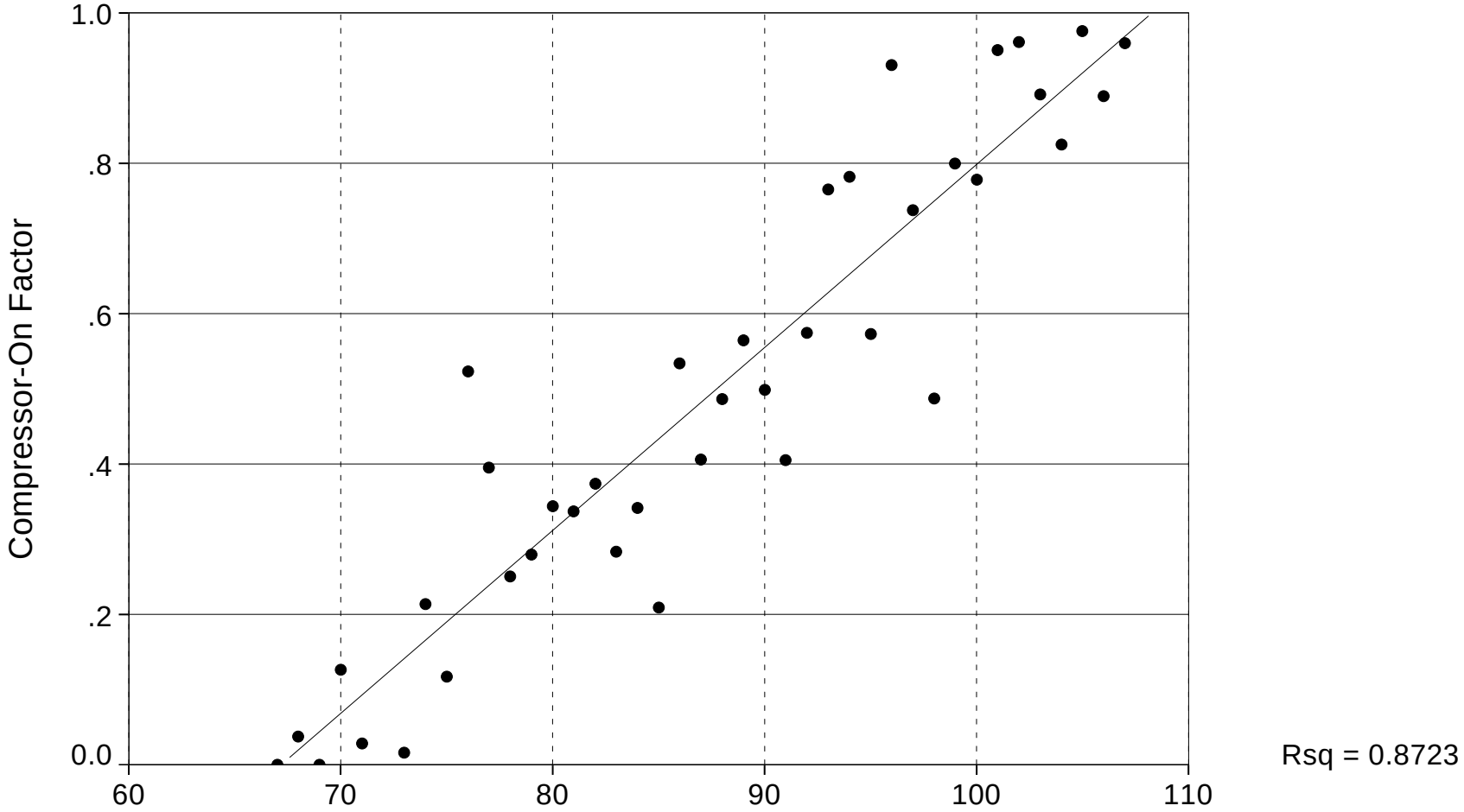
Average Compressor-On by Temperature

Phoenix A/C Survey - Non-idle trips



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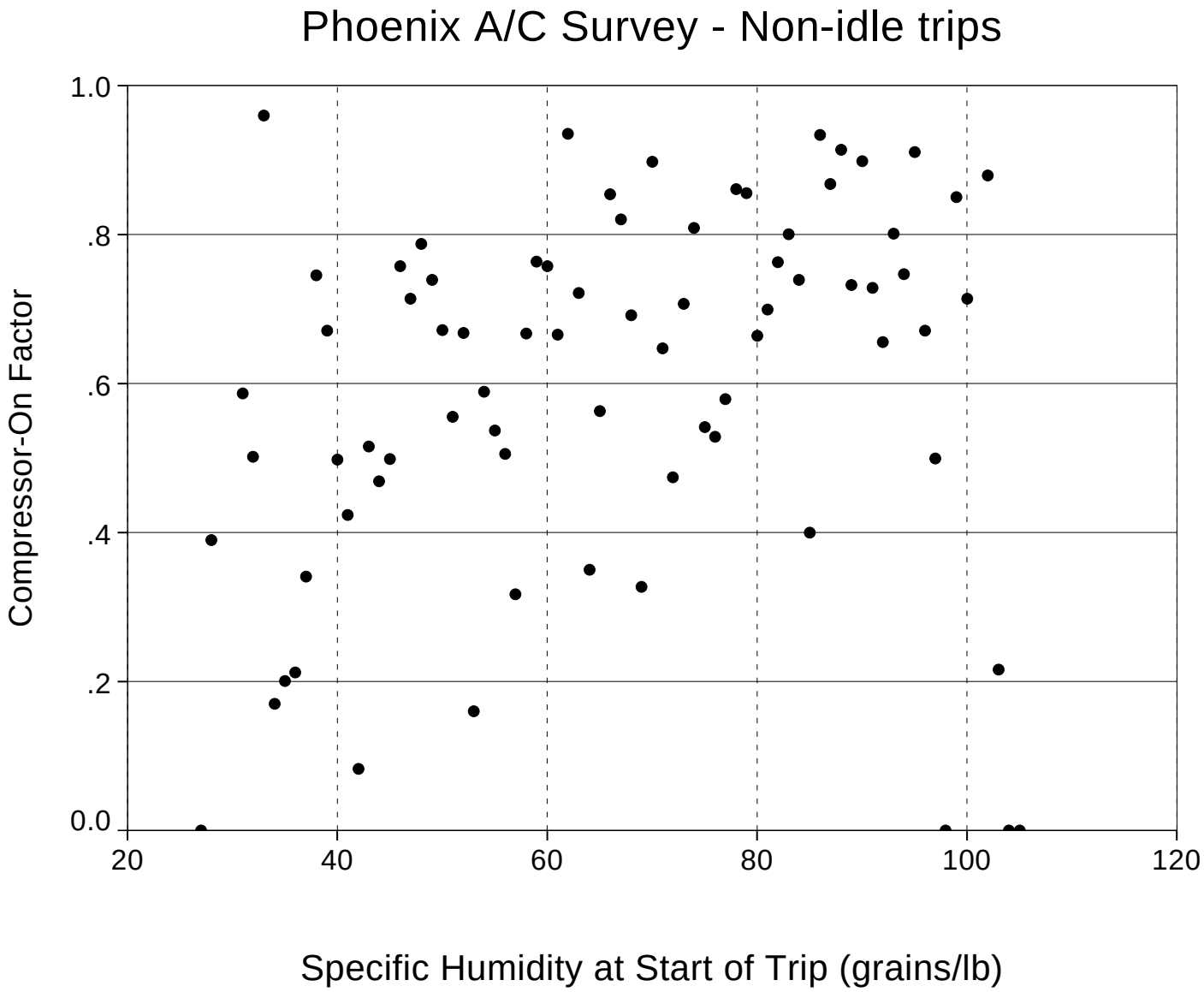
Average Compressor-On by Humidity



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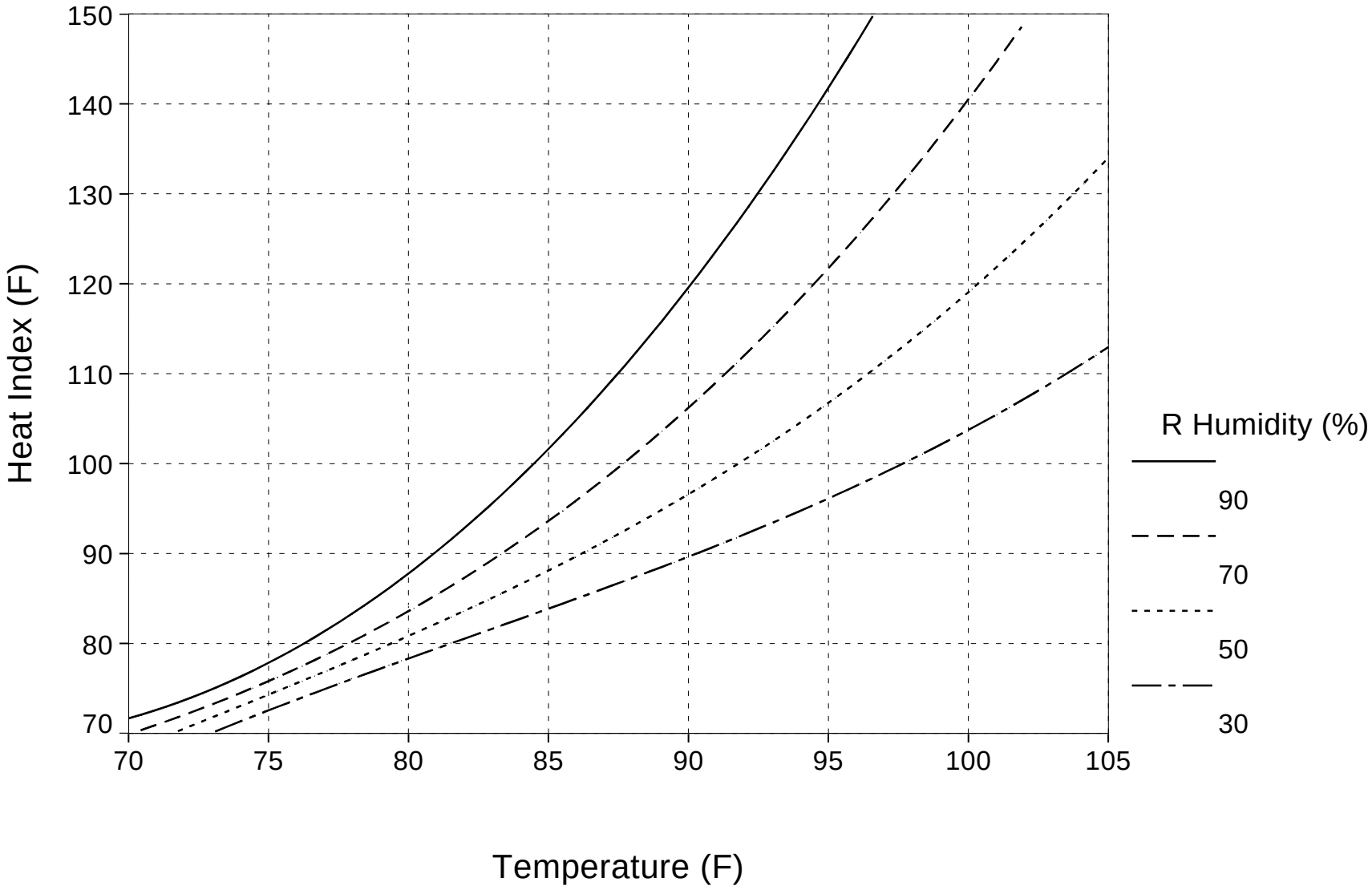
Heat Index by Temperature & Humidity



Note: based on shady condition; full sun exposure increases up to 15 deg

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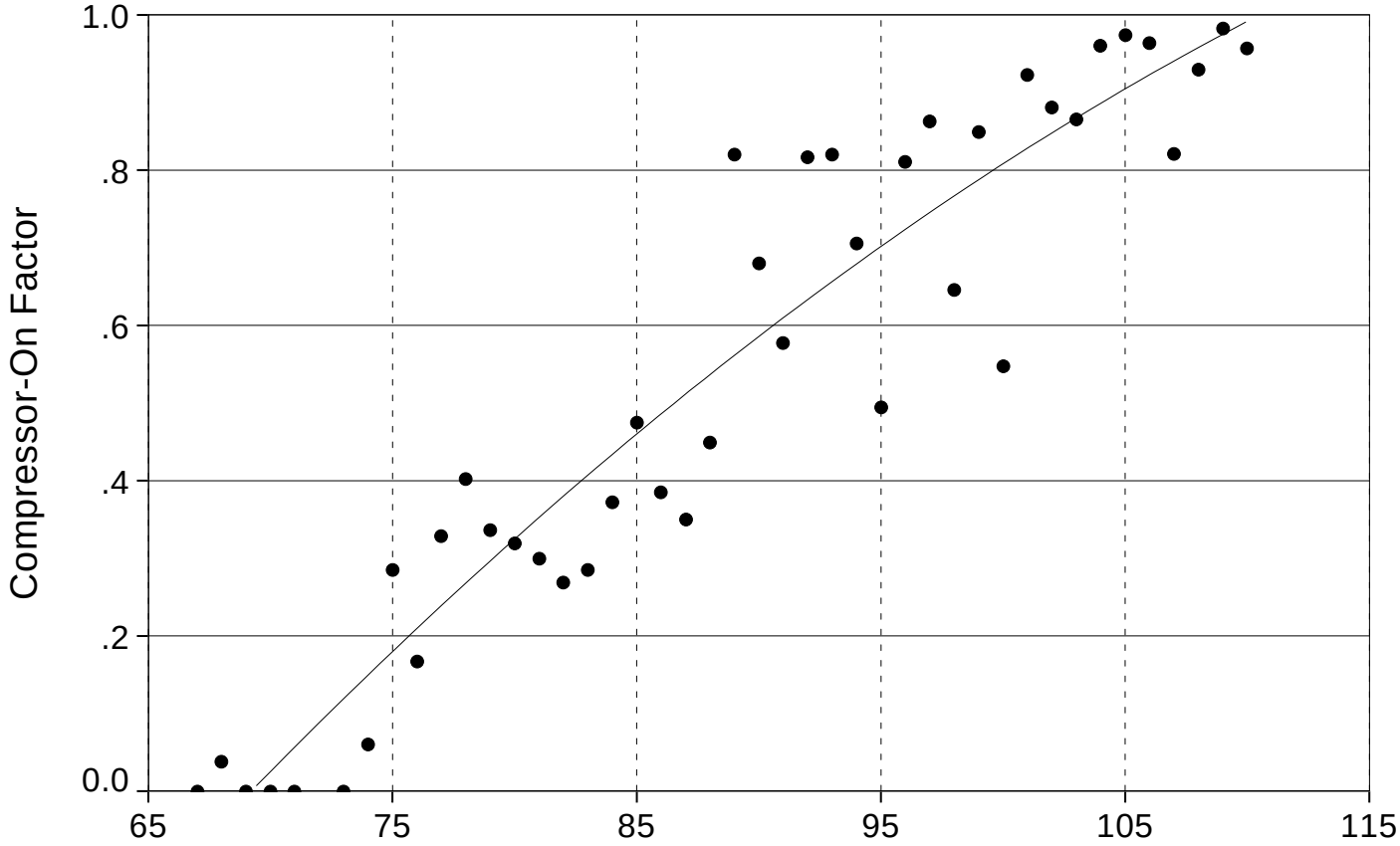
Average Compressor-On by Heat Index

Phoenix A/C Survey - Non-idle trips



Rsq = 0.8967

Note: Heat Index formula based on shady condition