# Load Quantification for Light Rail, Heavy Rail, and Commuter Rail Transit Infrastructure

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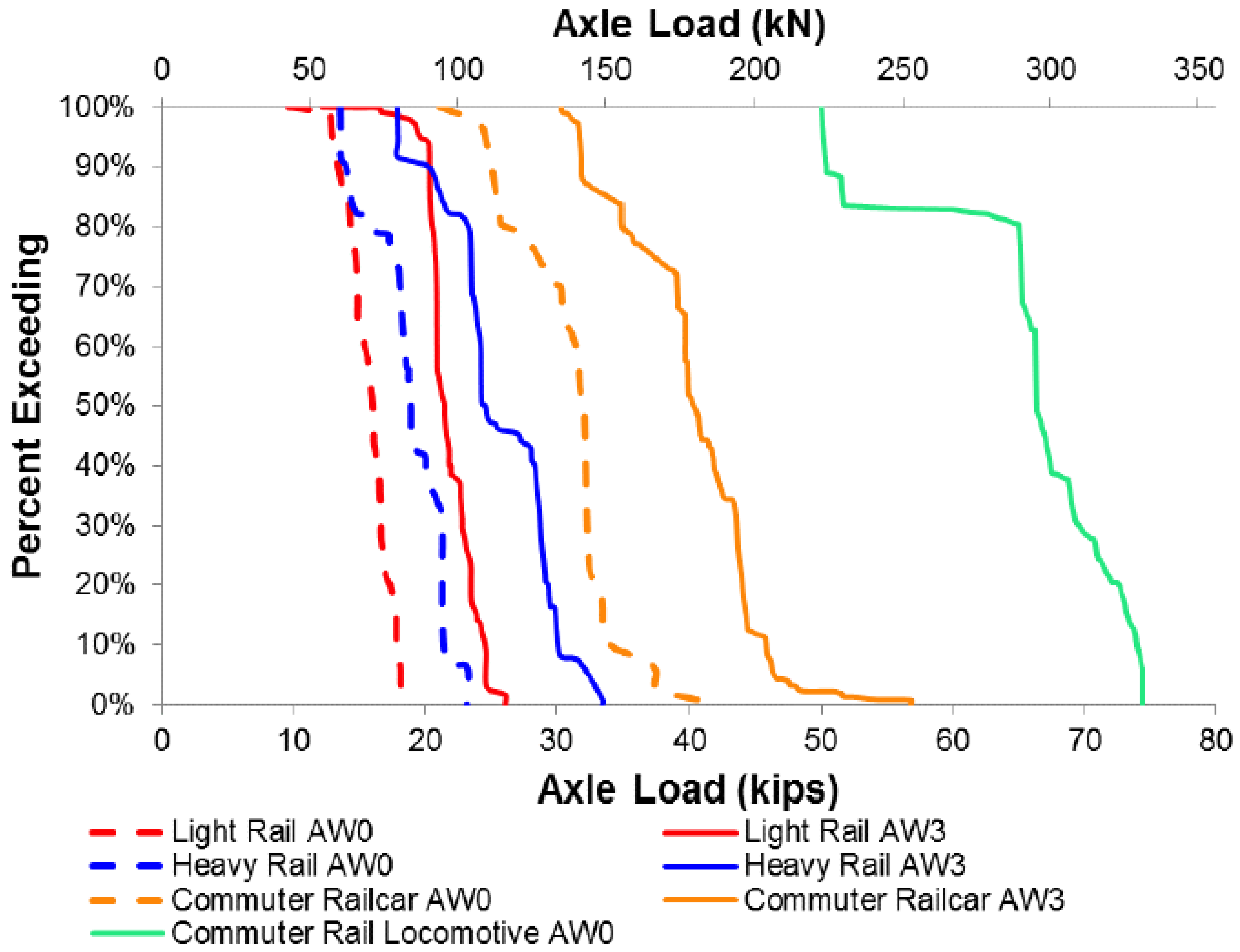
## Rail Transit Static Load Quantification

The rail transit industry is currently using AW3 standards to calculate the maximum load that track components can withstand, which equals to empty car weight plus the product of average passenger weight and the maximum passenger capaccity for the vehicle.

- Empty car weight for passenger vehicles and locomotives was collected using various sources, including vehicle design specifications and datasheets.
- The average passenger weight is updated to be 195 pounds (88 kg) to take into account chaanges in average weight.
- The 2013 Revenue Vehicle Inventory provides the passenger capacity, both seated and standing capacity, as well as the number of active revenue vehicles for each transit vehicle model in the United States.

The axle load distribution for three modes is shown in the figure and the table below. It shows the percentage of rail transit vehicles in the United States exceeding particular axle loads for light rail, heavy rail, and commuter rail systems.




*Light Rail, Heavy Rail, and Commuter Rail Axle Load Distribution*

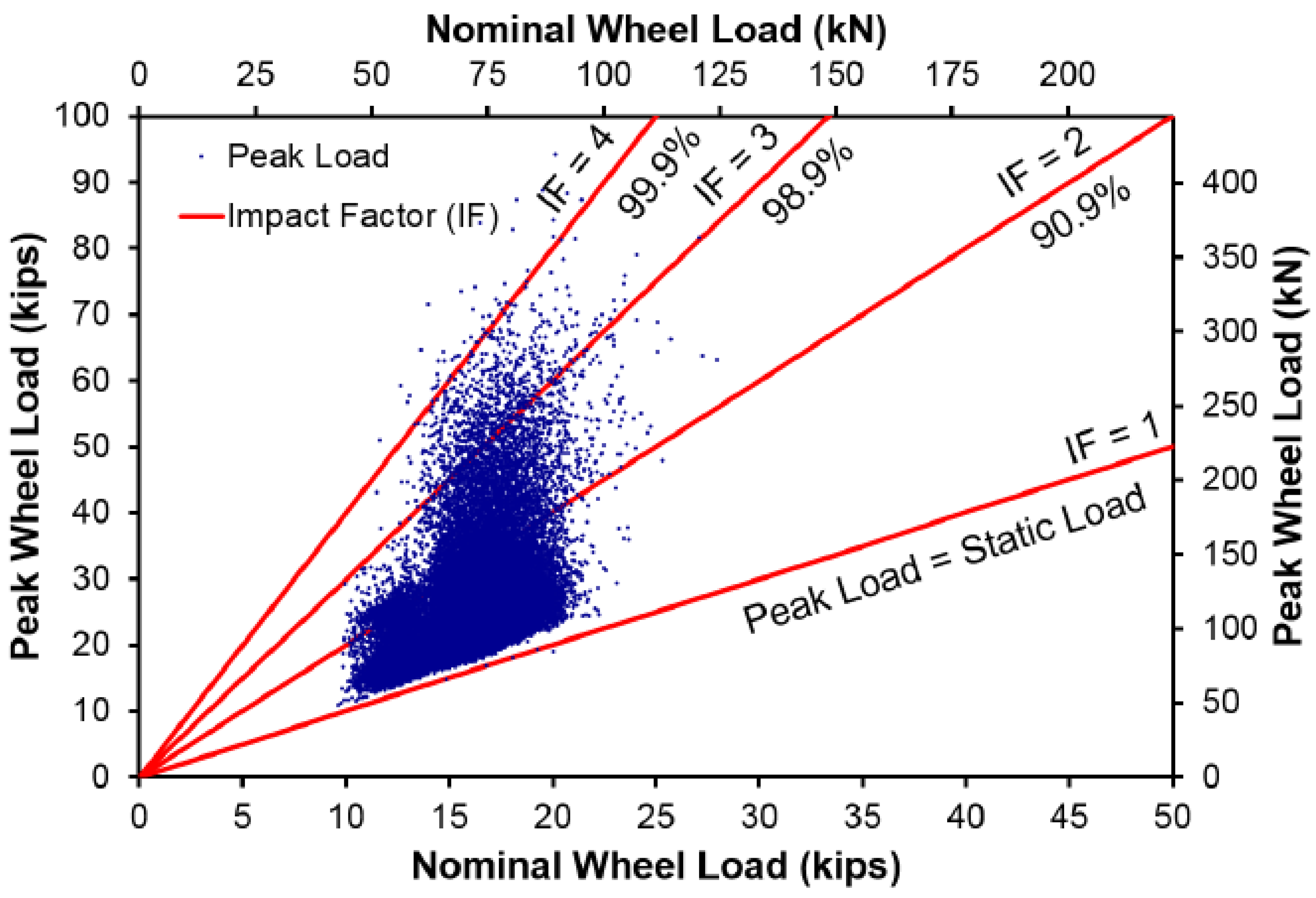
| Imperial Units | | | | | | |
|---|---|---|---|---|---|---|
| | AW0 Axle Load (kips) | | | AW3 Axle Load (kips) | | |
| Transit Mode | Minimum | Maximum | Average | Minimum | Maximum | Average |
| Light Rail | 9.6 | 18.2 | 15.7 | 12.2 | 26.1 | 21.8 |
| Heavy Rail | 11.9 | 23.2 | 18.7 | 16.2 | 33.5 | 25.5 |
| Commuter Railcar | 21.1 | 40.8 | 30.6 | 30.4 | 56.7 | 40.0 |
| Commuter Locomotive | 50.0 | 74.4 | 65.4 | N/A | N/A | N/A |

| Metric Units | | | | | | |
|---|---|---|---|---|---|---|
| | AW0 Axle Load (kN) | | | AW3 Axle Load (kN) | | |
| Transit Mode | Minimum | Maximum | Average | Minimum | Maximum | Average |
| Light Rail | 42.7 | 81.0 | 69.9 | 54.3 | 116.1 | 97.0 |
| Heavy Rail | 53.0 | 103.2 | 83.2 | 72.1 | 149.1 | 113.5 |
| Commuter Railcar | 93.9 | 181.6 | 136.2 | 135.3 | 252.3 | 178.0 |
| Commuter Locomotive | 222.5 | 331.1 | 291.0 | N/A | N/A | N/A |

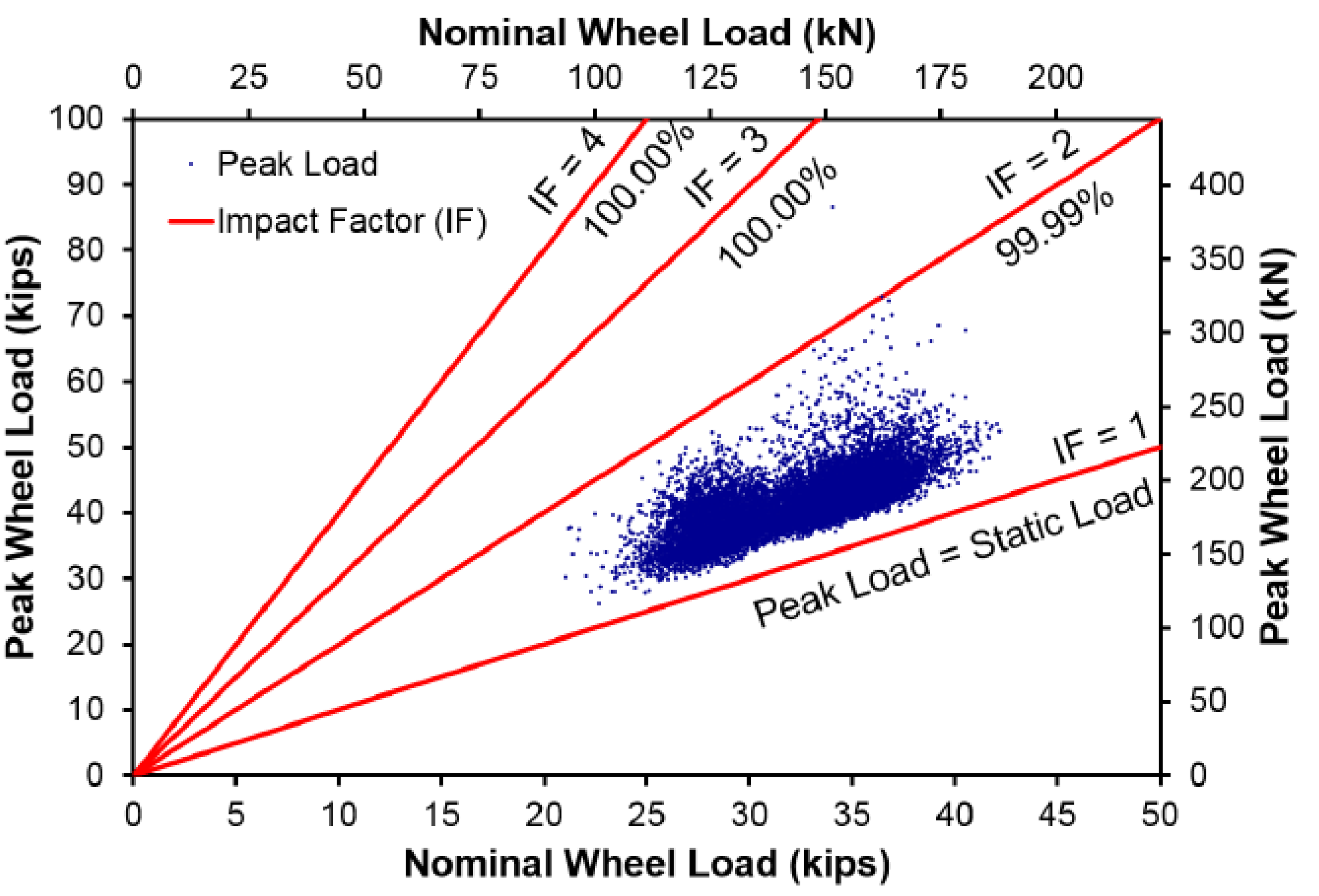
*AW0 (Empty Load) and AW3 (Crush Load) Axle Loads for Light Rail, Heavy Rail and Commuter Rail Transit Vehicles*

## Evaluation of Impact Factor

- The American Railway Engineering and Maintenance-of-way Assoication (AREMA) Manual on Railway Engineering defines the impact factor as a percentage increase over static vertical loads intended to estimmate the dynamic effect of wheel and rail irregularities.
- The AREMA Manual currently specifies an impact factor of 200%, which indicates the design load is three times the static load, equivalent to an impact load factor of three.
- The applicability of the impact factor requires further studies with respect to today's rail transit loading environment. Using the Wheel Impact Load Detector (WILD) data at Edgewood, MD, Marcus Hook, PA, and Mansfield, MA, the peak load is plotted against the nominal load in figures below for commuter railcars and locomotives respectively with lines representing the impact factor of one, two, three, and four.




*Relationship between peak and nominal wheel loads of commuter railcars on Amtrak Infrastructure*




*Relationship between peak and nominal wheel loads of commuter locomotives on Amtrak Infrastructure*

## Conclusions

- The impact factor of three specified by the AREMA Manual is adequate for calculating the design load for commuter rail vehicles.
- The impact factor of two exceeds 99.99% of the commuter locomotive wheel loads, which indicates an impact factor of two is sufficient for calculating the peak wheel load for commuter locomotives.
- An impact factor of two for commuter locomotives could reduce the design load for passenger-only track, as the nominal wheels of commuter locomotives are significantly higher than those of commuter railcars.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