

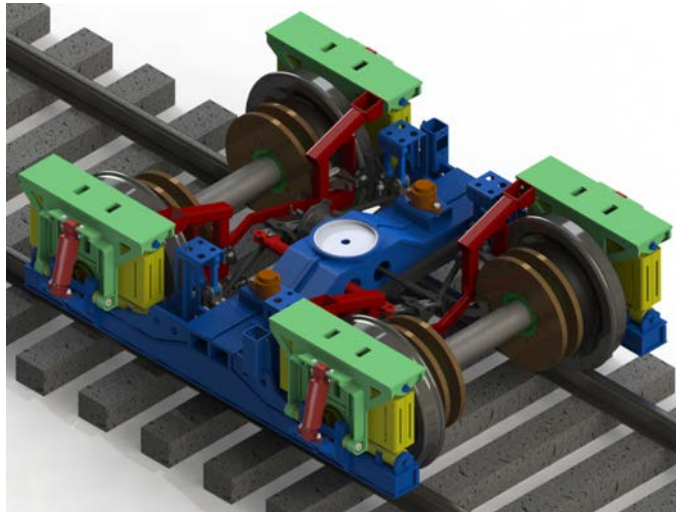


U.S. Department of
Transportation

**Federal Railroad
Administration**

HIGHER SPEED FREIGHT TRUCK DESIGN PERFORMANCE REQUIREMENTS

Office of Research
and Development
Washington, DC 20590



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13. ABSTRACT (Maximum 200 words) This proposed requirements document combines a set of requirements for high-speed freight car truck design and performance from the generally accepted standards in the U.S. Code of Federal Regulation (CFR), the Association of American Railroads (AAR) Manual of Standards and Recommended Practices (MSRP), and the American Public Transportation Association Standards (APTA). The proposal will ideally establish a set of design and performance requirements specifically for freight car trucks intended to operate at speeds of up to 125 mph. This proposed requirements document covers the design and performance requirements for freight car trucks applied to freight cars that are intended for use in rail service at speeds of up to 125 mph, the Track Class 7 maximum allowable operating speed. Accordingly, only elements essential to track worthiness, basic equipment, and strength are addressed. Special component and braking requirements are not addressed in this document. In addition to design and strength, safety performance requirements based on lateral wheel load, vertical wheel unloading, L/V ratio, and lateral and vertical car body accelerations are addressed in this report.				
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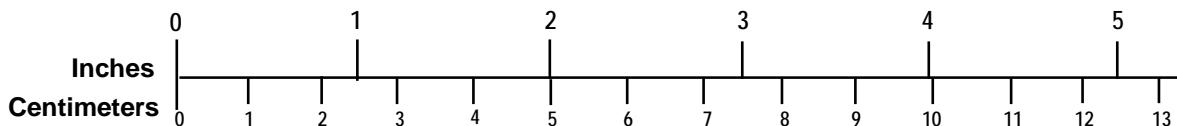
METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

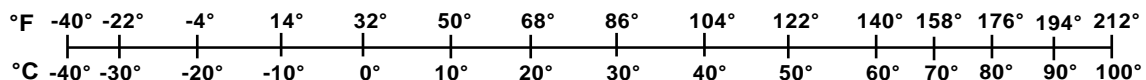
METRIC TO ENGLISH

<p>LENGTH (APPROXIMATE)</p> <p>1 inch (in) = 2.5 centimeters (cm)</p> <p>1 foot (ft) = 30 centimeters (cm)</p> <p>1 yard (yd) = 0.9 meter (m)</p> <p>1 mile (mi) = 1.6 kilometers (km)</p>	<p>LENGTH (APPROXIMATE)</p> <p>1 millimeter (mm) = 0.04 inch (in)</p> <p>1 centimeter (cm) = 0.4 inch (in)</p> <p>1 meter (m) = 3.3 feet (ft)</p> <p>1 meter (m) = 1.1 yards (yd)</p> <p>1 kilometer (km) = 0.6 mile (mi)</p>
<p>AREA (APPROXIMATE)</p> <p>1 square inch (sq in, in²) = 6.5 square centimeters (cm²)</p> <p>1 square foot (sq ft, ft²) = 0.09 square meter (m²)</p> <p>1 square yard (sq yd, yd²) = 0.8 square meter (m²)</p> <p>1 square mile (sq mi, mi²) = 2.6 square kilometers (km²)</p> <p>1 acre = 0.4 hectare (he) = 4,000 square meters (m²)</p>	<p>AREA (APPROXIMATE)</p> <p>1 square centimeter (cm²) = 0.16 square inch (sq in, in²)</p> <p>1 square meter (m²) = 1.2 square yards (sq yd, yd²)</p> <p>1 square kilometer (km²) = 0.4 square mile (sq mi, mi²)</p> <p>10,000 square meters (m²) = 1 hectare (ha) = 2.5 acres</p>
<p>MASS - WEIGHT (APPROXIMATE)</p> <p>1 ounce (oz) = 28 grams (gm)</p> <p>1 pound (lb) = 0.45 kilogram (kg)</p> <p>1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)</p>	<p>MASS - WEIGHT (APPROXIMATE)</p> <p>1 gram (gm) = 0.036 ounce (oz)</p> <p>1 kilogram (kg) = 2.2 pounds (lb)</p> <p>1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons</p>
<p>VOLUME (APPROXIMATE)</p> <p>1 teaspoon (tsp) = 5 milliliters (ml)</p> <p>1 tablespoon (tbsp) = 15 milliliters (ml)</p> <p>1 fluid ounce (fl oz) = 30 milliliters (ml)</p> <p>1 cup (c) = 0.24 liter (l)</p> <p>1 pint (pt) = 0.47 liter (l)</p> <p>1 quart (qt) = 0.96 liter (l)</p> <p>1 gallon (gal) = 3.8 liters (l)</p> <p>1 cubic foot (cu ft, ft³) = 0.03 cubic meter (m³)</p> <p>1 cubic yard (cu yd, yd³) = 0.76 cubic meter (m³)</p>	<p>VOLUME (APPROXIMATE)</p> <p>1 milliliter (ml) = 0.03 fluid ounce (fl oz)</p> <p>1 liter (l) = 2.1 pints (pt)</p> <p>1 liter (l) = 1.06 quarts (qt)</p> <p>1 liter (l) = 0.26 gallon (gal)</p> <p>1 cubic meter (m³) = 36 cubic feet (cu ft, ft³)</p> <p>1 cubic meter (m³) = 1.3 cubic yards (cu yd, yd³)</p>
<p>TEMPERATURE (EXACT)</p> <p>$[(x-32)(5/9)]\text{ }^\circ\text{F} = y\text{ }^\circ\text{C}$</p>	<p>TEMPERATURE (EXACT)</p> <p>$[(9/5)y + 32]\text{ }^\circ\text{C} = x\text{ }^\circ\text{F}$</p>

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1. Proposed Requirements—General

This proposed requirements document combines a set of requirements for high-speed freight car truck design and performance from the generally accepted standards in the U.S. Code of Federal Regulation (CFR), the Association of American Railroads (AAR) Manual of Standards and Recommended Practices (MSRP), and the American Public Transportation Association Standards (APTA). The purpose of this standard is to establish a set of design and performance requirements specifically for freight car trucks that are intended to operate at speeds of up to 125 mph.

2. Scope

This proposed requirements report covers the design and performance requirements for freight car trucks intended for use in rail service at speeds of up to 125 mph, the track Class 7 maximum allowable operating speed. Accordingly, only elements essential to track worthiness, basic equipment, and strength are addressed. Special component and braking requirements are not addressed in this document.

3. Design and Clearance

3.1 Material

3.1.1 Frames, Bolsters, and Other Structural Components

The material of structural truck components, including frames, bolsters, and any other primarily load bearing member, shall meet the minimum requirements of AAR M-201 for castings and AAR M-213 for fabricated components [1].

3.1.2 Steel Coil Springs

The material and processing of steel coil springs shall conform to the requirements of AAR M-114 [2].

3.2 Construction

Fabricated frames shall be constructed according to the requirements of AAR M-1001 Chapter 5 [3].

3.3 Limiting Profile

Trucks shall meet the dimensional requirements of 49 CFR 229.71 [4] and AAR S-2026-88 Plate B limiting profile [5], and AAR S-301, S-302, and S-303 [6] truck design dimensions.

3.4 Components

3.4.1 Wheels

Wheels shall meet the requirements of AAR M-107/208 Class B Wheels [7].

3.4.2 Axles

Axles shall meet the requirements of AAR M-101 [7].

3.4.3 Roller Bearings

Roller bearings shall meet the requirements of AAR M-924 [8].

3.4.4 Side Bearings

Side bearings, if used, shall meet the requirements of AAR M-948 [2].

3.4.5 Steel Center Plate Liners

Steel center plate liners, if used, shall meet the requirements of AAR S-305, S-306, S-307, and S-308 [2].

4. Strength and Endurance

4.1 Test Requirements

Frames and bolsters shall meet the strength and endurance requirements of AAR M-202, M-203, M-203-A, M-204, and M-213 [3] depending on their cast or fabricated construction.

5. Safety and Performance

The safety and performance requirements listed below are intended for revenue service track. These requirements can also be used to assess truck performance through analytical simulations where track defects are represented by the Minimally Compliant Analytical Track (MCAT) methodology described in 49 CFR Parts 213 and 238 [9]. Each referenced specification covers all aspects of testing, including data collection and signal conditioning. For minimum and maximum vertical wheel loads, the Federal Railroad Administration and CFR data collection and signal conditioning standards may be substituted for the APTA and EN standards to enable more uniform test and analysis operations.

5.1 Wheel Load Limits

5.1.1 Minimum Vertical Wheel Load

For safety against derailment on track twist (warped track) in the form of curve spirals and track level deviations, trucks shall meet the static and dynamic requirements of:

Static – APTA SS-M-014-06 – 4.0 Wheel Load Equalization Requirements – 4.2 Class R Passenger Equipment [10]

> 35 percent of static vertical wheel load at 2-inch single wheel vertical displacement, and

> 0 percent of static vertical wheel load at 2.5-inch single wheel vertical displacement

Dynamic – 49 CFR 213.345 – Vehicle/Track Interaction Safety Limits (VTISL) – Single Wheel Vertical Load [8].

≥ 15 percent of static vertical wheel load; not to be less than this value for 5 foot or more length along the track

5.1.2 Maximum Wheel L/V

For safety against wheel climb derailment in curves, spirals, track twist, and track level deviations, trucks shall meet the dynamic requirements of 49 CFR 213.345 – VTISL – Single Wheel L/V Ratio [8].

$\leq (\text{Tan}(\delta) - \mu) / (1 + \mu \cdot \text{Tan}(\delta))$; not to exceed this value for 5 feet or more; where

δ = Flange Angle,

μ = Coefficient of Friction, 0.5 shall be used as per 49 CFR 213.345 Proposed Rule

5.1.3 Net Axle Lateral L/V Ratio

For safety against track panel shift, trucks shall meet the requirements of 49 CFR 213.345 Proposed Rule – VTISL – Net Axle Lateral L/V Ratio [8].

$\leq 0.4 + 5.0/Va$; not to exceed this value for 5 feet or more; where

V_a = Static Vertical Axle Load (kips)

5.1.4 Truck Side L/V

For safety against track rail roll over, trucks shall meet the requirements of 49 CFR 213.345 – VTISL – Truck Side L/V Ratio [8].

≤ 0.6 ; not to exceed this value for 5 feet or more

5.2 Acceleration Limits

5.2.1 Car body Lateral Sustained

For safety against derailment, and track damage prevention, trucks shall meet the requirements of 49 CFR 213.345 Proposed Rule – VTISL – Car body Lateral (Sustained Oscillatory) – Other Vehicles [9].

$\leq 0.12g$ rms, 4-second window, 4 seconds sustained

5.2.2 Car body Vertical Maximum

For vehicle track interaction safety, trucks shall meet the requirements of AAR Chapter XI.

$\leq 1g$ dynamic augment, loaded car only

5.3 Performance Limits Summary Tables

Table 1. Wheel Rail Forces

	Safety Limit	Window
Min Vertical Wheel Load	$\geq 15\%$ Static Vertical Wheel Load	5 ft
Max Wheel L/V	$\leq (\tan(\delta) - \mu) / (1 + \mu \cdot \tan(\delta))$; where δ = Flange Angle, μ = Coefficient of Friction, 0.5 shall be used as per 49 CFR 213.345 Proposed Rule	5 ft
Net Axle Lateral L/V	$\leq 0.4 + 5.0/V_a$; where V_a = Static Vertical Axle Load (kips)	5 ft
Max Truck Side L/V	≤ 0.6	5 ft
Static Twist Load Equalization - test only		
Min Wheel Vertical Load (Truck Twist – Static)	$\geq 35\%$ Static at 2-inch wheel lift $\geq 0\%$ Static at 2.5-inch wheel lift	Min Wheel Vertical Load (Truck Twist – Static)

Table 2. Carbody Acceleration

	Safety Limit	Window/Condition
Carbody Lateral Sustained	$\leq 0.12g$ rms	4-second window, 4 second sustained
Carbody Vertical Transient	$\leq 1.0 g$ dynamic augment	instantaneous

6. References

1. Association of American Railroads (AAR) – Manual of Standards and Recommended Practices (MSRP) – Section S - Casting Details.
2. AAR – MSRP – Section D - Truck and Truck Details.
3. AAR – MSRP – Section C – Part II – Design Fabrication and Construction of Freight Cars.
4. U.S. Code of Federal Regulation – 49 CFR 229.71 – Clearance Above Top of Rail
5. AAR – MSRP – Section C – Car Construction Fundamentals and Details.
6. AAR – MSRP – Section S-II - Truck Details and Casting Codes.
7. AAR – MSRP – Section G - Wheels and Axles.
8. AAR – MSRP – Section H - Journal Bearings and Lubrication.
9. U.S. Code of Federal Regulation – 49 CFR 213.345 – Vehicle/Track System Qualification and Appendix D.
10. American Public Transportation Association Standards – 14. APTA SS-M-014-06 Standard for Wheel Load Equalization of Passenger Railroad Rolling Stock.

Abbreviations and Acronyms

AAR	Association of American Railroads
APTA	American Public Transportation Association
CFR	Code of Federal Regulations
FRA	Federal Railroad Administration
MSRP	Manual of Standards and Recommended Practices