TEDS Simulation
LNG Train (Tank Car DOT 113)

Project Update

693JJ618D000006

Task Order - 693JJ618F000138

March 31, 2020

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SHARMA & ASSOCIATES, INC.

Summary

- Background
- Routes details
- Train summary
- TEDS simulation on Route 1 Legs
- Coupler forces overview
- L/V ratio on selected vehicles
- Average and operation speeds

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Background

- FRA requested a simulation study using TEDS to evaluate operations of an Liquefied Natural Gas (LNG) unit train (DOT-113 cars) on two routes between Wyalusing, PA to Paulsboro, NJ through Philadelphia, PA with length of approximately 411 miles and 356 miles, respectively, as highlighted on the map on next slides #3&4.
- Various legs of the two routes are included in table on slide #5.
- **Simulation results in this presentation are for Route 1.** Simulations for Route 2 are in progress.

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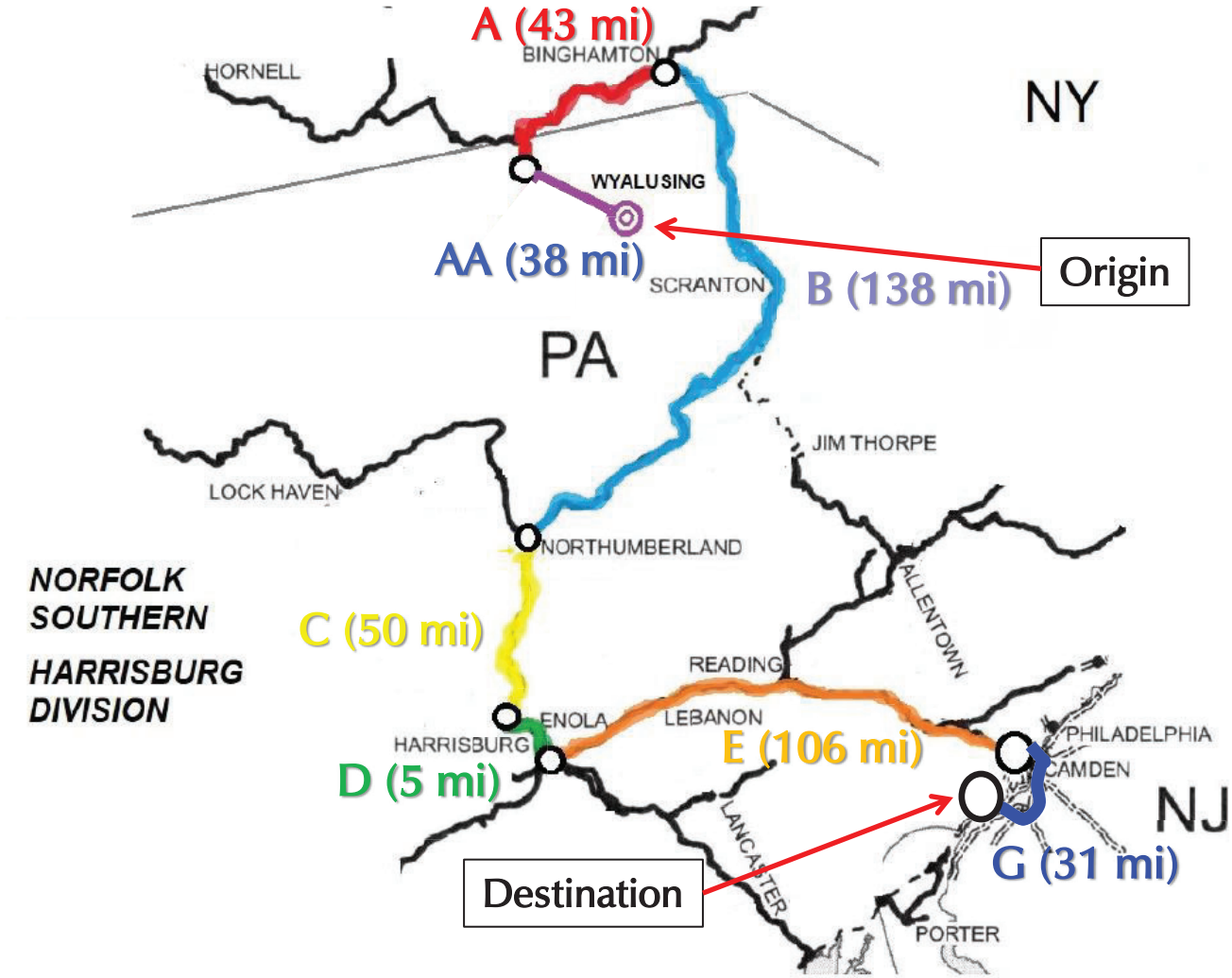
LNG ROUTE 1 (~411 miles)



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LNG ROUTE 2 (~356 miles)

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Details of Routes 1 & 2

Route 1

Leg	Start	End	Length (miles)
AA	Wyalusing	Waverly	38
A	Waverly	Binghamton	43
B	Binghamton	Northumberland	138
C	Northumberland	Enola	50
D	Enola	Harrisburg	5
E	Harrisburg	Philadelphia	106
G	Philadelphia	Paulsboro	31
Total			411

Route 2

Leg	Start	End	Length (miles)
A	Wyalusing	Waverly	38
B	Waverly	Binghamton	43
C	Binghamton	Dupont	65
D	Dupont	Jim Thorpe	56
E	Jim Thorpe	Allentown	29
F	Allentown	Reading	44
G	Reading	Philadelphia	50
GG	Philadelphia	Paulsboro	31
Total			356

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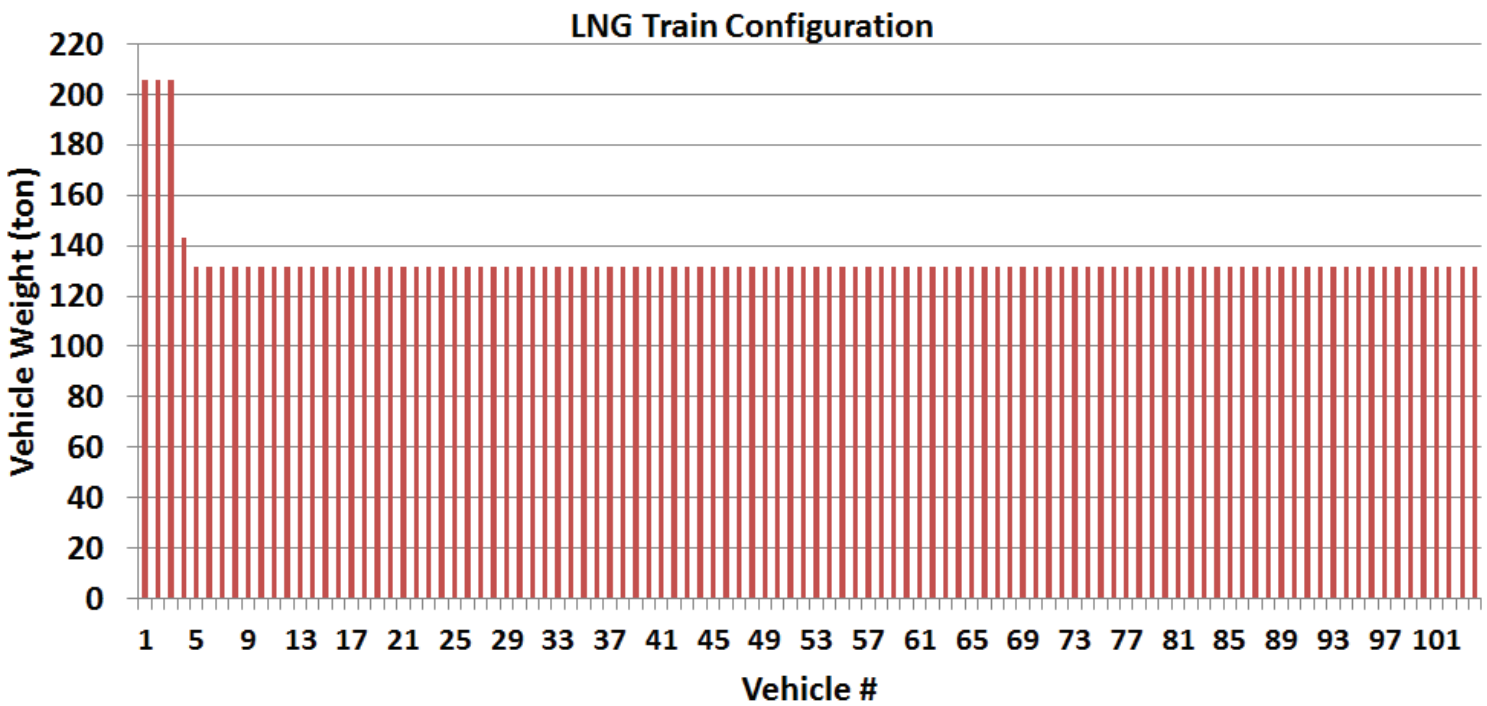
Train Configuration

- Three (3) 4,400 HP AC Locos, 1 Buffer car and 100 DOT-113 tank cars
- Trailing Tonnage: 13,293 tons
- Total Train Length: 8,462 ft HP/ton: 0.903



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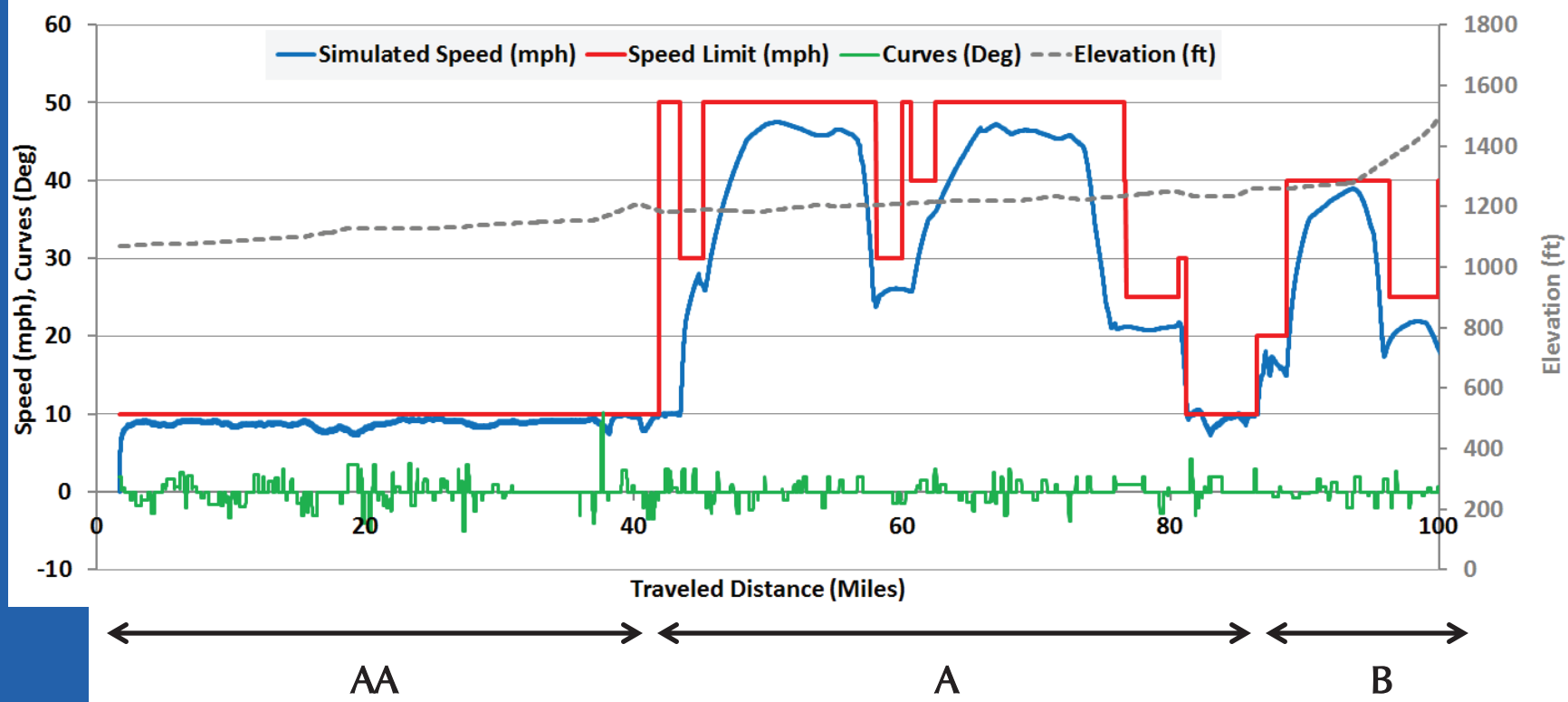
Speed Profile (on Traversed Legs)



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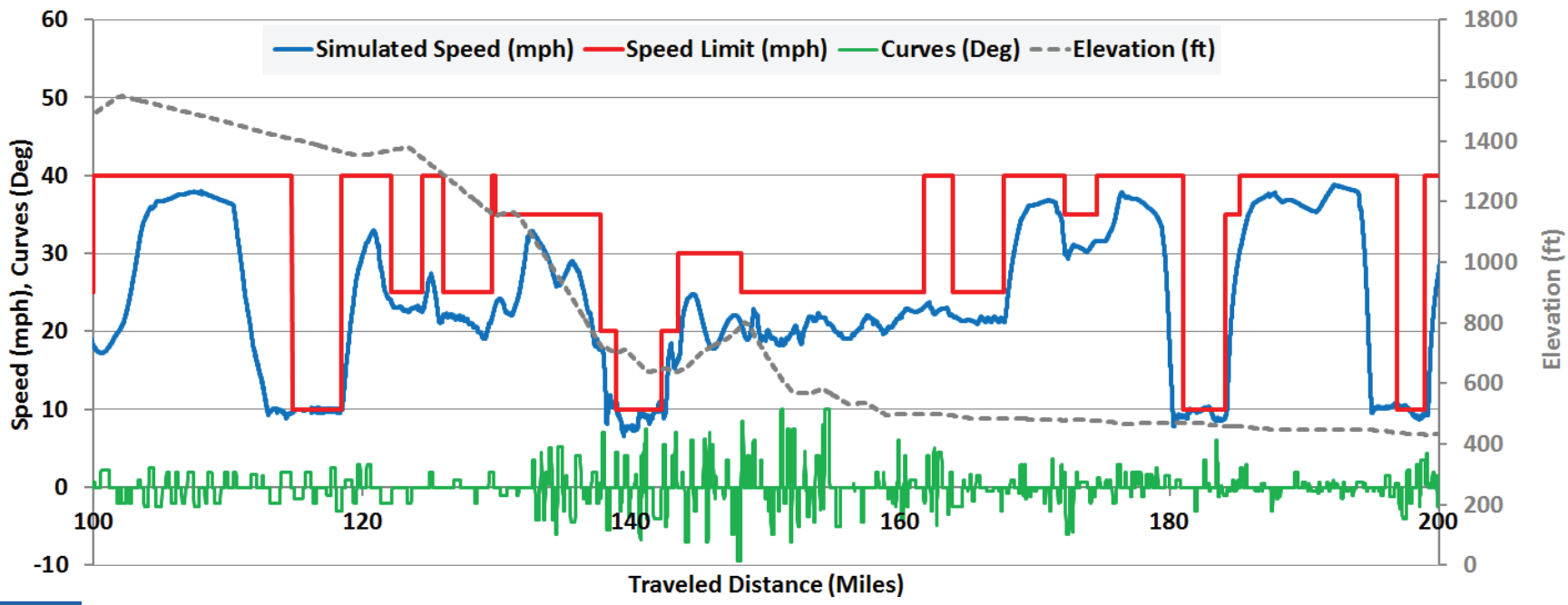
Speed Profile (on Traversed Legs..)



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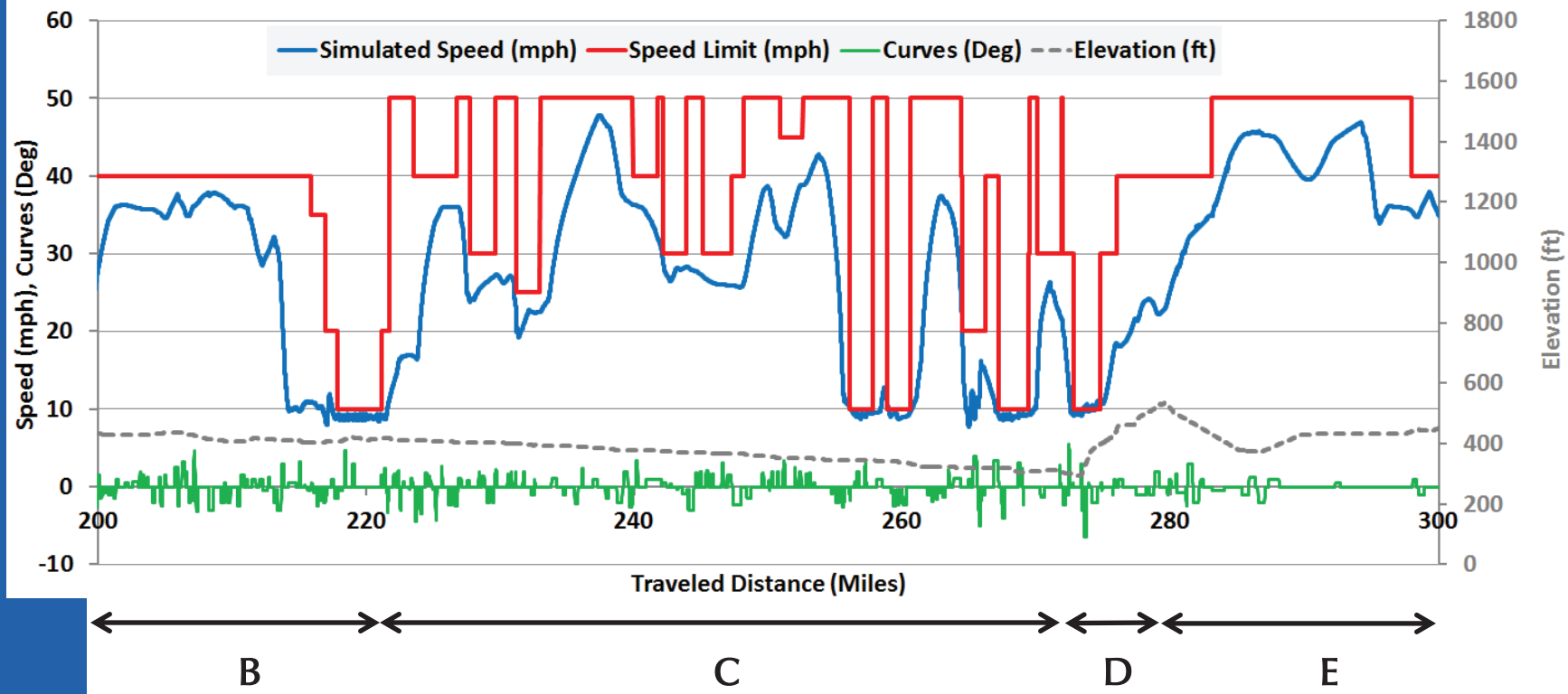
Speed Profile (on Traversed Legs..)



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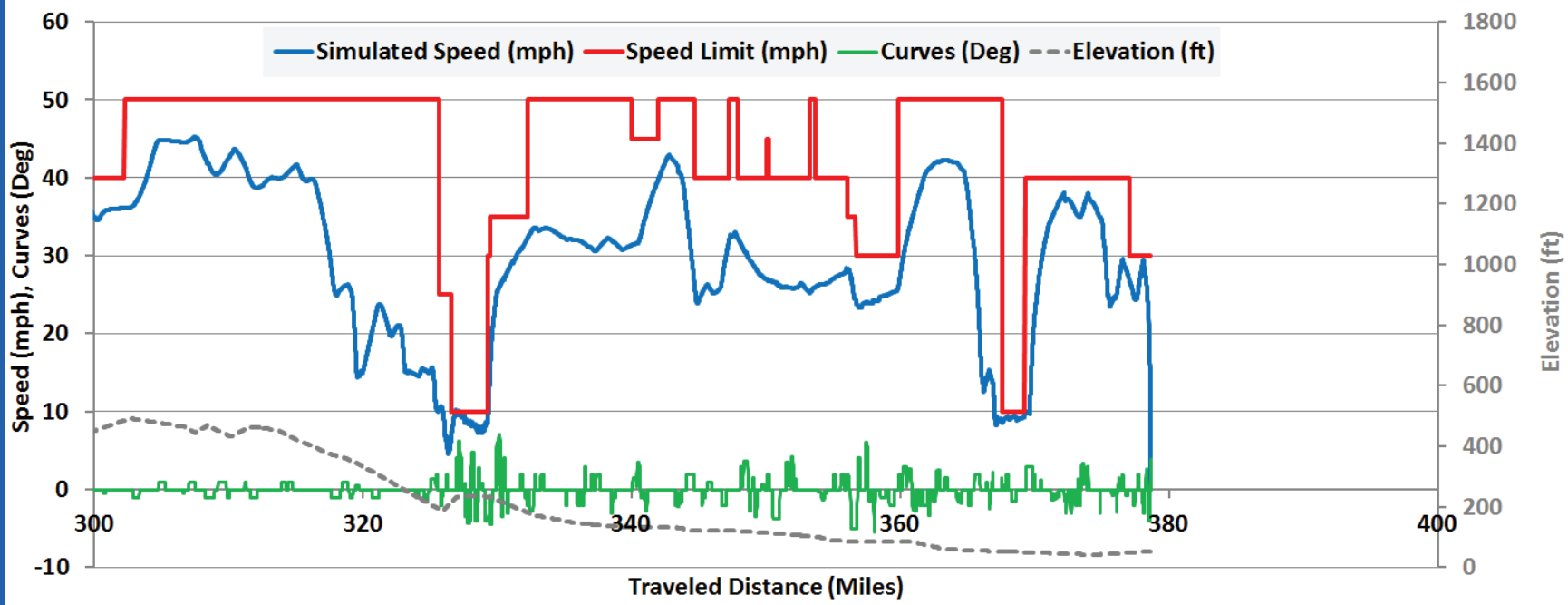
Speed Profile (on Traversed Legs..)



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Note: The simulation of the last Leg G of the route (Philadelphia to refinery facility) is in progress.

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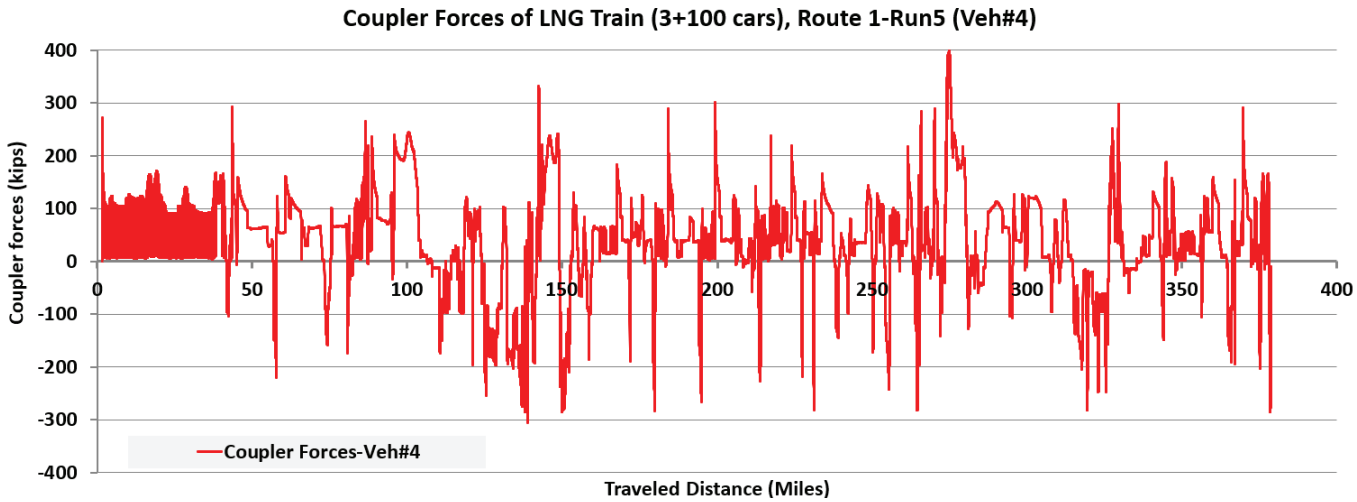
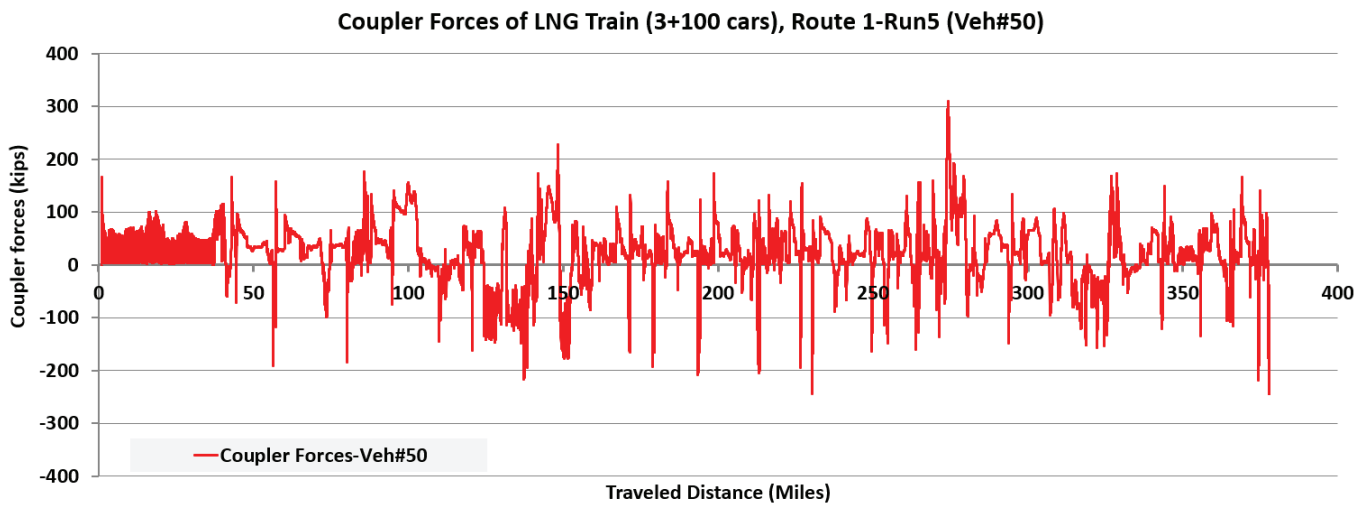
Coupler Force (Front end) Vehicles #4 & #50





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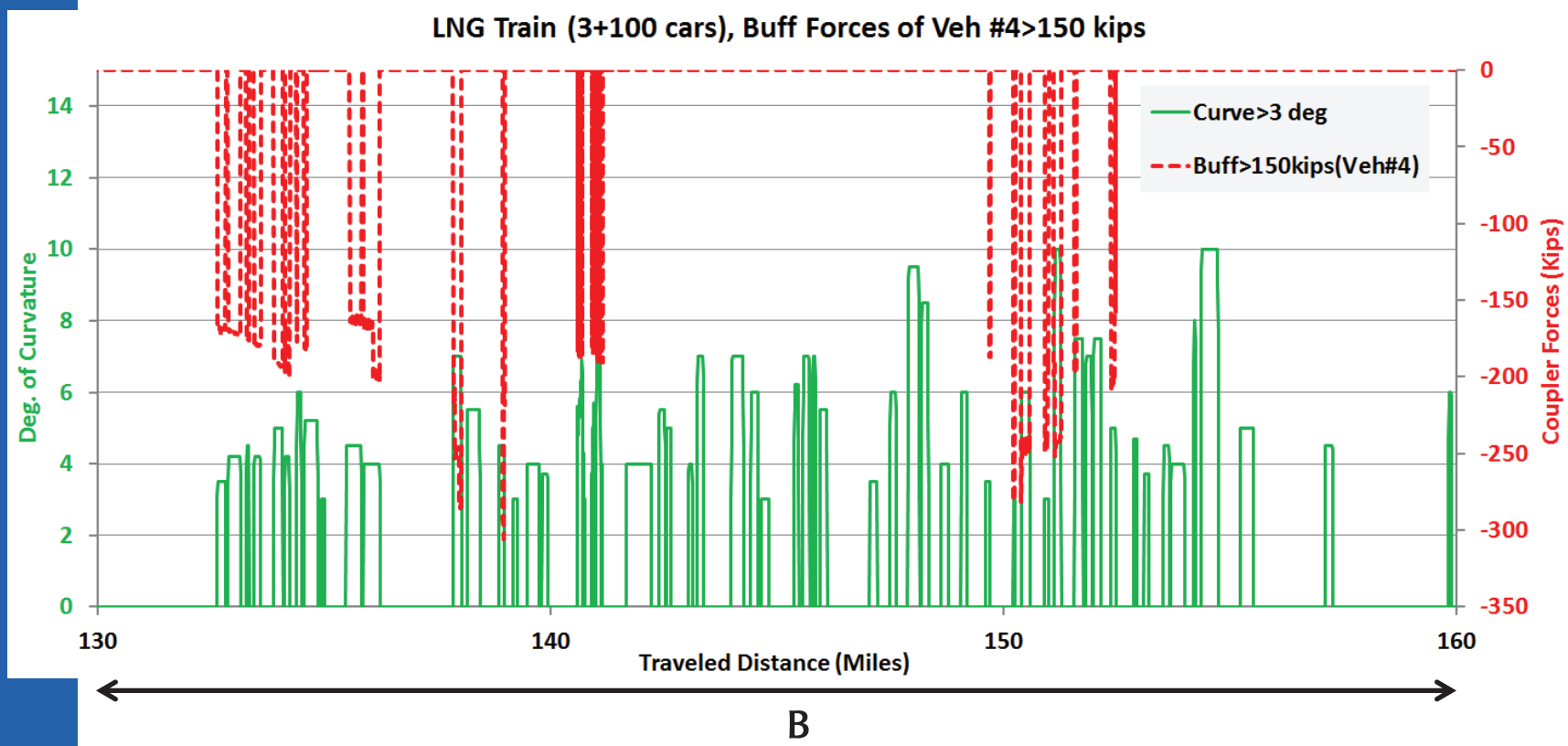
Drawbar/Coupler Force (Buff) on Vehicle 4, in Curves>3 deg.



Note: Curves are shown with magnitude of degree of curvatures.
Buff force is more safety critical during negotiation.

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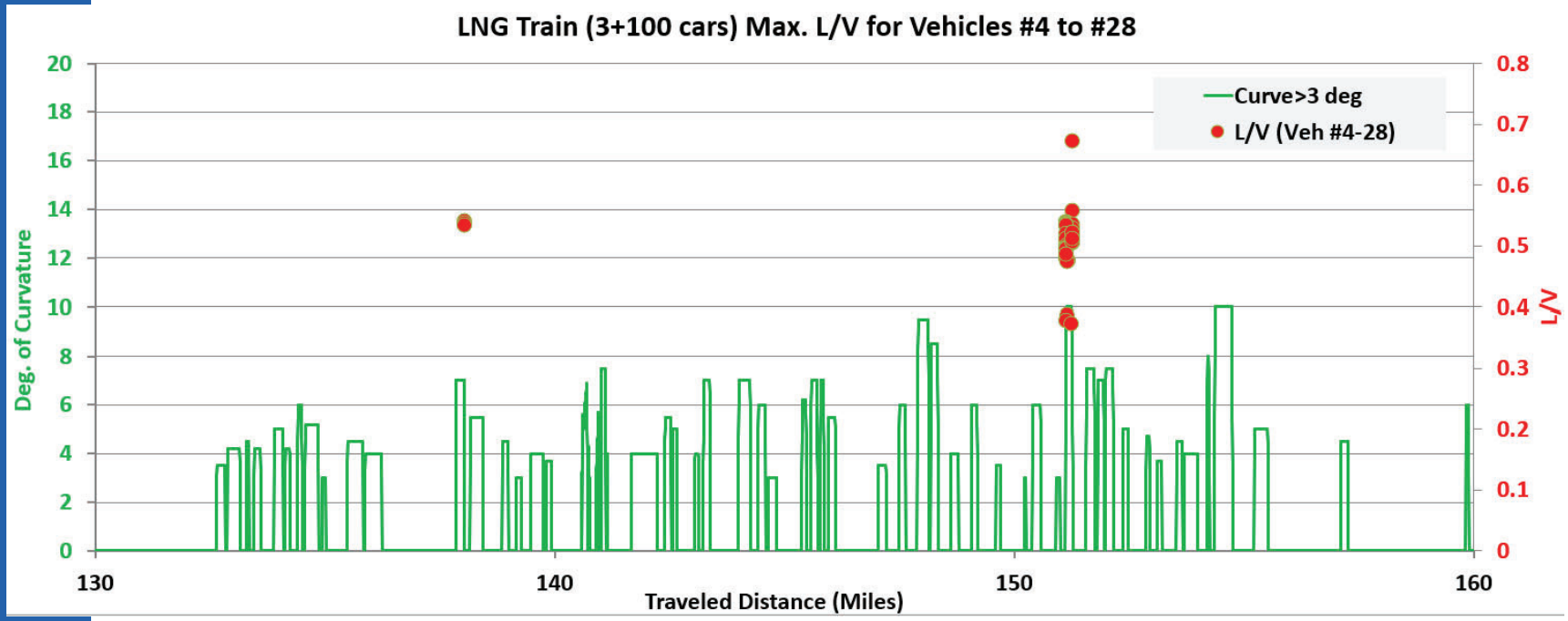
Predicted Max L/V for Selected Vehicles (#4-28) through Critical Part of the Route



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Note: Curves are shown with magnitude of degree of curvatures

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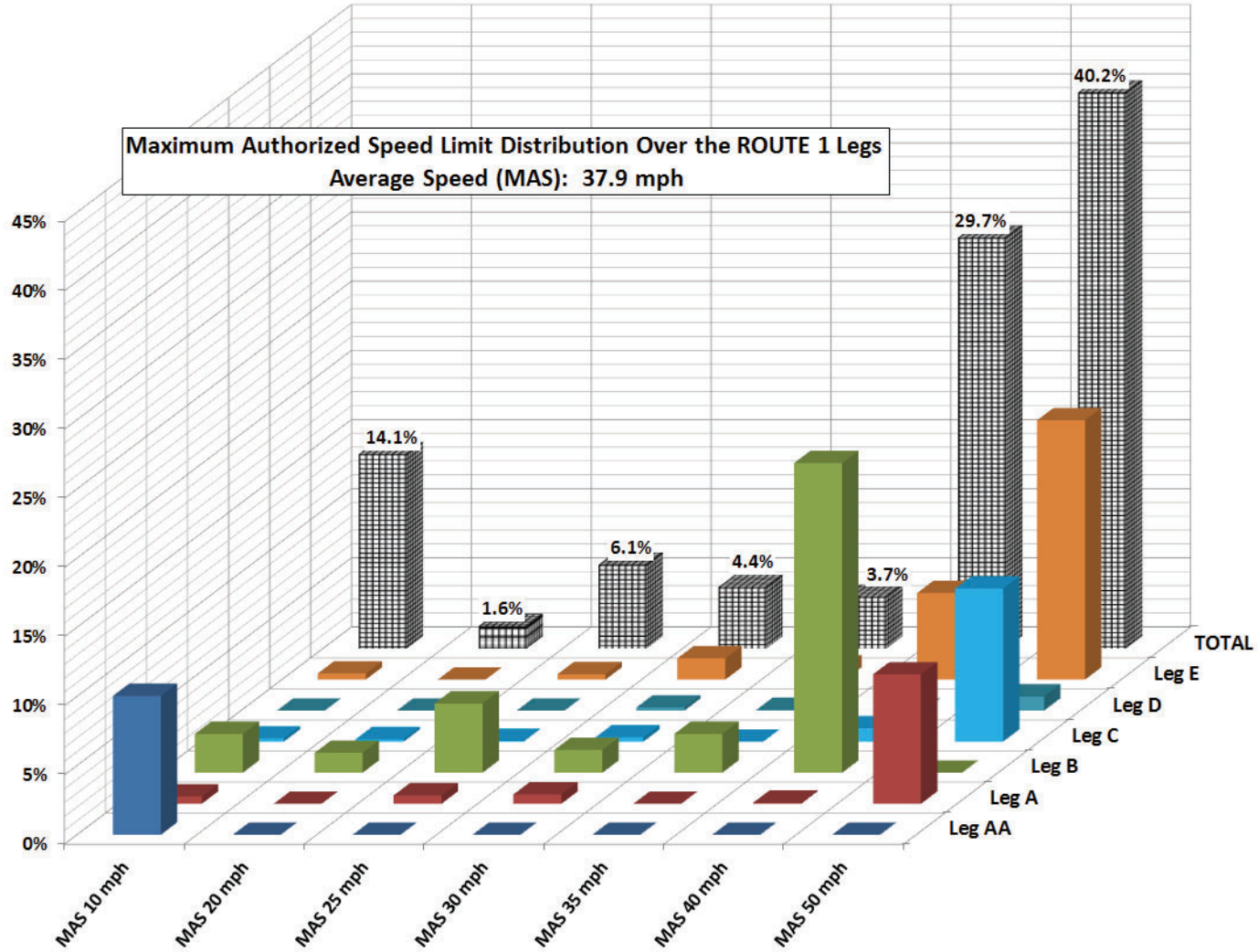
Track Speed Limit Distribution

(Timetable Data, Not Simulation Predicted Speed)



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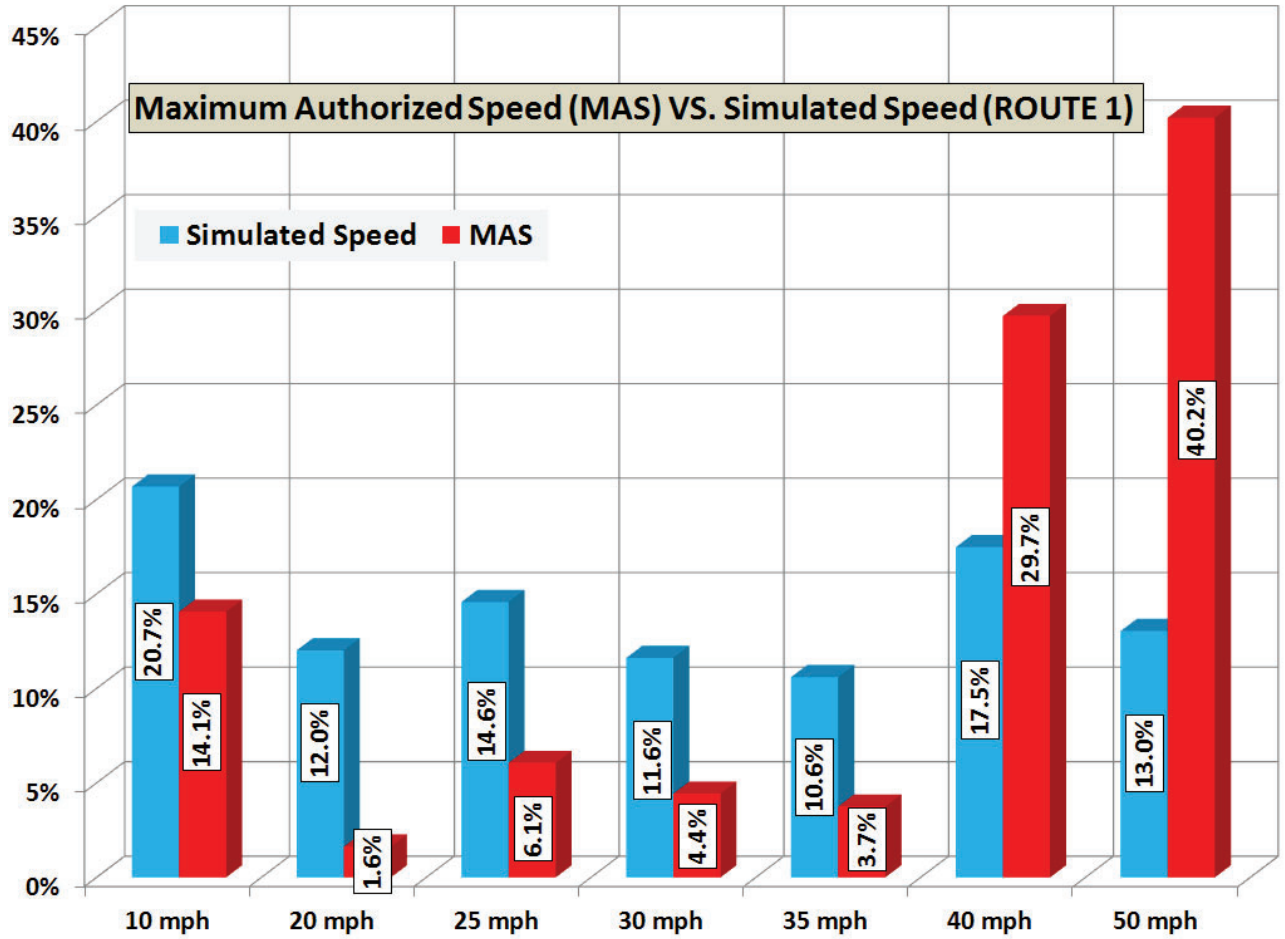
Comparison-Speed Distribution

MAS (Timetable Data) VS. Simulated Speed



Note: Only 14.1% of Route has 10 mph speed limit, but train runs at 10 mph over 20.7% of the route.

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Average Speed

MAS (Timetable Data) VS. Simulated Speed)

- Avg. MAS: 37.9 mph
- Avg. Simulated Speed: 25.7 mph

  Both average speeds are calculated using the following formula:

$$\text{Avg. Speed} = \frac{\sum Speed \times Distance}{\sum Distance}$$

- By using "total simulated distance/total simulated time" formula, the average operational speed of train is estimated to be 18.7* mph

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* Simulated Route 1 distance: 378 miles, TEDS simulated train operation time: 20.2 hours.

Sample Revenue Unit Train

As a benchmark, FRA provided Event Recorder data sample for a unit train operated by NS on the Leg B of Route 1.

For qualitative analysis, TEDS simulated speed profile on this leg was compared to the speed from this sample train.

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