INFLUENCE OF SIZE AND WEIGHT VARIABLES ON THE STABILITY AND CONTROL PROPERTIES OF HEAVY TRUCKS

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Appendices

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TITLE

INFLUENCE OF SIZE AND WEIGHT VARIABLES ON THE
STABILITY AND CONTROL PROPERTIES OF HEAVY
TRUCKS

AUTHOR(S)

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CONTRACT MANAGER

Dr. R. Hegmon (HNR-20)

ABSTRACT

This study has determined the influence of variations in truck size and
weight constraints on the stability and control properties of heavy vehicles.
The size and weight constraints of interest include axle load, gross vehicle
weight, length, width, type of multiple-trailer combinations, and bridge
formula allowances. Variations in location of the center of gravity of the
payload were also considered as a separate subject. The influence of these
parametric variations on stability and control behavior was explored by means
of both full-scale vehicle tests and computer simulations.

In Volume I, the findings of the study were presented in a manner which
is intended to inform the non-technical reader and, specifically, the
persons concerned with formulating policies and laws regarding truck size
and weight.

Volume II presents the methodology and summary results from the full-
scale test program. The test findings relating size and weight variables
to vehicle dynamic behavior are compared with those derived from simulation
results. Volume II also presents the results of a special set of experi-
mental measurements showing the dynamic loads which heavy trucks impose on
the pavement. Volume III contains appendices of test and simulation data.

KEY WORDS

size and weight, heavy trucks, stability and control, traffic safety,
pavement loading, dynamic wheel load tests, simulation

UNLIMITED
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<td>Three-Axle Tractor-Semitrailer, T1-TR1</td>
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<tr>
<td>Five-Axle Tractor-Semitrailer, T3-TR6.</td>
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<tr>
<td>Five-Axle Tractor-Semitrailer, T7-TR6.</td>
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<td>Five-Axle Tractor-Semitrailer, T5-TR6.</td>
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<td>Five-Axle Double, T1-TR1-TR2</td>
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</tr>
<tr>
<td>Seven-Axle Triple, T1-TR1-TR2-TR3.</td>
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<td>Seven-Axle Rocky Mountain Double, T7-TR6-TR8</td>
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<td>Nine-Axle Turnpike Double, T3-TR5-TR6.</td>
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</table>
Introduction

This document constitutes a volume of data obtained in support of the major report entitled "The Influence of Size and Weight Variables on the Stability and Control Properties of Heavy Trucks." The project involved both computerized simulations and full-scale test methods for studying how changes in truck dimensions and loading influenced the properties which determine vehicle response to steering and braking. This volume of the report presents plots of simulation results which are arranged according to the types of analyses which were conducted. Within each set of simulations, various vehicles are represented and each is considered with varying values of size and weight variables.

The test results are presented in groups corresponding to individual test vehicle configurations. For each configuration, various plots are presented showing braking, cornering, roll stability, and rearward amplification information measured under differing size and weight conditions.

In general, single measures of performance were employed for summarizing the influence of size and weight variables in the reporting of study findings in Volumes I and II. The measures in question were derived from plots illustrated in this volume.
Results of Simplified Braking Calculations

The following plots present the normalized longitudinal force, \( F_x/F_z \), at each axle of the vehicle during steady braking, as well as longitudinal deceleration, in g's, versus the brake input pressure at the treadle valve. Each plot shows individual curves for each of the vehicle's axles, numbered according to axle position, from front to rear. For a given value of line pressure, the value of \( F_x/F_z \) on a given curve represents the brake force at that axle (given the proportioning scheme) and the total vertical load on the axle (given the load transfer mechanisms and the pertinent height and length parameters of the vehicle). The measures of \( F_x/F_z \) for a given value of applied pressure can be interpreted as reflecting the level of tire/road friction at which the axle in question would achieve lockup. Thus, the axle curve which is the "highest" on a given plot identifies the limiting axle, from a lock-up point of view. For any combinations of tire/road friction and applied brake pressure falling below this "highest" curve, the vehicle's braking performance would be said to be "lockup limited."

Although approximately 100 such plots were produced to examine the various size and weight cases in this study, only the plots representing the sensitivities of the five-axle tractor-semitrailer and five-axle double to variations in axle loading are included in this appendix. These plots provide example illustrations of the manner in which the braking performance analyses were finally established.
Loading Cases Covered in the Following Plots of Straight-Line Braking

<table>
<thead>
<tr>
<th>Axle Loads/1000 lb</th>
<th>Axle Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td><strong>F</strong> (Baseline)</td>
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</tbody>
</table>
AXLE LOAD - D.3

BRAKE PRESSURE
### BRAKE PRESSURE vs AXLE LOAD - D.5

The diagram illustrates the relationship between brake pressure and axle load for different scenarios. The axes are labeled as follows:

- **Y-axis**: $F_x/F_z$ (normalized force)
- **X-axis**: Brake Pressure
- **Legend**: Various lines labeled from 1 to 5 indicate different axle load configurations or conditions.

The curves show how the normalized force changes with brake pressure for each scenario.
APPLIED PRESSURE (PSI)
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 1
STRAIGHT LINE BRAKING
APPLIED PRESSURE (PSI)
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 2
STRAIGHT LINE BRAKING
APPLIED PRESSURE (PSI)
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 3
STRAIGHT LINE BRAKING
APPLIED PRESSURE (PSI)
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 4
STRAIGHT LINE BRAKING

+- DECEL. (G'S)
* - BRK. EFFICIENCY
+ - DECEL. (G'S)
* - BRK. EFFICIENCY

APPLIED PRESSURE (PSI)
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 5
STRAIGHT LINE BRAKING
Handling Diagrams - Axle Load Variations

Maneuver: Ramp steer - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

Loading and Vehicles:

<table>
<thead>
<tr>
<th>Case</th>
<th>Axle Number</th>
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<td>(Baseline)</td>
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</table>
Format for Handling Diagram Plots

The handling diagram is a plot of the steady-state cornering behavior of the power unit (straight truck or tractor) of a vehicle combination. The plot readily illustrates the trend toward understeer (sloping up toward the left) or oversteer (sloping toward the right).

The lateral acceleration of the power unit is scaled along the vertical axis, while the horizontal axis is scaled according to the composite term

\[ \left[ L \cdot \frac{R}{V} - \frac{DSW}{NG} \right] \text{ (degrees)} \]

where

- \( L \) = tractor (or truck) wheelbase
- \( R \) = path radius
- \( V \) = vehicle velocity
- \( DSW \) = steering wheel angle
- \( NG \) = effective steering ratio, steering wheel to front wheels
TWO AXLE STRAIGHT TRUCK

L*R/V-DSW/NG (DEG)

TRACTOR AY (G)

- 12-20
+ 12-22
■ 12-18
0 12-24
THREE AXLE STRAIGHT TRUCK

TRACTOR AY, (G)

L*R/V-DSW/NG (DEG)

12-34
12-38
12-32
12-36
Handling Diagrams - Gross Weight Variations

Maneuver: Ramp steer - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

Loading and Vehicles:

<table>
<thead>
<tr>
<th>Vehicle / Case</th>
<th>Axle No. - (Baseline)</th>
<th>Axle Loads/1000 lb.</th>
<th>A</th>
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<td></td>
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<td>10</td>
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</tbody>
</table>
L*R/V-DSW/NG (DEG)
FIVE AXLE TRACTOR-SEMI
Handling Diagrams - Mixed Tire Installation

Maneuver:  Ramp steer input - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

Loading and Vehicles:

Tire Installation:  Baseline - all radials
Mix - radials, steering axle; bias-ply lug tires, drive axle(s)
TWO AXLE STRAIGHT TRUCK

TRACTOR A Y [G]

L*R/V-DSW/NG (DEG)

-- BASELINE
+- LUGS ON DRIVE AXLE
THREE AXLE TRACTOR-SEMI
BIAS LUGS ON DRIVE AXLE

TRACTOR AY [G]

L*R/V-DSW/NG (DEG)

THREE AXLE TRACTOR-SEMI
BIAS LUGS ON DRIVE AXLE
BASELINE
+- LUGS ON DRIVE AXLE

TRACTOR AY (G)

L*R/V-DSW/NG (DEG)

FOUR AXLE TRACTOR-SEMI
5 AXLE TRACTOR-SEMITRAILER

*** LUG TIRES REAR

000 BASELINE

L*R/U - DSW/NG (DEG)
5 AXLE DOUBLE

TED

0.5

0.4

0.3

0.2

0.1

tractor

ay (g,s)

-2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0

l*r/u - dsw/nd (deg)

000 baseline

*** lug tires rear

32
Handling Diagrams - C.G. Height Variations

Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle
Speed: 55 mph (88 km/h)
Loading: 80,000 and 88,000 lbs (36.3 and 39.9 m tons) GCW
Payload c.g. height varies as labeled
Vehicles: five-axle tractor-semitrailer (with 45' trailer)
five-axle double (with 27' trailers)
Handling Diagrams - C.G. Lateral Offset

Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

Loading: 80,000 and 88,000 lbs (36.3 and 39.9 m tons) GCW Payload c.g. offset laterally as labeled (Note the offset is always toward the outside of the turn)

Vehicles: five-axle tractor-semitrailer (with 45' trailer) five-axle doubles (with 27' trailers)
Handling Diagram - Truck Wheelbase Variation

Maneuver: Ramp steer input – 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

Loading Condition: 12,000 lbs (5.4 m tons) – front axle
34,000 lbs (15.4 m tons) – rear tandem

Vehicle:

<table>
<thead>
<tr>
<th>Vehicle / Case</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>L5</th>
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</thead>
<tbody>
<tr>
<td>A. Straight 1</td>
<td>22</td>
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<tr>
<td>Truck 2</td>
<td>24</td>
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<tr>
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<td>5</td>
<td>30</td>
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</tbody>
</table>

Length, ft
3-AXLE STRAIGHT TRUCKS
WHEELBASE VARIATIONS

0.5 DEG/SEC RAMP STEER

AY (G'S)

-2.0 -1.5 -1.0 -0.5 0.0

L*R/U - DSW/NG (DEG)
Handling Diagrams - Width Variations

Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

Loading: 80,000 and 88,000 lbs (36.3 and 39.9 m tons) GCW as per table below

Width Dimension Variations:

<table>
<thead>
<tr>
<th>Cases</th>
<th>$W_B$</th>
<th>$W_S$</th>
<th>$W_T$</th>
<th>Gross Wgt (LBS)</th>
<th>Tractor Width (IN)</th>
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</thead>
<tbody>
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<td>1 (Baseline)</td>
<td>96</td>
<td>38</td>
<td>96</td>
<td>80k</td>
<td>96</td>
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<tr>
<td>2*</td>
<td>102</td>
<td>38</td>
<td>96</td>
<td>80k</td>
<td>96</td>
</tr>
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<td>3</td>
<td>102</td>
<td>38</td>
<td>96</td>
<td>80k</td>
<td>96</td>
</tr>
<tr>
<td>4*</td>
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<td>38</td>
<td>102</td>
<td>80k</td>
<td>96</td>
</tr>
<tr>
<td>5*</td>
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<td>44</td>
<td>102</td>
<td>80k</td>
<td>96</td>
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<td>44</td>
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<td>50</td>
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<td>80k</td>
<td>102</td>
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</tbody>
</table>
CASE 1
CASE 3
CASE 7
CASE 8

--- CASE 1
+ CASE 3
v CASE 7
o CASE 8

L*R/V-DSW/NG (DEG)
FIVE AXLE TRACTOR-SEMI
WIDTH VARIATIONS
CASE 1
CASE 8
CASE 9
CASE 10
CASE 11

L*R/V-DSW/NG [DEG]
FIVE AXLE TRACTOR-SEMI
WIDTH VARIATIONS
Jackknife Dynamics - Tractor Wheelbase Variations

Maneuver: Braking in a steady turn - tractor drive axles are locked up and the ensuing jackknife divergency is characterized.

The following four plots present the time histories of the yaw rate and articulation angle responses of the tractor, showing how the jackknife motion ensues following wheel lockup at approximately Time = 3.25 seconds.

Initial Speed: 55 mph (88 km/h)

Initial Lateral Acceleration: -0.17 g's

Surface Friction Levels: $\mu = 0.3$ and 0.8

Vehicle:
LOW MU (0.3)

--- 12 FT WHEELBASE

000 16
XXX 18
+++ 20
LOW MU (0.3)

--- 12 FT WHEELBASE
OOO 16
XXX 18
+++ 20

ARTICULATION ANGLE [DEG]

20.
15.
10.
5.
0.

TIME (SEC)

0. 1. 2. 3. 4. 5.

BRAKING IN A TURN
TRACTOR WHEELBASE VARIATIONS
HI MU (0.8)

--- 12 FT WHEELBASE
000 16
XXX 18
+++ 20

TRACTOR YAW RATE (DEG/SEC)

TIME (SEC)

BRAKING IN A TURN
TRACTOR WHEELBASE VARIATIONS
BRAKING IN A TURN
TRACTOR WHEELBASE VARIATIONS

HIGH $\mu$ (0.8)

--- 12 FT WHEELBASE
000 16
XXX 18
+++ 20

ARTICULATION ANGLE (DEG)

TIME (SEC)
Low-Speed Offtracking - Length Variations

Maneuver: 90-degree intersection turn
Reference curve - 35-foot (10.7-m) radius
(tracked by outside steering tire on tractor)

Speed: -0 mph (0 km/h)

Vehicles:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>A. Truck/ Full Trailer</td>
<td>1</td>
<td>22</td>
<td>22</td>
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<tr>
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<td>2</td>
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<td>20</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>20</td>
<td>24</td>
</tr>
</tbody>
</table>

| B. Tractor/ Semitrailer | 1 | 12 | 45 |
|                         | 2 | 16 | 45 |
|                         | 3 | 18 | 45 |
|                         | 4 | 20 | 45 |
|                         | 5 | 21 | 27 |
|                         | 6 | 18 | 35 |
|                         | 7 | 18 | 35 |
|                         | 8 | 18 | 35 |

| C. Rocky Mtn. Doubles | 1 | 12 | 15 | 21 |
|                       | 2 | 12 | 15 | 27 |
|                       | 3 | 12 | 15 | 27 |
|                       | 4 | 12 | 15 | 27 |
|                       | 5 | 12 | 15 | 45 |
|                       | 6 | 12 | 45 | 27 |
|                       | 7 | 12 | 45 | 27 |
|                       |   |   | 45 | 45 |

| D. Turnpike Doubles | 1 | 12 | 15 | 15 |
|                     | 2 | 12 | 40 | 40 |
|                     | 3 | 12 | 45 | 45 |
|                     | 4 | 12 | 45 | 45 |

| E. Single Axle Doubles | 1 | 11 | 21 |
|                        | 2 | 11 | 24 |
|                        | 3 | 11 | 24 |
|                        | 4 | 11 | 24 |
|                        | 5 | 11 | 24 |

| F. Single Axle Triples | 1 | 11 | 27 |
|                       | 2 | 11 | 35 |
|                       | 3 | 11 | 35 |
|                       | 4 | 11 | 35 |
|                       | 5 | 11 | 35 |

| G. Single Axle (5 & Quad-) | 1 | 11 | 27 |
|                            | 2 | 11 | 35 |
|                            | 3 | 11 | 35 |
|                            | 4 | 11 | 35 |
|                            | 5 | 11 | 35 |

| H. B-Train | 1 | 11 | 27 |
|            | 2 | 11 | 35 |
|            | 3 | 11 | 35 |
TRAJECTORY OF INNERMOST POINT ON VEHICLE

* - BASELINE [CASE 6]

0 - REFERENCE CURVE
+
+- REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT RADIUS
TRUCK/FULL TRAILER - SHORT TONGUE
(TRUCK WHEELBASE VARIATION)
TRAJECTORY OF INNERMOST POINT ON VEHICLE

- BASELINE (CASE 6)

0-REFERENCE CURVE
+-REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS
TRUCK/FULL TRAILER - SHORT TONGUE
(TRAILER LENGTH VARIATION)
TRAJECTORY OF INNERMOST POINT ON VEHICLE

- BASELINE (CASE 6)
+ REFERENCE CURVE
+ REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS
TRUCK/FULL TRAILER - LONG TONGUE
(TRUCK WHEELBASE VARIATION)
TRAJECTORY OF INNERMOST POINT ON VEHICLE

- BASELINE (CASE 6)

0-REFERENCE CURVE
+
-REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

TRUCK/FULL TRAILER - LONG TONGUE
(TRAILER LENGTH VARIATION)
TRAJECTORY OF INNERMOST POINT ON VEHICLE

- BASELINE (CASE 3)

O - REFERENCE CURVE
+
+ - REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

TRACTOR+45 FT SEMITRAILER
(TRACTOR WHEELBASE VARIATION)
TRAJECTORY OF INNERMOST POINT ON VEHICLE

*—BASELINE (CASE 3)

O—REFERENCE CURVE
+
—REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS
TRACTOR (18 FT WB) + SEMITRAILER
(SEMITRAILER LENGTH VARIATION)
TRAJECORY OF INNERMOST POINT ON VEHICLE

- BASELINE (CASE 6)

O-REFERENCE CURVE
+-REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

ROCKY MOUNTAIN DOUBLES
TRAJECORY OF INNERMOST POINT ON VEHICLE

- BASELINE (CASE 6)

O-REFERENCE CURVE
+
- REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

ROCKY MOUNTAIN DOUBLES
OFF-TRACKING
90 DEG TURN, 35 FT RADIUS
TURNPIKE DOUBLES
TRAJECTORY OF INNERMOST POINT ON VEHICLE

0-REFERENCE CURVE
+-REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT RADIUS
SINGLE AXLE DOUBLES
TRAJECTORY OF INNERMOST POINT ON VEHICLE

5 - 27 FT QUADRUPLES

0-REFERENCE CURVE
+-REF. CURVE CENTER

OFF-TRACKING
90 DEG TURN, 35 FT RADIUS

SINGLE AXLE TRIPLES
(and quadruples)
0. CFTI
OFF-TRACKING 90 DEG TURN, 35 FT REF. RADIUS
B-TRAIN

TRAJECTORY OF INNERMOST POINT ON VEHICLE

0-REFERENCE CURVE +-REF. CURVE CENTER

ENTRY

EXIT

(FT) 0. 10. 20. 30. 40. 50. 60. 70.

0 10. 20. 30. 40. 50. 60. 70.
Low- and High-Speed Offtracking -- Numerical Results

On the following pages are presented tabular values of measures depicting specific low- and high-speed offtracking performance for all of the vehicle configurations examined under the "length" issue. The "low-speed offtracking" performance measure represents a zero-speed turning maneuver through a 90-degree intersection. The outside front tire on the tractor steering axle is caused to track along a reference curve of 35-foot radius. The measure of offtracking, called Maximum Path Width, describes the maximum projected width of the vehicle occurring during the turn, measured from the outside edge of the front tire on the tractor steering axle to the inside edge of the inside tire on the rearmost trailer axle. The maximum path width is listed for each vehicle case, measured in feet.

For each vehicle case, the number of the vehicle unit (tractor, trailer, or dolly) is listed, together with the dimensions, in inches, of the nominal wheelbase of each unit and the longitudinal distance from the center of the rearmost axle (or tandem center, in the case of a tandem pair) to the next hitch point. This distance pertains, for example, to kingpin offsets on tractors and dollies and to the overhang distance to the pintle hook at the rear of a straight truck or trailer. The longitudinal distance to the hitch is expressed as positive if the hitch is ahead of the rear axle (or tandem) center.

The same geometric input data defining the vehicles were used in calculations of high-speed offtracking. The reference turn employed in the high-speed offtracking cases involved a 600-foot (183-m) curve at a speed of 55 mph (88 km/h). The resulting high-speed offtracking measure is defined as the radial distance from the reference curve (which is tracked, in this case, by the center of the tractor steering axle) to the center of the rearmost trailer axle (or tandem center). The high-speed offtracking measures are listed at the right side of the sheet adjacent to the computer-printed results from the low-speed offtracking calculations.

The low- and high-speed offtracking measures are illustrated, respectively, in the next two figures.
Low Speed Offtracking in a 90° Intersection Turn
High Speed Offtracking in a Steady Turn
<table>
<thead>
<tr>
<th>Vehicle / Case</th>
<th>Length, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Truck / Full Trailer</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>L1 16</td>
</tr>
<tr>
<td>2</td>
<td>L1 20</td>
</tr>
<tr>
<td>3</td>
<td>L1 24</td>
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<td>L1 20</td>
</tr>
<tr>
<td>7</td>
<td>L1 20</td>
</tr>
<tr>
<td>C. Tractor Semitrailer</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>L1 12</td>
</tr>
<tr>
<td>2</td>
<td>L1 16</td>
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<tr>
<td>6</td>
<td>L1 27</td>
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<td>7</td>
<td>L1 27</td>
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<tr>
<td>8</td>
<td>L1 27</td>
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<tr>
<td>D. Rocky Mtn. Doubles</td>
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<tr>
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<td>7</td>
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<tr>
<td>E. Turnpike Doubles</td>
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<td>F. Single Axle Doubles</td>
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<tr>
<td>G. Single Axle Triples (B. Quad-rupies)</td>
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<td>H. B-Train</td>
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<tr>
<td>2</td>
<td>L1 11</td>
</tr>
<tr>
<td>3</td>
<td>L1 11</td>
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</table>

Length Variations

66
### Zero Speed Off-tracking Calculation

**Case 1:**

Zero Speed Off-tracking - 90 Degrees, 35.0 ft. Radius.

**Input Geometry of Combination (in.):**

<table>
<thead>
<tr>
<th>E (inches)</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>182.00</td>
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<tr>
<td>2</td>
<td>73.00</td>
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<tr>
<td>3</td>
<td>202.00</td>
</tr>
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</table>

**Condition of Maximum Off-tracking (ft.; deg.):**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX PATH WIDTH</td>
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<td>MIN. INSTANTANEOUS RADIUS</td>
<td>44.209</td>
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<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>60.442</td>
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</tbody>
</table>

**High-speed Offtracking, FT**

1.213

### Zero Speed Off-tracking Calculation

**Case 2:**

Zero Speed Off-tracking - 90 Degrees, 35.0 ft. Radius.

**Input Geometry of Combination (in.):**

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<th>E (inches)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>2</td>
<td>73.00</td>
</tr>
<tr>
<td>3</td>
<td>202.00</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-tracking (ft.; deg.):**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX PATH WIDTH</td>
<td>16.838</td>
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<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>49.068</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>60.980</td>
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</tbody>
</table>

1.403
ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 3.
INFLUENTIAL GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR FRONT UNIT (AHEAD OF AXLE/S C.L.) - POSITIVE SIGN.
UNIT WHEELBASE E
1 288.000 -140.589
2 73.000 1.000
3 202.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.) :
REFERENCE :
MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF TRACKING POINT
- MIN. TURNING CENTER
OUTPUT TRAJECTORY
18.105
55.045
61.769
X Y
20.110 27.017
65.083 51.162

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 4.
INFLUENTIAL GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR FRONT UNIT (AHEAD OF AXLE/S C.L.) - POSITIVE SIGN.
UNIT WHEELBASE E
1 240.000 -102.157
2 73.000 1.000
3 130.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.) :
REFERENCE :
MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF TRACKING POINT
- MIN. TURNING CENTER
OUTPUT TRAJECTORY
14.792
46.160
63.913
X Y
16.921 25.873
54.656 44.776
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/UTTI TRAILER, SHORT TONGUE, CASE 5.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE'S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE'S C.L., POSITIVE SIGN).
UNIT: WHLBASE  E
1 240.000  -102.157
2 73.000   1.000
3 154.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):
REFERENCE: OUTPUT TRAJECTORY

MAXIMUM PATH WIDTH  15.404
MIN. INSTANTANEOUS RADIUS  46.746
LAST UNIT HEADING ANGLE  62.457
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT  x 17.036  y 25.919
- MIN. TURNING CENTER  x 55.536  y 45.685

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/UTTI TRAILER, SHORT TONGUE, CASE 6.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE'S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE'S C.L., POSITIVE SIGN).
UNIT: WHLBASE  E
1 240.000  -102.157
2 73.000   1.000
3 154.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):
REFERENCE: OUTPUT TRAJECTORY

MAXIMUM PATH WIDTH  16.090
MIN. INSTANTANEOUS RADIUS  47.837
LAST UNIT HEADING ANGLE  61.685
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT  x 18.349  y 26.036
- MIN. TURNING CENTER  x 56.942  y 46.829
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREE, 35.0 FT. RADIUS.

TRUCK/FRONT TRAILER, SHORT TONGUE, CASE 7.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S.C.L = POSITIVE SIGN).
UNIT WHEELBASE E
1 240.000 -102.157
2 73.000 1.000
3 226.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT ; DEG.):
REFERENCE:

<table>
<thead>
<tr>
<th>MAXIMUM PATH WIDTH</th>
<th>MIN. INSTANTANEOUS RADIUS</th>
<th>LAST UNIT HEADING ANGLE</th>
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OUTPUT TRAJECTORY

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
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<tbody>
<tr>
<td>19.878</td>
<td>26.476</td>
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<tr>
<td>60.523</td>
<td>49.444</td>
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</table>

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FRONT TRAILER, SHORT TONGUE, CASE 8.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S.C.L = POSITIVE SIGN).
UNIT WHEELBASE E
1 240.000 -102.157
2 73.000 1.000
3 226.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT ; DEG.):
REFERENCE:

<table>
<thead>
<tr>
<th>MAXIMUM PATH WIDTH</th>
<th>MIN. INSTANTANEOUS RADIUS</th>
<th>LAST UNIT HEADING ANGLE</th>
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<td></td>
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</table>

OUTPUT TRAJECTORY

<table>
<thead>
<tr>
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<th>Y</th>
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<tbody>
<tr>
<td>21.131</td>
<td>26.885</td>
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<tr>
<td>63.599</td>
<td>51.558</td>
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</table>
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S.C.L. = POSITIVE SIGN).

UNIT WHIPLASE  E
1 192.000  63.726
2 262.274  1.000
3 202.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

REFERENCE:

MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

OUTPUT TRAJECTORY

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.367</td>
<td>56.828</td>
</tr>
</tbody>
</table>


1.443

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S.C.L. = POSITIVE SIGN).

UNIT WHIPLASE  E
1 240.000 -102.157
2 182.843  1.000
3 202.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

REFERENCE:

MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

OUTPUT TRAJECTORY

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.488</td>
<td>26.598</td>
</tr>
</tbody>
</table>

1.586

61.694  51.655
**ZERO SPEED OFF-TRACKING CALCULATION**

**ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.**

**TRUCK/FULL TRAILER, LONG TONGUE, CASE 1.**

**INPUT GEOMETRY OF COMBINATION (IN.):**

- **E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).**

<table>
<thead>
<tr>
<th>UNIT WHEELBASE</th>
<th>( E )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>288.000</td>
</tr>
<tr>
<td>2</td>
<td>96.111</td>
</tr>
<tr>
<td>3</td>
<td>202.000</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE :</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>18.406</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>54.754</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>61.162</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF TRACKING POINT</td>
<td>20.450</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>64.909</td>
</tr>
</tbody>
</table>

**ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.**

**TRUCK/FULL TRAILER, LONG TONGUE, CASE 4.**

**INPUT GEOMETRY OF COMBINATION (IN.):**

- **E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).**

<table>
<thead>
<tr>
<th>UNIT WHEELBASE</th>
<th>( E )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>240.000</td>
</tr>
<tr>
<td>2</td>
<td>254.143</td>
</tr>
<tr>
<td>3</td>
<td>130.000</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE :</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>19.567</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>52.611</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>58.339</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF TRACKING POINT</td>
<td>21.891</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>63.267</td>
</tr>
</tbody>
</table>
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING = 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 5.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT WHITBASE E
1 240.000 -102.157
2 230.843 1.000
3 154.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>19.266</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>51.755</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>58.107</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X 21.653  Y 26.668</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>62.199  51.808</td>
</tr>
</tbody>
</table>

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING = 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 6.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT WHITBASE E
1 240.000 -102.157
2 206.843 1.000
3 178.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>19.106</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>51.280</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>57.955</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X 21.544  Y 26.544</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>61.620  51.627</td>
</tr>
</tbody>
</table>
## ZERO SPEED OFF-TRACKING CALCULATION

**ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.**

**TRUCK/FULL TRAILER, LONG TONGUE, CASE 7.**

**INPUT GEOMETRY OF COMBINATION (IN.):**

$E = \text{DISTANCE FROM REAR AXLE/S C.I. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.I.) = POSITIVE SIGN).}$

**UNIT WHILDBASE $E$:**

<table>
<thead>
<tr>
<th></th>
<th>240.000</th>
<th>158.813</th>
<th>226.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>19.214</td>
</tr>
<tr>
<td>MIN. INSTANTSSENSUS RADIUS</td>
<td>51.801</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>56.243</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>62.218 51.057</td>
</tr>
</tbody>
</table>

---

## ZERO SPEED OFF-TRACKING CALCULATION

**ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.**

**TRUCK/FULL TRAILER, LONG TONGUE, CASE 8.**

**INPUT GEOMETRY OF COMBINATION (IN.):**

$E = \text{DISTANCE FROM REAR AXLE/S C.I. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.I.) = POSITIVE SIGN).}$

**UNIT WHILDBASE $E$:**

<table>
<thead>
<tr>
<th></th>
<th>240.000</th>
<th>122.843</th>
<th>262.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>19.675</td>
</tr>
<tr>
<td>MIN. INSTANTSSENSUS RADIUS</td>
<td>53.371</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>58.730</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>21.899 27.049</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>64.099 52.676</td>
</tr>
</tbody>
</table>
## Zero Speed Off-Tracking Calculation

### Case 1

**Tractor-Semitrailer, Case 1.**

**Input Geometry of Combination (in.):**

- \( E \) = Distance from rear axle/s c.l. to articulation joint for next unit (ahead of axle/s c.l. = positive sign).

**Unit Wheelbase**

<table>
<thead>
<tr>
<th>( E )</th>
<th>144.000</th>
<th>14.953</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>454.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-Tracking (ft.; deg.):**

**Reference:**

<table>
<thead>
<tr>
<th>Maximum Path Width</th>
<th>Min. Instantaneous Radius</th>
<th>Last Unit Heading Angle</th>
<th>Instantaneous Location of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Max. Off-Tracking Point</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Min. Turning Center</td>
</tr>
</tbody>
</table>

**Output Trajectory:**

<table>
<thead>
<tr>
<th></th>
<th>( X )</th>
<th>( Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Path Width</td>
<td>25.101</td>
<td></td>
</tr>
<tr>
<td>Min. Instantaneous Radius</td>
<td>68.237</td>
<td></td>
</tr>
<tr>
<td>Last Unit Heading Angle</td>
<td>60.244</td>
<td></td>
</tr>
<tr>
<td>Instantaneous Location of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Max. Off-Tracking Point</td>
<td>26.425</td>
<td>30.055</td>
</tr>
<tr>
<td>- Min. Turning Center</td>
<td>82.193</td>
<td>61.936</td>
</tr>
</tbody>
</table>

### Case 2

**Tractor-Semitrailer, Case 2.**

**Input Geometry of Combination (in.):**

- \( E \) = Distance from rear axle/s c.l. to articulation joint for next unit (ahead of axle/s c.l. = positive sign).

**Unit Wheelbase**

<table>
<thead>
<tr>
<th>( E )</th>
<th>192.000</th>
<th>19.137</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>454.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-Tracking (ft.; deg.):**

**Reference:**

<table>
<thead>
<tr>
<th>Maximum Path Width</th>
<th>Min. Instantaneous Radius</th>
<th>Last Unit Heading Angle</th>
<th>Instantaneous Location of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Max. Off-Tracking Point</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Min. Turning Center</td>
</tr>
</tbody>
</table>

**Output Trajectory:**

<table>
<thead>
<tr>
<th></th>
<th>( X )</th>
<th>( Y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Path Width</td>
<td>26.034</td>
<td></td>
</tr>
<tr>
<td>Min. Instantaneous Radius</td>
<td>68.603</td>
<td></td>
</tr>
<tr>
<td>Last Unit Heading Angle</td>
<td>59.283</td>
<td></td>
</tr>
<tr>
<td>Instantaneous Location of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Max. Off-Tracking Point</td>
<td>27.300</td>
<td>30.406</td>
</tr>
<tr>
<td>- Min. Turning Center</td>
<td>82.840</td>
<td>63.406</td>
</tr>
</tbody>
</table>
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR/SEMIRAILER, CASE 3.

INPUT GEOMETRY OF COMBINATION (IN.):

1 - DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (BEHIND AXLE/S C.L.) - POSITIVE SIGN.

UNIT WHEELBASE E
1 216.000 21.529
2 454.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

REFERENCE:

MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
  MAX. OFF-TRACKING POINT
  MIN. TURNING CENTER

OUTPUT TRAJECTORY

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.589</td>
<td>69.239</td>
</tr>
<tr>
<td>58.860</td>
<td></td>
</tr>
<tr>
<td>27.791</td>
<td>30.667</td>
</tr>
<tr>
<td>83.630</td>
<td>64.403</td>
</tr>
</tbody>
</table>

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR/SEMIRAILER, CASE 4.

INPUT GEOMETRY OF COMBINATION (IN.):

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (BEHIND AXLE/S C.L.) - POSITIVE SIGN.

UNIT WHEELBASE E
1 240 000 23.921
2 454 000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

REFERENCE:

MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
  MAX. OFF-TRACKING POINT
  MIN. TURNING CENTER

OUTPUT TRAJECTORY

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.196</td>
<td>70.027</td>
</tr>
<tr>
<td>68.443</td>
<td></td>
</tr>
<tr>
<td>28.338</td>
<td>30.936</td>
</tr>
<tr>
<td>84.601</td>
<td>65.491</td>
</tr>
</tbody>
</table>
### Zero Speed Off-Tracking Calculation

#### Case 5

**Tractor-Semitrailer, Case 5.**

**Input Geometry of Combination (in.):**

E = Distance from rear axle/s. c. l. to articulation joint for next unit (head of axle/s. c. l. = positive sign).  

<table>
<thead>
<tr>
<th>Unit</th>
<th>Wheelbase</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>216,000</td>
<td>21.529</td>
</tr>
<tr>
<td>2</td>
<td>166,000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-Tracking (ft.; deg.):**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>15.100</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>42.429</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>60.884</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X 17.628  Y 25.294</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>X 51.201  Y 43.992</td>
</tr>
</tbody>
</table>

#### Case 6

**Tractor-Semitrailer, Case 6.**

**Input Geometry of Combination (in.):**

E = Distance from rear axle/s. c. l. to articulation joint for next unit (head of axle/s. c. l. = positive sign).  

<table>
<thead>
<tr>
<th>Unit</th>
<th>Wheelbase</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>216,000</td>
<td>21.529</td>
</tr>
<tr>
<td>2</td>
<td>230,000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-Tracking (ft.; deg.):**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>17.501</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>47.821</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>59.647</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X 19.915  Y 26.131</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>X 57.729  Y 48.275</td>
</tr>
</tbody>
</table>
ZERO SPEED OFF-TRACKING CALCULATION

**TRACTOR SEMITRAILER, CASE 7.**

**INPUT GEOMETRY OF COMBINATION (IN.):**

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

**UNIT WHEELBASE E**

<table>
<thead>
<tr>
<th></th>
<th>216,000</th>
<th>21.529</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>334,000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE :</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>21.283</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>56.781</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>59.159</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF TRACKING POINT</td>
<td>23.204</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>68.519</td>
</tr>
</tbody>
</table>

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ZERO SPEED OFF-TRACKING CALCULATION

**TRACTOR SEMITRAILER, CASE 8.**

**INPUT GEOMETRY OF COMBINATION (IN.):**

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

**UNIT WHEELBASE E**

<table>
<thead>
<tr>
<th></th>
<th>216,000</th>
<th>21.529</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>574,000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE :</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>32.291</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>82.867</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>58.726</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF TRACKING POINT</td>
<td>32.675</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>100.082</td>
</tr>
</tbody>
</table>

0.249
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

**TURNPIKE DUMBIES, CASE 1.**

`E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).`

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WHL BASE</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144.000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>334.000</td>
<td>-50.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>334.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>26.980</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>65.402</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>55.840</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td>X = 28.369</td>
</tr>
<tr>
<td>MAX. OFF-TRACKING POINT</td>
<td>X = 79.178</td>
</tr>
<tr>
<td>MIN. TURNING CENTER</td>
<td></td>
</tr>
</tbody>
</table>

---

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

**TURNPIKE DUMBIES, CASE 2.**

`E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).`

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WHL BASE</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144.000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>394.000</td>
<td>-50.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>394.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>31.417</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>74.596</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>55.475</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td>X = 32.083</td>
</tr>
<tr>
<td>MAX. OFF-TRACKING POINT</td>
<td>X = 90.245</td>
</tr>
<tr>
<td>MIN. TURNING CENTER</td>
<td></td>
</tr>
</tbody>
</table>
## ZERO SPEED OFF-TRACKING CALCULATION

**TURNPIKE DOUBLES, CASE 3.**

**Input Geometry of Combination (In.):**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Wheelbase</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144,000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>454,000</td>
<td>-50,000</td>
</tr>
<tr>
<td>3</td>
<td>73,000</td>
<td>1,000</td>
</tr>
<tr>
<td>4</td>
<td>454,000</td>
<td>0,0</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-Tracking (ft.; deg.):**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>35.964</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>84.128</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>56.256</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X: 35.821 , Y: 35.508</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>X: 101.647 , Y: 81.197</td>
</tr>
</tbody>
</table>

---

## ZERO SPEED OFF-TRACKING CALCULATION

**TURNPIKE DOUBLES, CASE 4.**

**Input Geometry of Combination (In.):**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Wheelbase</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144,000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>514,000</td>
<td>-50,000</td>
</tr>
<tr>
<td>3</td>
<td>73,000</td>
<td>1,000</td>
</tr>
<tr>
<td>4</td>
<td>514,000</td>
<td>0,0</td>
</tr>
</tbody>
</table>

**Condition of Maximum Off-Tracking (ft.; deg.):**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>40.594</td>
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<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>93.953</td>
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<td>LAST UNIT HEADING ANGLE</td>
<td>55.099</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X: 39.548 , Y: 38.258</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>X: 113.322 , Y: 89.726</td>
</tr>
</tbody>
</table>
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE DOUBLES, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L..+ POSITIVE SIGN).
UNIT WHEELBASE E
1 132.000 21.345
2 190.000 -26.000
3 73.000 1.000
4 190.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):
REFERENCE:
OUTPUT TRAJECTORY
MAXIMUM PATH WIDTH
MINIMUM INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

1.313

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE DOUBLES, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L..+ POSITIVE SIGN).
UNIT WHEELBASE E
1 132.000 21.345
2 226.000 -26.000
3 73.000 1.000
4 226.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):
REFERENCE:
OUTPUT TRAJECTORY
MAXIMUM PATH WIDTH
MINIMUM INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

1.3666
ZERO SPEED OFF-TRACKING CALCULATION

SINGLE AXLE DOUBLES, CASE 3.

INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S.C.L. = POSITIVE SIGN).

UNIT WHEELBASE  E
1  132.000  21.345
2  298.000  -26.000
3  73.000   1.000
4  298.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

REFERENCE:

<table>
<thead>
<tr>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
</tr>
</tbody>
</table>

INSTANTANEOUS LOCATION OF:
- MAX. OFF TRACKING POINT
- MIN. TURNING CENTER

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td></td>
<td></td>
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<tr>
<td>24.016</td>
<td>27.670</td>
<td>65.834</td>
<td>55.553</td>
<td></td>
<td></td>
</tr>
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</table>

ZERO SPEED OFF-TRACKING CALCULATION

SINGLE AXLE DOUBLES, CASE 4.

INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S.C.L. = POSITIVE SIGN).

UNIT WHEELBASE  E
1  132.000  21.345
2  298.000  -26.000
3  73.000   1.000
4  298.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

REFERENCE:

<table>
<thead>
<tr>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
</tr>
</tbody>
</table>

INSTANTANEOUS LOCATION OF:
- MAX. OFF TRACKING POINT
- MIN. TURNING CENTER

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Y</td>
<td>X</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.119</td>
<td>29.036</td>
<td>72.255</td>
<td>60.063</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ZERO SPEED OFF-TRACKING CALCULATION

SINGLE AXLE DOUBLES, CASE 5.

INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT WHEELBASE E
1 132.000  21.345
2 358.000  -26.000
3 73.000    1.000
4 358.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
<td>28.646</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>68.771</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>55.722</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>29.755 31.417</td>
</tr>
<tr>
<td></td>
<td>83.275 67.897</td>
</tr>
</tbody>
</table>
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.):
F = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (HEAD OF AXLE/S.C.L. = POSITIVE SIGN).

UNIT Width Base E
1 132.000 21.345
2 262.000 -26.000
3 73.000 1.000
4 262.000 -26.000
5 73.000 1.000
6 262.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):
REFERENCE : OUTPUT TRAJECTORY

MAXIMUM PAH WIDTH 26.495
MIN. INSTANTANEOUS RADIUS 61.704
LAST UNIT HEADING ANGLE 53.781
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT 28.132 29.984
- MIN. TURNING CENTER 74.686 64.079

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.):
F = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (HEAD OF AXLE/S.C.L. = POSITIVE SIGN).

UNIT Width Base E
1 132.000 21.345
2 358.000 -26.000
3 73.000 1.000
4 358.000 -26.000
5 73.000 1.000
6 358.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):
REFERENCE : OUTPUT TRAJECTORY

MAXIMUM PAH WIDTH 35.371
MIN. INSTANTANEOUS RADIUS 79.459
LAST UNIT HEADING ANGLE 53.334
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT 35.291 35.231
- MIN. TURNING CENTER 95.819 80.292
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 3.

INPUT GEOMETRY OF COMBINATION (IN):
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WHEELBASE</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>132.000</td>
<td>21.345</td>
</tr>
<tr>
<td>2</td>
<td>190.000</td>
<td>-26.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>190.000</td>
<td>-26.000</td>
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<tr>
<td>5</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>6</td>
<td>190.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

CONDITION OF MAXIMUM OFF-TRACKING (FT; DEG):

REFERENCE:
OUTPUTTRAJECTORY

MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
  - MAX. OFF-TRACKING POINT
  - MIN. TURNING CENTER

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
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<tbody>
<tr>
<td>23.082</td>
<td>26.441</td>
</tr>
<tr>
<td>59.918</td>
<td>52.936</td>
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</table>

ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 4.

INPUT GEOMETRY OF COMBINATION (IN):
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WHEELBASE</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>132.000</td>
<td>21.345</td>
</tr>
<tr>
<td>2</td>
<td>226.000</td>
<td>-26.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>226.000</td>
<td>-26.000</td>
</tr>
<tr>
<td>5</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>6</td>
<td>226.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

CONDITION OF MAXIMUM OFF-TRACKING (FT; DEG):

REFERENCE:
OUTPUTTRAJECTORY

MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
  - MAX. OFF-TRACKING POINT
  - MIN. TURNING CENTER

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.534</td>
<td>28.188</td>
</tr>
<tr>
<td>67.166</td>
<td>58.383</td>
</tr>
</tbody>
</table>
>>> ZERO SPEED OFF-TRACKING CALCULATION <<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE QUADRUPLES (CASE 5).
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S.C.L. = POSITIVE SIGN).
UNIT WHEELBASE E
1  132.000  21.345
2  262.000 -26.000
3  73.000  1.000
4  262.000 -26.000
5  73.000  1.000
6  262.000 -26.000
7  73.000  1.000
8  262.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):
REFERENCE:
MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

OUTPUT TRAJECTORY
30.066
68.444
52.238
X  Y
31.562  32.263
82.509  71.727

>>> ZERO SPEED OFF-TRACKING CALCULATION <<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

R-TRAIN, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.):
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S.C.L. = POSITIVE SIGN).
UNIT WHEELBASE E
1  132.000  21.345
2  302.000 -50.000
3  262.000  0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT.; DEG.):
REFERENCE:
MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

OUTPUT TRAJECTORY
22.764
57.681
56.900
X  Y
24.743  28.328
69.687  57.627
ZERO SPEED OFF-TRACKING CALCULATION

ZER0 SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS

B-TRAIL, CASE 2.

INPUT GEOMETRY OF COMBINATION (IN.):

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT WHEELBASE E
1 132 000 21.345
2 338 000 -50.000
3 298 000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):

REFERENCE
MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

OUTPUT TRAJECTORY
25.353
63.118
56.894
X
Y
26.925
28.722
76.254
62.304

B-TRAIL, CASE 3.

INPUT GEOMETRY OF COMBINATION (IN.):

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT WHEELBASE E
1 132 000 21.345
2 338 000 -50.000
3 298 000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):

REFERENCE
MAXIMUM PATH WIDTH
MIN. INSTANTANEOUS RADIUS
LAST UNIT HEADING ANGLE
INSTANTANEOUS LOCATION OF:
- MAX. OFF-TRACKING POINT
- MIN. TURNING CENTER

OUTPUT TRAJECTORY
29.804
72.401
56.099
X
Y
30.660
32.142
87.404
70.336
### ZERO SPEED OFF-TRACKING CALCULATION

**ROCKY MOUNTAIN DOUBLES, CASE 1.**

**INITIAL GEOMETRY OF COMBINATION (IN.):**
- **E** = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L.* POSITIVE SIGN).

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WHEELBASE</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144.000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>334.000</td>
<td>-50.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>180.000</td>
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</tr>
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**CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PAI Width</td>
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<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
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<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>56.858</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X 24.459  Y 28.155</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>68.079  56.632</td>
</tr>
</tbody>
</table>

---

### ZERO SPEED OFF-TRACKING CALCULATION

**ROCKY MOUNTAIN DOUBLES, CASE 2.**

**INITIAL GEOMETRY OF COMBINATION (IN.):**
- **E** = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L.* POSITIVE SIGN).

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WHEELBASE</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144.000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>334.000</td>
<td>-50.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>262.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.):**

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>OUTPUT TRAJECTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PAI Width</td>
<td>24.536</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
<td>60.318</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>56.152</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
<td></td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
<td>X 26.288  Y 29.203</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
<td>73.061  60.572</td>
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</tbody>
</table>
### ZERO SPEED OFF-TRACKING CALCULATION

#### ROCKY MOUNTAIN DOUBLES, CASE 3.

**Input Geometry of Combination (in.):**

- $E = \text{Distance from Rear Axle/S.C.L. to Articulation Joint for Next Unit (Ahead of Axle/S.C.L. = Positive Sign)}$

<table>
<thead>
<tr>
<th>Unit</th>
<th>Wheelbase</th>
<th>$E$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144.000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>394.000</td>
<td>-50.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>190.000</td>
<td>0.0</td>
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</tbody>
</table>

#### Condition of Maximum Off-Tracking (ft. : deg.):

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Path Width</td>
<td>24.925</td>
</tr>
<tr>
<td>Min. Instantaneous Radius</td>
<td>61.490</td>
</tr>
<tr>
<td>Last Unit Heading Angle</td>
<td>56.070</td>
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<tr>
<td>Instantaneous Location of:</td>
<td></td>
</tr>
<tr>
<td>- Max. Off Tracking Point</td>
<td>$X$</td>
</tr>
<tr>
<td>- Min. Turning Center</td>
<td>26.536</td>
</tr>
<tr>
<td></td>
<td>74.734</td>
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### ZERO SPEED OFF-TRACKING CALCULATION

#### ROCKY MOUNTAIN DOUBLES, CASE 4.

**Input Geometry of Combination (in.):**

- $E = \text{Distance from Rear Axle/S.C.L. to Articulation Joint for Next Unit (Ahead of Axle/S.C.L. = Positive Sign)}$

<table>
<thead>
<tr>
<th>Unit</th>
<th>Wheelbase</th>
<th>$E$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>144.000</td>
<td>14.353</td>
</tr>
<tr>
<td>2</td>
<td>394.000</td>
<td>-50.000</td>
</tr>
<tr>
<td>3</td>
<td>73.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>262.000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### Condition of Maximum Off-Tracking (ft. : deg.):

<table>
<thead>
<tr>
<th>Reference</th>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Path Width</td>
<td>26.919</td>
</tr>
<tr>
<td>Min. Instantaneous Radius</td>
<td>65.391</td>
</tr>
<tr>
<td>Last Unit Heading Angle</td>
<td>56.146</td>
</tr>
<tr>
<td>Instantaneous Location of:</td>
<td></td>
</tr>
<tr>
<td>- Max. Off Tracking Point</td>
<td>$X$</td>
</tr>
<tr>
<td>- Min. Turning Center</td>
<td>28.261</td>
</tr>
<tr>
<td></td>
<td>79.244</td>
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<tr>
<td>ZER SPOFTRACK</td>
<td>ZER SPOFTRACK</td>
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<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>REFERENCE:</td>
<td>REFERENCE:</td>
</tr>
<tr>
<td>MAXIMUM PULL-WAY RAD.</td>
<td>MAXIMUM PULL-WAY RAD.</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
<td>LAST UNIT HEADING ANGLE</td>
</tr>
<tr>
<td>INST. DEG.</td>
<td>INST. DEG.</td>
</tr>
<tr>
<td>1</td>
<td>141,000</td>
</tr>
<tr>
<td>2</td>
<td>27,000</td>
</tr>
<tr>
<td>3</td>
<td>45,000</td>
</tr>
<tr>
<td>4</td>
<td>194,000</td>
</tr>
<tr>
<td>OUTPUT TRAJECTORY</td>
<td>OUTPUT TRAJECTORY</td>
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<tr>
<td>6.73</td>
<td>6.73</td>
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<tr>
<td>29.36</td>
<td>29.36</td>
</tr>
<tr>
<td>66.00</td>
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<tr>
<td>85.69</td>
<td>85.69</td>
</tr>
<tr>
<td>69.07</td>
<td>69.07</td>
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</tbody>
</table>

90
ZERO SPEED OFF-TRACKING CALCULATION

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 7.

INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S.C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (BEHIND AXLE/S.C.L. - POSITIVE SIGN).

UNIT WHEELBASE E
1 114.000 14.353
2 262.000 -26.000
3 73.000 1.000
4 454.000 0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :

<table>
<thead>
<tr>
<th>Output Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM PATH WIDTH</td>
</tr>
<tr>
<td>MIN. INSTANTANEOUS RADIUS</td>
</tr>
<tr>
<td>LAST UNIT HEADING ANGLE</td>
</tr>
<tr>
<td>INSTANTANEOUS LOCATION OF:</td>
</tr>
<tr>
<td>- MAX. OFF-TRACKING POINT</td>
</tr>
<tr>
<td>- MIN. TURNING CENTER</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.418</td>
<td>31.678</td>
</tr>
<tr>
<td>85.977</td>
<td>68.815</td>
</tr>
</tbody>
</table>
Rearward Amplification - Gross Weight Variation

Maneuver: Continuous steering sinusoid (simplified, linear amplification model)

Speed: 55 mph (88 km/h)

Vehicles: Identified on data sheets by vehicle letter (B,C) and case number (1,2,3, etc.)

(For each case, the maximum numerical values of rearward amplification are first listed as evaluated within the range of steering input frequency from 0 to 3.15 radians/sec (.5 Hz). The term, GM, is used to depict this maximum amplification "gain" exhibited by the overall vehicle combination. Additional "gain components" are also listed, representing the contribution to the total amplification gain attributed to each portion of the vehicle combination (such as that portion of the semitrailer existing between the tractor c.g. and the semitrailer c.g.). Following the numerical data, plots are presented showing the spectrum of rearward amplification levels for each vehicle configuration over a broad range of steering input frequencies.)
VEHICLE IDENTIFICATION: B1-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.99 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., G1 = 1.148
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, G2 = 1.302
1ST. FULL TRAILER, PINTLE EYE TO CG., G3 = 1.256

VEHICLE IDENTIFICATION: B2-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.06 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., G1 = 1.148
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, G2 = 1.407
1ST. FULL TRAILER, PINTLE EYE TO CG., G3 = 1.277

VEHICLE IDENTIFICATION: B3-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.96 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., G1 = 1.148
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, G2 = 1.362
1ST. FULL TRAILER, PINTLE EYE TO CG., G3 = 1.256
MAX. AMPLIFICATION GAIN FOR \( W \leq 3.15 \) RAD/SEC:
\[
G_M = 2.09 \text{ AT } W = 3.15 \text{ RAD/SEC}
\]

AMPLIFICATION GAIN COMPONENTS AT \( W = 3.15 \) RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = 1.148 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.424 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.282 \)

MAX. AMPLIFICATION GAIN FOR \( W \leq 3.15 \) RAD/SEC:
\[
G_M = 2.02 \text{ AT } W = 3.15 \text{ RAD/SEC}
\]

AMPLIFICATION GAIN COMPONENTS AT \( W = 3.15 \) RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = 1.148 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.394 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.266 \)
GROSS WEIGHT VARIATION

AMPLIFICATION GAIN

FREQ. RAD/SEC

CASE | GVW
-----|-----
B4   | 92K
B2   | 88K
B5   | 84K
B1   | 80K
B3   | 73.3K
VEHICLE IDENTIFICATION: C1-GW

MAX. AMPLIFICATION GAIN FOR $w=3.15 \text{ rad/sec}$:

$$G_M = 1.95 \text{ at } w = 3.15 \text{ rad/sec}$$

AMPLIFICATION GAIN COMPONENTS AT $w = 3.15 \text{ rad/sec}$

STRAIGHT TRUCK, CG. TO PINTLE HOOK, $G_2 = 1.558$

1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 1.251$

VEHICLE IDENTIFICATION: C2-GW

MAX. AMPLIFICATION GAIN FOR $w=3.15 \text{ rad/sec}$:

$$G_M = 2.01 \text{ at } w = 3.15 \text{ rad/sec}$$

AMPLIFICATION GAIN COMPONENTS AT $w = 3.15 \text{ rad/sec}$

STRAIGHT TRUCK, CG. TO PINTLE HOOK, $G_2 = 1.558$

1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 1.293$

VEHICLE IDENTIFICATION: C3-GW

MAX. AMPLIFICATION GAIN FOR $w=3.15 \text{ rad/sec}$:

$$G_M = 1.96 \text{ at } w = 3.15 \text{ rad/sec}$$

AMPLIFICATION GAIN COMPONENTS AT $w = 3.15 \text{ rad/sec}$

STRAIGHT TRUCK, CG. TO PINTLE HOOK, $G_2 = 1.532$

1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 1.282$
Rearward Amplification - Length Variations

Maneuver: Continuous steering sinusoid (using simplified, linear amplification model)

Speed: 55 mph (88 km/h)

Vehicles: All multiply-articulated vehicles except for B-train (vehicles identified by vehicle letter (B,D,E, etc.) and case number (1,2,3, etc.). Note that truck/full trailers are represented in two sets, namely, the set (B1-LEN through B7-LEN) having a fixed drawbar length of 6.1 feet (1.86 m) and the set (B1-LEN-65 through B7-LEN-65) having variable drawbar length and fixed overall length of 65 feet (19.8 m).

<table>
<thead>
<tr>
<th>Vehicle / Case</th>
<th>Length, ft</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>L5</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Truck/Full Trailer</td>
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<td>6</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>20</td>
<td>22</td>
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<tr>
<td></td>
<td>3</td>
<td>24</td>
<td>22</td>
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<td>7</td>
<td>24</td>
<td>20</td>
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<tr>
<td>C. Rocky Mt. Doubles</td>
<td>1</td>
<td>12</td>
<td>35</td>
<td>21</td>
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</tr>
<tr>
<td></td>
<td>2</td>
<td>12</td>
<td>35</td>
<td>21</td>
<td></td>
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<tr>
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<td>3</td>
<td>12</td>
<td>40</td>
<td>27</td>
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<td>40</td>
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<td>D. Technik Doubles</td>
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<td>35</td>
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<td>12</td>
<td>50</td>
<td>50</td>
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</tr>
<tr>
<td>E. Single Axis Doubles</td>
<td>1</td>
<td>11</td>
<td>21</td>
<td>21</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>11</td>
<td>24</td>
<td>24</td>
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<td>F. Single Axis Triples</td>
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<td>11</td>
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<td>27</td>
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<td>11</td>
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<tr>
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<td>11</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
</tbody>
</table>
**Truck/Full Trailer**

**Vehicle Identification:** B1-LEN

**Max. Amplification Gain for \( \omega \leq 3.15 \text{ rad/} \text{sec} \):**

\[ G_m = 1.77 \text{ at } \omega = 3.15 \text{ rad/sec} \]

**Amplification Gain Components at \( \omega = 3.15 \text{ rad/sec} \):**

- Straight truck, CG to Pintle hook: \( G_2 = 1.366 \)
- 1st. full trailer, pintle eye to CG.: \( G_3 = 1.501 \)

**Vehicle Identification:** B2-LEN

**Max. Amplification Gain for \( \omega \leq 3.15 \text{ rad/} \text{sec} \):**

\[ G_m = 2.04 \text{ at } \omega = 3.15 \text{ rad/sec} \]

**Amplification Gain Components at \( \omega = 3.15 \text{ rad/sec} \):**

- Straight truck, CG to Pintle hook: \( G_2 = 1.569 \)
- 1st. full trailer, pintle eye to CG.: \( G_3 = 1.301 \)

**Vehicle Identification:** B3-LEN

**Max. Amplification Gain for \( \omega \leq 3.15 \text{ rad/} \text{sec} \):**

\[ G_m = 2.33 \text{ at } \omega = 3.15 \text{ rad/sec} \]

**Amplification Gain Components at \( \omega = 3.15 \text{ rad/sec} \):**

- Straight truck, CG to Pintle hook: \( G_2 = 1.794 \)
- 1st. full trailer, pintle eye to CG.: \( G_3 = 1.301 \)
VEHICLE IDENTIFICATION: B4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.05 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.31

VEHICLE IDENTIFICATION: B5-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.06 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.313
VEHICLE IDENTIFICATION: B6-LEN

MAX. AMPLIFICATION GAIN FOR \( \omega \leq 3.15 \) RAD/SEC:

\[ G_M = 2.05 \text{ at } \omega = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT \( \omega = 3.15 \) RAD/SEC

Straight Truck, CG to Pintle Hook, \( G_2 = 1.569 \)

1st Full Trailer, Pintle Eye to CG, \( G_3 = 1.31 \)

---

VEHICLE IDENTIFICATION: B7-LEN

MAX. AMPLIFICATION GAIN FOR \( \omega \leq 3.15 \) RAD/SEC:

\[ G_M = 2.02 \text{ at } \omega = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT \( \omega = 3.15 \) RAD/SEC

Straight Truck, CG to Pintle Hook, \( G_2 = 1.569 \)

1st Full Trailer, Pintle Eye to CG, \( G_3 = 1.287 \)
VEHICLE IDENTIFICATION: B1-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM = 1.21 AT W = 2.45 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W = 2.45 RAD/SEC

STRAIGHT TRUCK, CG. TO PINTLE HOOK,

G2 = 1.213

1ST. FULL TRAILER, PINTLE EYE TO CG.,

G3 = 0.999

VEHICLE IDENTIFICATION: B2-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM = 1.68 AT W = 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

STRAIGHT TRUCK, CG. TO PINTLE HOOK,

G2 = 1.569

1ST. FULL TRAILER, PINTLE EYE TO CG.,

G3 = 1.072

VEHICLE IDENTIFICATION: B3-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM = 2.3 AT W = 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

STRAIGHT TRUCK, CG. TO PINTLE HOOK,

G2 = 1.794

1ST. FULL TRAILER, PINTLE EYE TO CG.,

G3 = 1.282
VEHICLE IDENTIFICATION: B4-LEN-65

MAX. AMPLIFICATION GAIN FOR $\omega = 3.15$ RAD/SEC:

$$GM = 1.52 \text{ at } \omega = 3.15 \text{ RAD/SEC}$$

AMPLIFICATION GAIN COMPONENTS AT $\omega = 3.15$ RAD/SEC

STRAIGHT TRUCK, CG TO PINTLE HOOK, $G_2 = 1.569$

1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 0.971$


VEHICLE IDENTIFICATION: B5-LEN-65

MAX. AMPLIFICATION GAIN FOR $\omega = 3.15$ RAD/SEC:

$$GM = 1.57 \text{ at } \omega = 3.15 \text{ RAD/SEC}$$

AMPLIFICATION GAIN COMPONENTS AT $\omega = 3.15$ RAD/SEC

STRAIGHT TRUCK, CG TO PINTLE HOOK, $G_2 = 1.569$

1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 1.004$
VEHICLE IDENTIFICATION: E6-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ G_M = 1.62 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, \( G_2 = 1.569 \)
1ST.FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.037 \)

VEHICLE IDENTIFICATION: B7-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ G_M = 1.73 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, \( G_2 = 1.569 \)
1ST.FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.106 \)
MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM = 1.28 AT W = 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., G1 = 0.96
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, G2 = 1.509
1ST. FULL TRAILER, PINTLE EYE TO CG., G3 = 1.301

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM = 1.31 AT W = 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., G1 = 0.96
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, G2 = 1.509
1ST. FULL TRAILER, PINTLE EYE TO CG., G3 = 1.251

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM = 1.68 AT W = 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., G1 = 0.858
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, G2 = 1.508
1ST. FULL TRAILER, PINTLE EYE TO CG., G3 = 1.301
VEHICLE IDENTIFICATION: D4-LEN

MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:

\[ G_M = 1.61 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT \( W = 3.15 \text{ RAD/SEC} \)

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = .858 \)
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.508 \)
1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.251 \)

---

VEHICLE IDENTIFICATION: D5-LEN

MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:

\[ G_M = 1.47 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT \( W = 3.15 \text{ RAD/SEC} \)

SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = .756 \)
SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.495 \)
1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.301 \)

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VEHICLE IDENTIFICATION: D6-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ G_M = 1.41 \text{ at } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = 0.756 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.495 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.251 \)

VEHICLE IDENTIFICATION: D7-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ G_M = 1.62 \text{ at } W = 3.05 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.05 RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = 1.152 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.355 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.04 \)
**TURNPIKE DOUBLES**

**VEHICLE IDENTIFICATION: E1-LEN**

**MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:**

\[ G_M = 1.67 \text{ at } W = 3.15 \text{ RAD/SEC} \]

**AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC**

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = 0.96 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.5 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.164 \)

**VEHICLE IDENTIFICATION: E2-LEN**

**MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:**

\[ G_M = 1.41 \text{ at } W = 2.9 \text{ RAD/SEC} \]

**AMPLIFICATION GAIN COMPONENTS AT W= 2.9 RAD/SEC**

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( G_1 = 0.891 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( G_2 = 1.426 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.114 \)
VEHICLE IDENTIFICATION: E3-LEN

MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:

GM= 1.22 AT W= 2.45 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 2.45 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1 = .86
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2 = 1.306
1ST.FULL TRAILER, PINTLE EYE TO CG., G3 = 1.087

VEHICLE IDENTIFICATION: E4-LEN

MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:

GM= 1.11 AT W= 1.95 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 1.95 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1 = .878
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2 = 1.195
1ST.FULL TRAILER, PINTLE EYE TO CG., G3 = 1.062

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SINGLE AXLE DOUBLES

VEHICLE IDENTIFICATION: F1-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ GM = 2.24 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \[ G_1 = 1.287 \]
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \[ G_2 = 1.332 \]
- 1ST FULL TRAILER, PINTLE EYE TO CG., \[ G_3 = 1.306 \]

VEHICLE IDENTIFICATION: F2-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ GM = 2.14 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \[ G_1 = 1.222 \]
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \[ G_2 = 1.359 \]
- 1ST FULL TRAILER, PINTLE EYE TO CG., \[ G_3 = 1.287 \]

VEHICLE IDENTIFICATION: F3-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ GM = 1.99 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \[ G_1 = 1.148 \]
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \[ G_2 = 1.382 \]
- 1ST FULL TRAILER, PINTLE EYE TO CG., \[ G_3 = 1.256 \]
VEHICLE IDENTIFICATION: F4-LEN

MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:

\[ GM = 1.84 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W = 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., \( G_1 = 1.08 \)
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, \( G_2 = 1.4 \)
1ST.FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.217 \)

---

VEHICLE IDENTIFICATION: F5-LEN

MAX. AMPLIFICATION GAIN FOR W<3.15 RAD/SEC:

\[ GM = 1.55 \text{ AT } W = 3.05 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W = 3.05 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., \( G_1 = 0.971 \)
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, \( G_2 = 1.392 \)
1ST.FULL TRAILER, PINTLE EYE TO CG., \( G_3 = 1.15 \)
MAX. AMPLIFICATION GAIN FOR $\omega \leq 3.15$ RAD/SEC:

$GM = 3.51$ AT $\omega = 3.15$ RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT $\omega = 3.15$ RAD/SEC

- SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., $G_1 = 1.140$
- SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, $G_2 = 1.382$
- 1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 1.256$
- 1ST. FULL TRAILER, CG.TO PINTLE HOOK, $G_4 = 1.402$
- 2ND. FULL TRAILER, PINTLE EYE TO CG., $G_5 = 1.256$

MAX. AMPLIFICATION GAIN FOR $\omega \leq 3.15$ RAD/SEC:

$GM = 2.52$ AT $\omega = 3.15$ RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT $\omega = 3.15$ RAD/SEC

- SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., $G_1 = 0.96$
- SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, $G_2 = 1.417$
- 1ST. FULL TRAILER, PINTLE EYE TO CG., $G_3 = 1.139$
- 1ST. FULL TRAILER, CG.TO PINTLE HOOK, $G_4 = 1.426$
- 2ND. FULL TRAILER, PINTLE EYE TO CG., $G_5 = 1.139$
VEHICLE IDENTIFICATION: G3-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ G_M = 3.96 \text{ at } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

1. SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \[ G_1 = 1.287 \]
2. SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \[ G_2 = 1.332 \]
3. 1ST. FULL TRAILER, PINTLE EYE TO CG., \[ G_3 = 1.306 \]
4. 1ST. FULL TRAILER, CG. TO PINTLE HOOK, \[ G_4 = 1.354 \]
5. 2ND. FULL TRAILER, PINTLE EYE TO CG., \[ G_5 = 1.306 \]

VEHICLE IDENTIFICATION: G4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

\[ G_M = 3.8 \text{ at } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

1. SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \[ G_1 = 1.222 \]
2. SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \[ G_2 = 1.359 \]
3. 1ST. FULL TRAILER, PINTLE EYE TO CG., \[ G_3 = 1.287 \]
4. 1ST. FULL TRAILER, CG. TO PINTLE HOOK, \[ G_4 = 1.381 \]
5. 2ND. FULL TRAILER, PINTLE EYE TO CG., \[ G_5 = 1.297 \]
VEHICLE IDENTIFICATION: GS-LEN

MAX. AMPLIFICATION GAIN FOR \( W \leq 3.15 \) RAD/SEC:

\[ G_M = 6.19 \text{ AT } W = 3.15 \text{ RAD/SEC} \]

AMPLIFICATION GAIN COMPONENTS AT \( W = 3.15 \) RAD/SEC

- SEMI-TRAILER, TRACTOR CG. TO TRAILER CG., \( g_1 = 1.148 \)
- SEMI-TRAILER, TRAILER CG. TO TRAILER PINTLE HOOK, \( g_2 = 1.382 \)
- 1ST. FULL TRAILER, PINTLE EYE TO CG., \( g_3 = 1.256 \)
- 1ST. FULL TRAILER, CG. TO PINTLE HOOK, \( g_4 = 1.402 \)
- 2ND. FULL TRAILER, PINTLE EYE TO CG., \( g_5 = 1.256 \)
- 2ND. FULL TRAILER, CG. TO PINTLE HOOK, \( g_6 = 1.402 \)
- 3RD. FULL TRAILER, PINTLE EYE TO CG., \( g_7 = 1.256 \)
Rearward Amplification - Length Variation, B-Trains

Maneuver: Continuous steering sinusoid (using linear yaw plane model)

Speed: 55 mph (88 km/h)

Vehicle: B-train doubles - curves identified by trailer lengths as listed below

<table>
<thead>
<tr>
<th>CASE</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
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<tbody>
<tr>
<td>H. B-Train</td>
<td>27</td>
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<td>27</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>30</td>
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</tr>
<tr>
<td>3</td>
<td>35</td>
<td>35</td>
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LENGTH VARIATIONS - B-TRAiNS

27 FT TRAILERS - BASELINE
30 FT TRAILERS
35 FT TRAILERS
Rollover threshold values for cases involving variation in width and loading parameters. See Volume I for identification of load distributions.

<table>
<thead>
<tr>
<th>Cases</th>
<th>W_a</th>
<th>W_s</th>
<th>W_l</th>
<th>Gross Wt Veh. B (t/ct)</th>
<th>Gross Wt Vehicle A</th>
<th>Width</th>
<th>Tractor (or Truck Steering Axle)</th>
<th>Rollover Threshold, G's</th>
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<tbody>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>VEHICLE B</td>
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<td>MDD PRELOAD DENS. LOAD DENS. FREIGHT</td>
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<td>102</td>
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<td>0.451</td>
</tr>
</tbody>
</table>

A. [Diagram A]

B. [Diagram B]

C. [Diagram C]
Rollover threshold values obtained for cases involving axle load variation:

<table>
<thead>
<tr>
<th>Vehicles / Case</th>
<th>Axle Number</th>
<th>Axle Loads/1000 lb</th>
<th>G's</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>A</td>
<td>(Baseline)</td>
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</tr>
<tr>
<td>1</td>
<td>12</td>
<td>20</td>
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<td>22</td>
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<td>3</td>
<td>12</td>
<td>18</td>
<td>.332</td>
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<tr>
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<td>24</td>
<td>.264</td>
</tr>
<tr>
<td>B</td>
<td>(Baseline)</td>
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<tr>
<td>C</td>
<td>(Baseline)</td>
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<td>D</td>
<td>(Baseline)</td>
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Rollover threshold values for cases involving gross weight variations: (Results for the doubles combination show values for both the front unit—the tractor-semi-trailer—and the rear unit—the full trailer)

<table>
<thead>
<tr>
<th>Case</th>
<th>Axle No.</th>
<th>Axle Loads/1000 lb</th>
<th>GVW</th>
<th>4's</th>
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<td>(1)</td>
<td>(Baseline)</td>
<td>12 17 17 17 17 (80)</td>
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<td>12 19 19 19 19 (80)</td>
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<td>9.3 16 16 16 16 (73.3)</td>
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<td>10 17.5 17.5 17.5 17.5 (80)</td>
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<td>10 20 20 19 19 (80)</td>
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<td>12 20 20 20 20 (92)</td>
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<td>12 20 20 20 20 (92)</td>
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<td>.331</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>10 10.5 10.5 10.5 10.5 (94)</td>
<td>.356</td>
<td>.356</td>
</tr>
</tbody>
</table>
### Rollover threshold values for cases involving variations in payload c.g. height and gross vehicle weight.

Axle load distributions for these cases are tabulated below.

<table>
<thead>
<tr>
<th>Gross Vehicle Wgt. (lbs)</th>
<th>80,000</th>
<th>88,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload C.G. Hgt. (in)</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>.435</td>
<td>.369</td>
<td>.309</td>
</tr>
<tr>
<td>.350</td>
<td>.292</td>
<td>.231</td>
</tr>
<tr>
<td>.457</td>
<td>.394</td>
<td>.343</td>
</tr>
<tr>
<td>.379</td>
<td>.326</td>
<td>.280</td>
</tr>
<tr>
<td>.463</td>
<td>.399</td>
<td>.347</td>
</tr>
<tr>
<td>.384</td>
<td>.330</td>
<td>.285</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Axle Loads/1000 lb</th>
<th>Axle No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>GVW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tractor-Semitrailer</strong></td>
<td></td>
<td>12</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>(80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>(88)</td>
</tr>
<tr>
<td><strong>Double</strong></td>
<td></td>
<td>10</td>
<td>17.5</td>
<td>17.5</td>
<td>17.5</td>
<td>17.5</td>
<td>(80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>19.5</td>
<td>19.5</td>
<td>19.5</td>
<td>19.5</td>
<td>(88)</td>
</tr>
</tbody>
</table>
Results from Full-Scale Tests
- **Configuration:** 3 Axle Straight Truck ("ST-2").

- **Power Unit:** Wheelbase: 209 in.
  
  Axle-group Rated Capacities: 
  
  front - 12,000 lb; rear - 38,000 lb.

- **Trailer(s):** None.

- **Test Conditions and Codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Payload</th>
<th>Axle Loads/1000 lb</th>
<th>GCW 1000 lbs.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST2-C1</td>
<td>70.5</td>
<td>12 34</td>
<td>46</td>
<td>baseline</td>
</tr>
<tr>
<td>ST2-C2</td>
<td>79.0</td>
<td>12 38</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>ST2-C3</td>
<td>93.0</td>
<td>12 34</td>
<td>50</td>
<td>high C.G.</td>
</tr>
<tr>
<td>ST2-C4</td>
<td>70.5</td>
<td>12 34</td>
<td>50</td>
<td>radials fr., bias rear</td>
</tr>
</tbody>
</table>

- **Test Procedure Plots**

- **Test Conditions:**

  1. **Straight Line Braking**

  C1 & C2-dry & wet, C3-wet only.

  2. **Braking in a turn**

  C1 & C2-dry & wet, C3-wet only.

  3. **Trapezoidal Steer**

  all

  4. **Sinusoidal Steer**

  none
LONGITUDINAL ACCELERATION [G'S]

BRAKE COMMAND PRESSURE (PSI)

STRAIGHT TRUCK
STRAIGHT LINE BRAKING - DRY
LONGITUDINAL ACCELERATION (G'S)

BRAKE COMMAND PRESSURE (PSI)

STRAIGHT TRUCK
STRAIGHT LINE BRAKING - WET
BRAKE COMMAND PRESSURE (PSI)

STRAIGHT TRUCK

BRAKING IN A TURN - DRY
STRAIGHT TRUCK

BRAKING IN A TURN - DRY

LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

+-ST2-C1
*-ST2-C2
BRAKE COMMAND PRESSURE (PSI)

LONGITUDINAL ACCELERATION (G's)

STRAIGHT TRUCK

BRAKING IN A TURN - WET

+=ST2-C1
*=ST2-C2
X=ST2-C3
STRAIGHT TRUCK
BRAKING IN A TURN - WET
TRAPEZOIDAL STEER

STRAIGHT TRUCK
TRAPEZOIDAL STEER

STRAIGHT TRUCK
LATERAL ACCELERATION

CG'SI

STRAIGHT TRUCK
TRAPEZOIDAL STEER

138
Configuration: 3 Axle Tractor-Semitrailer ("TI-TR1").

- Power Unit: Wheelbase: 135 in.
Axle-group Rated Capacities: front-12,000 lb; rear-23,000 lb.

- Trailer(s): No. of axles in group Length (ft)
#1: 1 27

- Test Conditions and Codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>CG Height(in.)</th>
<th>Axle Loads/1000 lb.</th>
<th>GCW 1000 lb.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI-TR1-C1</td>
<td>72</td>
<td>11 20 20</td>
<td>52</td>
<td>baseline</td>
</tr>
<tr>
<td>TI-TR1-C2</td>
<td>80</td>
<td>11 22 22</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>TI-TR1-C3</td>
<td>80</td>
<td>11 22 22</td>
<td>56</td>
<td>radials fr., bias rear</td>
</tr>
</tbody>
</table>

- Test Procedure Plots

- Test Conditions:

1. Straight Line Braking C1 & C2
2. Braking in a Turn C1 & C2
3. Trapezoidal Steer all
4. Sinusoidal Steer C1 only
BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 27 FT TRAILER
STRAIGHT LINE BRAKING
DRY SURFACE
BRAKE COMMAND PRESSURE
CPSII
TWO AXLE TRACTOR - 27 FT TRAILER
STRAIGHT LINE BRAKING
WET SURFACE
BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 27 FT TRAILER
BRAKING IN A TURN
DRY SURFACE
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

TWO AXLE TRACTOR- 27 FT TRAILER
BRAKING IN A TURN
DRY SURFACE

+- T1-TR1-C1
*- T1-TR1-C2
BRAKE COMMAND PRESSURE (PSI)

LONGITUDINAL ACCELERATION (G'S)

TWO AXLE TRACTOR - 27 FT TRAILER
BRAKING IN A TURN
WET SURFACE
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

TWO AXLE TRAILER- 27 FT TRAILER
BRAKING IN A TURN
WET SURFACE
STEERING WHEEL ANGLE (DEG) vs. LATERAL ACCELERATION (G's)

TWO AXLE TRACTOR - 27 FT VAN TRAILER

Symbols:
- T1-TR1-C1
- T1-TR1-C2
X T1-TR1-C3

Dimensions:
-200 - 200
-100 - 100
0 - 0
-0.1 - 0.1
-0.2 - 0.2
-0.3 - 0.3
-0.4 - 0.4
-0.5 - 0.5
-0.6 - 0.6
TWO AXLE TRACTOR - 27 FT VAN TRAILER

LATERAL ACCELERATION (G'S)

ABS(R*L/V) - ABS(DSW/NG) [DEG]

-2.5 -2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5

+- T1-TR1-C1
*- T1-TR1-C2
X- T1-TR1-C3
LATERAL ACCELERATION (G'S)

TWO AXLE TRACTOR- 27 FT VAN TRAILER

+- T1-TR1-C1
*- T1-TR1-C2
X- T1-TR1-C3
STEERING INPUT AMPLITUDE (DEG)

TRACTOR LATERAL ACCELERATION PEAK (G'S)

TWO AXLE TRACTOR - 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

+- T1-TR1-C1
TWO AXLE TRACTOR - 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

YAW RATE TIME LAG (S)

TRACTOR PEAK LATERAL ACCELERATION (G'S)

TWO AXLE TRACTOR - 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

+- T1-TR1-C1
REARWARDAMPLIFICATION (AYN/AY1)

---

PEAKTRACTOR LATERALACCELERATION (G'S)

TWO AXLETRACTOR- 27 FT TRAILER
SINUSOIDALSTEER
TWO SEC PERIOD

+- T1-TR1-C1
- Configuration: 5 Axle Tractor-Semitrailer ("T3-TR6").

- Power Unit: Wheelbase: 142 in. Axle-group Rated Capacities: front-12,000 lb; rear-34,000 lb.

- Trailer(s): No. of axles in group | length (ft.)
  #1: 2 | 45

- Test Conditions and Codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Payload CG Height(in.)</th>
<th>Axle Loads/1000 lbs.</th>
<th>GCW 1000 lb.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3-TR6-C1</td>
<td>70</td>
<td>12 34 34 80</td>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>T3-TR6-C2</td>
<td>78.5</td>
<td>12 38 38 88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3-TR6-C3</td>
<td>70</td>
<td>10 35 35 80</td>
<td></td>
<td>Radials fr, Bias rear</td>
</tr>
<tr>
<td>T3-TR6-C4</td>
<td>70</td>
<td>10 35 35 80</td>
<td></td>
<td>Empty</td>
</tr>
<tr>
<td>T3-TR5-Empty</td>
<td>-</td>
<td>- 35 35 80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Test Procedure Plots

1. Straight Line Braking | C1, C2 & Empty
2. Braking in a Turn    | C1, C2 & Empty
3. Trapezoidal Steer    | All
4. Sinusoidal Steer     | C1 only
BRAKE COMMAND PRESSURE (PSI)

THREE AXLE TRACTOR - 45 FT TRAILER

STRAIGHT LINE BRAKING

DRY SURFACE
THREE AXLE TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING
WET SURFACE
BRAKE COMMAND PRESSURE

THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
DRY SURFACE
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

TWO AXLE TRACTOR- 45 FT TRAILER BRAKING IN A TURN DRY SURFACE
BRAKE COMMAND PRESSURE (PSI)

THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
WET SURFACE

LONGITUDINAL ACCELERATION (G'S)

+- T3-TR6-C1
*= T3-TR6-C2
O- T3-TR5-EMPTY
LONGITUDINAL ACCELERATION (G'S)

<table>
<thead>
<tr>
<th>PEAK YAW RATE (DEG/S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.0</td>
</tr>
<tr>
<td>12.0</td>
</tr>
<tr>
<td>9.0</td>
</tr>
<tr>
<td>6.0</td>
</tr>
<tr>
<td>3.0</td>
</tr>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>-3.0</td>
</tr>
<tr>
<td>-6.0</td>
</tr>
<tr>
<td>-9.0</td>
</tr>
<tr>
<td>-12.0</td>
</tr>
<tr>
<td>-15.0</td>
</tr>
</tbody>
</table>

THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
WET SURFACE

+-- T3-TR6-C1
*-- T3-TR6-C2
O-- T3-TR5-EMPTY
THREE AXLE TRACTOR- 45 FT TRAILER
TRAPEZOIDAL STEER

+-- T3-TR6-C1
*-- T3-TR6-C2
X-- T3-TR6-C3
***-- T3-TR6-C4
O-- T3-TR5-EMPTY
LATERAL ACCELERATION (G'S)

THREE AXLE TRACTOR-45 FT TRAILER
TRAPEZOIDAL STEER

+ - T3-TR6-C1
* - T3-TR6-C2
X - T3-TR6-C3
B - T3-TR6-C4
O - T3-TR5-EMPTY
THREE AXLE TRACTOR - 45 FT TRAILER
STEERING RATIO = 50
STEERING INPUT AMPLITUDE (DEG)

TRACTOR PEAK LATERAL ACCELERATION (G'S)

THREE AXLE TRACTOR- 45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

+- T3-TR6-C1
TRACTOR PEAK LATERAL ACCELERATION (G'S)

THREE AXLE TRACTOR- 45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD
REARWARD AMPLIFICATION \( (\text{AYN}/\text{AY}) \)

\[
\begin{array}{cccc}
2.5 & 2.0 & 1.5 & 1.0
\end{array}
\]

PEAK TRACTOR LATERAL ACCELERATION \( (\text{G'S}) \)

THREE AXLE TRACTOR- 45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

\[+ - \text{T3-TR6-C1}\]
- **Configuration:** 5 Axle Tractor-Semitrailer ("T7-TR6").

- **Power Unit:**
  - Wheelbase: 145 in.
  - Axle-group Rated Capacities:
    - front - 12,000 lb; rear - 38,000 lb.

- **Trailer(s):**
  - No. of Axles in group | length (ft).
  - 1 | 2 | 45

- **Test Conditions and Codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Payload</th>
<th>CG Height (in)</th>
<th>Axle Loads/1000 lb.</th>
<th>GCW 1000 lb.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>T7-TR6-C1</td>
<td>70</td>
<td>12</td>
<td>34</td>
<td>34</td>
<td>80</td>
</tr>
<tr>
<td>T7-TR6-C2</td>
<td>70</td>
<td>12</td>
<td>30</td>
<td>16</td>
<td>58</td>
</tr>
<tr>
<td>T7-TR6-C3</td>
<td>95</td>
<td>12</td>
<td>34</td>
<td>34</td>
<td>80</td>
</tr>
<tr>
<td>T7-TR6-C4</td>
<td>99</td>
<td>12</td>
<td>38</td>
<td>38</td>
<td>88</td>
</tr>
</tbody>
</table>

- **Test Procedure Plots**

<table>
<thead>
<tr>
<th>Test Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Straight Line Braking</td>
</tr>
<tr>
<td>2. Braking in a Turn</td>
</tr>
<tr>
<td>3. Trapezoidal Steer</td>
</tr>
<tr>
<td>4. Sinusoidal Steer</td>
</tr>
</tbody>
</table>

165
BRAKE COMMAND PRESSURE

CPSII

THREE AXLE TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING - DRY

LONGITUDINAL ACCELERATION (G'S)

0.0  0.1  0.2  0.3  0.4  0.5  0.6

0.  20.  40.  60.  80.  100.  120.

+ T7-TR6-C1
* T7-TR6-C2
X T7-TR6-C3
O T7-TR6-C4
BRAKE COMMAND PRESSURE (PSI)

THREE AXLE TRACTOR-45 FT TRAILER
STRAIGHT LINE BRAKING-WET
BRAKE COMMAND PRESSURE (PSI)
THREE AXLE TRACTOR-45 FT TRAILER
BRAKING IN A TURN - DRY
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

THREE AXLE TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - DRY

+ – T7-TR6-C1
* – T7-TR6-C2
X – T7-TR6-C3
O – T7-TR6-C4
LONGITUDINAL ACCELERATION (G'S)

BRAKE COMMAND PRESSURE (PSI)

THREE AXLE TRACTOR-45 FT TRAILER
BRAKING IN A TURN - WET

+-T7-TR6-C1
* - T7-TR6-C2
X - T7-TR6-C3
O - T7-TR6-C4
THREE AXLE TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - WET
TRAPEZOIDAL STEER

THREE AXLE TRACTOR - 45 FT TRAILER
THREE AXLE TRACTOR- 45 FT TRAILER
TRAPEZOIDAL STEER

THREE AXLE TRACTOR - 45 FT TRAILER
TRAPEZOIDAL STEER

LATERAL ACCELERATION [G'S]

STEERING WHEEL ANGLE [DEG]

+- T7-TR6-C1
* - T7-TR6-C2
X - T7-TR6-C3
0 - T7-TR6-C4
LATERAL ACCELERATION (G'S)

THREE AXLE TRACTOR- 45 FT TRAILER
TRAPEZOIDAL STEER

+ - T7-TR6-C1
* - T7-TR6-C2
X - T7-TR6-C3
O - T7-TR6-C4

YAW RATE RESPONSE TIME (S)

LATERAL ACCELERATION (G'S)
THREE AXLE TRACTOR-45 FT TRAILER
STEERING INPUT AMPLITUDE (DEG)

TRACTOR PEAK LATERAL ACCELERATION (G'S)

0.4
0.3
0.2
0.1
0.0

0.  40.  80.  120.  160.  200.

SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER
TRACTOR PEAK LATERAL ACCELERATION
CG'SI
SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER

T7-TR6-C1
SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER
- **Configuration:** 5 Axle Tractor-Semitrailer ("T5-TR6").

- **Power Unit:**
  - Wheelbase: 209 in.
  - Axle-group Rated Capacities: front - 12,000 lb; rear - 38,000 lb.

- **Trailer(s):**
  - No. of axles in group | length (ft.)
    - #1: 2 | 45

- **Test Conditions and Codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Payload</th>
<th>CG Height (in.)</th>
<th>Axle Loads/1000 lb</th>
<th>GCW 1000 lb</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>T5-TR6-C1</td>
<td>70</td>
<td>12</td>
<td>34</td>
<td>34</td>
<td>80</td>
</tr>
<tr>
<td>T5-TR6-C2</td>
<td>78.5</td>
<td>12</td>
<td>38</td>
<td>38</td>
<td>88</td>
</tr>
<tr>
<td>T5-TR6-C3</td>
<td>70</td>
<td>10</td>
<td>35</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>T5-TR-6-C4</td>
<td>70</td>
<td>10</td>
<td>35</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bias rear</td>
</tr>
</tbody>
</table>

- **Test Procedure Plots**

- **Test Conditions:**

2. Braking in a Turn     | C1 & C2.
3. Trapezoidal Steer     | All.
4. Sinusoidal Steer      | C1 only.
LWB TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING - DRY
BRAKE COMMAND PRESSURE

CPSII

LWB TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING - WET

LONGITUDINAL ACCELERATION (G'S)

+-T5-TR6-C1
*-T5-TR6-C2

BRAKE COMMAND PRESSURE (PSI)
BRAKE COMMAND PRESSURE

CPSII

LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - DRY
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

+ -T5-TR6-C1
* -T5-TR6-C2

LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - DRY
LONGITUDINAL ACCELERATION (G'S)

BRake COMMAND PRESSURE (PSI)

LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - WET
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

+-T5-TR6-C1
*--T5-TR6-C2

LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - WET
TRAPEZOIDAL STEER

LWB TRACTOR - 45 FT TRAILER
LWB TRACTOR - 45 FT TRAILER

AXES:
- Ay, G's
- Abs(RxL/V)-Abs(CDWM/NG) (DEG)
SINUSOIDAL STEER
TWO SEC PERIOD
LWB TRACTOR - 45 FT TRAILER

STEERING INPUT AMPLITUDE (DEG)

TRACTOR PEAK LATERAL ACCELERATION (G'S)
SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD
LWB TRACTOR - 45 FT TRAILER
- **Configuration:** 5 Axle Double ("TI-TR1-TR2")

- **Power Unit:**
  - Wheelbase: 135 in.
  - Axle-group Rated Capacities:
    - front - 12,000 lb; rear - 23,000 lb.

- **Trailer(s):**
  - No. of axles in group | length (ft.)
  - #1: 1 | 27
  - #2: 1 | 27

- **Test Conditions and Codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Payload CG Height (in)</th>
<th>Axle Loads/1000 lbs.</th>
<th>GCW 1000 lb.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI-TR1-TR2-C1</td>
<td>73</td>
<td>9.5 18 17.5 17.5 17.5</td>
<td>80</td>
<td>Baseline</td>
</tr>
<tr>
<td>TI-TR1-TR2-C2</td>
<td>80</td>
<td>9.5 20 19.5 19.5 19.5</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>TI-TR1-TR2-Empty</td>
<td>-</td>
<td>18 20 19.5 19.5 19.5</td>
<td>88</td>
<td>Empty</td>
</tr>
</tbody>
</table>

- **Test Procedure Plots**

<table>
<thead>
<tr>
<th>Test Conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Straight Line Braking</td>
</tr>
<tr>
<td>2. Braking in a Turn</td>
</tr>
<tr>
<td>3. Trapezoidal Steer</td>
</tr>
<tr>
<td>4. Sinusoidal Steer</td>
</tr>
</tbody>
</table>
TWO BRAKE COMMAND PRESSURE CPSI3 AXLE TRACTOR-TRAILERS STRAIGHT LINE BRAKING DRY SURFACE

BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
STRAIGHT LINE BRAKING
DRY SURFACE
TWO BRAKE COMMAND PRESSURE CPSII AXLE TRAILERS STRAIGHT LINE BRAKING WET SURFACE

LONGITUDINAL ACCELERATION (G'\text{S})

BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 2 27 FT TRAILERS STRAIGHT LINE BRAKING WET SURFACE

+-- T1-TR1-TR2-C1
*-- T1-TR1-TR2-C2
O-- T1-TR1-TR2-EMPTY

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BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE
LONGITUDINAL ACCELERATION (G'S)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE
BRAKE COMMAND PRESSURE

LONGITUDINAL ACCELERATION (G'S)

+-- T1-TR1-TR2-C1
*-- T1-TR1-TR2-C2
O-- T1-TR1-TR2-EMPTY

BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE
TWO AXLE TRACTOR- 2 27 FT TRAILERS
TRAPEZOIDAL STEER

STEERING WHEEL ANGLE (DEG)

LATERAL ACCELERATION (G'S)

+- T1-TR1-TR2-C2
*- T1-TR1-TR2-C2
O- T1-TR1-TR2-EMPTY
LATERAL ACCELERATION [G'S]

TWO AXLE TRACTOR - 2 27 FT TRAILERS
TRAPEZOIDAL STEER
TWO AXLE TRACTOR - 2 27 FT TRAILERS
TRAPEZOIDAL STEER
STEERING INPUT AMPLITUDE (DEG)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD
TRACTOR PEAK LATERAL ACCELERATION (G'S)

TWO AXLE TRACTOR- 2 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD
TRACTOR PEAK LATERAL ACCELERATION (G'S)
TWO AXLE TRACTOR- 2 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD

REARWARD AMPLIFICATION (AYN/AY1)

+- T1-TR1-TR2-C1
*- T1-TR1-TR2-C2
O- T1-TR1-TR2-EMPTY
- Configuration: 7 Axle Triple ("T1-TR1-TR2-TR3")

- Power Unit: Wheelbase: 135 in.
  Axle-group Rated Capacities:
  front - 12,000 lb; rear - 23,000 lb.

- Trailer(s):
  
<table>
<thead>
<tr>
<th>No. of axles in group</th>
<th>length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1: 1</td>
<td>27</td>
</tr>
<tr>
<td>#2: 1</td>
<td>27</td>
</tr>
<tr>
<td>#3: 1</td>
<td>27</td>
</tr>
</tbody>
</table>

- Test Conditions and Codes:

<table>
<thead>
<tr>
<th>Payload Code</th>
<th>CG Height (in.)</th>
<th>Axle Loads/1000 lb</th>
<th>GCW 1000 lb</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-TR1-TR2-TR3-Cl</td>
<td>9.5 16</td>
<td>15.5 each</td>
<td>103</td>
<td>Baseline</td>
</tr>
</tbody>
</table>

- Test Procedure Plots | Test Conditions:

  1. Straight Line Braking | Cl
  2. Braking in a Turn | Cl
  3. Trapezoidal Steer | No
  4. Sinusoidal Steer | Cl
BRAKE COMMAND PRESSURE (PSI)

TWO AXLE TRACTOR- 3 27 FT TRAILERS
STRAIGHT LINE BRAKING
DRY SURFACE
BRAKE COMMAND PRESSURE

TWO AXLE TRACTOR - 3 27 FT TRAILERS
STRAIGHT LINE BRAKING
WET SURFACE
BRAKE COMMAND PRESSURE

CPSII

TWO AXLE TRACTOR - 3 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE

LONGITUDINAL ACCELERATION (G'S)

+-- T1-TR1-TR2-TR3

BRAKE COMMAND PRESSURE (PSI)
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE

+- T1-TR1-TR2-TR3
BRAKE
COMPLANO
PRESSURE
CPSII
TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE

LONGITUDINAL ACCELERATION (G'S)

BRAKE COMMAND PRESSURE (PSI)

+- T1-TR1-TR2-TR3

TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE

209
LONGITUDINAL ACCELERATION (G'S)

TWO AXLE TRACTOR - 3 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE
Two axle tractor - 3 27 ft trailers
Sinusoidal steer
Two sec period
TRACTOR PEAK LATERAL ACCELERATION (G'S)

TWO AXLE TRACTOR- 3 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD

YAW RATE TIME LAG (S)

+ + + + + + + +

+- TR1-TR2-TR3
PEAK TRACTOR LATERAL ACCELERATION (G'S)

TWO AXLE TRACTOR - 3 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD

REARWARD AMPLIFICATION (AYN/AY1)

+- T1-TR1-TR2-TR3
- **Configuration:** Rocky Mountain Double ("T7-TR6-TR8")

- **Power Unit:**
  - Wheelbase: 145 in.
  - Axle-group Rated Capacities:
    - front - 12,000 lb; rear - 38,000 lb.

- **Trailer(s):**
  - No. of axles in group | length (ft)
    - #1: 2 | 45
    - #2: 1 | 27

- **Test Conditions and Codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Payload</th>
<th>Axle Loads/1000 lb</th>
<th>GCW</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>T7-TR6-TR8-C1</td>
<td>68</td>
<td>10</td>
<td>32</td>
<td>30</td>
</tr>
</tbody>
</table>

- **Test Procedure Plots**

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214
TRAPEZOIDAL STEER

THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER
LATERAL ACCELERATION

THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER

TRAPEZOIDAL STEER

YAW RATE RESPONSE TIME [S]

LATERAL ACCELERATION [G'S]

+-T7-TR6-TR8
THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER
STEERING INPUT AMPLITUDE (DEG)

THREE AXLE TRACTOR+45 FT TRAILER+27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD
TRACTOR PEAK LATERAL ACCELERATION (G'S)

THREE AXLE TRACTOR+45 FT TRAILER+27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD
PEAK TRACTOR LATERAL ACCELERATION (G'S)

THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD
- **Configuration:** Turnpike Double ("T3-TR5-TR6")

- **Power Unit:**
  - Wheelbase: 142 in.
  - Axlegroup Rated Capacities:
    - front - 12,000 lb; rear - 34,000 lb.

- **Trailer(s):**
  - No. of axles in group | length (ft)
    - #1: 2 | 45
    - #2: 2 | 45

- **Test Conditions and Codes:**

  - **Payload Axle Loads/1000 lb**
    - **GCW 1000 lb.**
    - **Notes**
    - **Code CG Height(in) 1 2 3 4 5 6 7 8 9 1000 lb.**

  - **T3-TR5-TR6**
    - 67 10 28 25 25 25 113 Baseline

- **Test Procedure Plots**
  1. Straight Line Braking - Yes
  2. Braking in a Turn - Yes
  3. Trajezoidal Steer - Yes
  4. Sinujoidal Steer - Yes
BRAKE COMMAND PRESSURE (PSI)
THREE AXLE TRACTOR- 2 45 FT TRAILERS
STRAIGHT LINE BRAKING
DRY SURFACE
Three axle tractor - 2 45 ft trailers
Straight line braking
Wet surface.
BRAKE COMMAND PRESSURE (PSI)
THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE
BRAKE COMMAND PRESSURE (PSI)

THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
WET SURFACE
LONGITUDINAL ACCELERATION (G'S)

PEAK YAW RATE (DEG/S)

THREE AXLE TRACTOR - 2 45 FT TRAILERS
BRAKING IN A TURN
WET SURFACE

+- T3-TR5-TR6
THREE AXLE TRACTOR - 2 45 FT TRAILERS
TRAPEZOIDAL STEER

STEERING WHEEL ANGLE (DEG)

LATERAL ACCELERATION (G'S)

-300.  -200.  -100.  0.   100.  200.  300.

-0.6  -0.5  -0.4  -0.3  -0.2  -0.1  0.  0.1  0.2  0.3  0.4  0.5  0.6

+- T3-TR5-TR6
LATERAL ACCELERATION (G'S)

YAW RATE RESPONSE TIME (S)

THREE AXLE TRACTOR - 2 45 FT TRAILERS
TRAPEZOIDAL STEER
THREE AXLE TRACTOR- 2 45 FT TRAILERS
TRAPEZOIDAL STEER
NG=50.
STEERING INPUT AMPLITUDE (DEG)

THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR - 2 45 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD

PEAK TRACTOR LATERAL ACCELERATION (G'S)

REARWARD AMPLIFICATION (A/Y/A)

+- T3-TR5-TR6

0.0 0.1 0.2 0.3 0.4

0.0 0.5 1.0 1.5 2.0 2.5
SINE WAVE PERIOD
CSJ
THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER

REARWARD AMPLIFICATION (AYN/AY1)

SINE WAVE PERIOD (S)

THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER

+- T3-TR5-TR6