Influence of a Trailer's Axle Arrangement and Loads on the Stability and Control of a Tractor/Semitrailer

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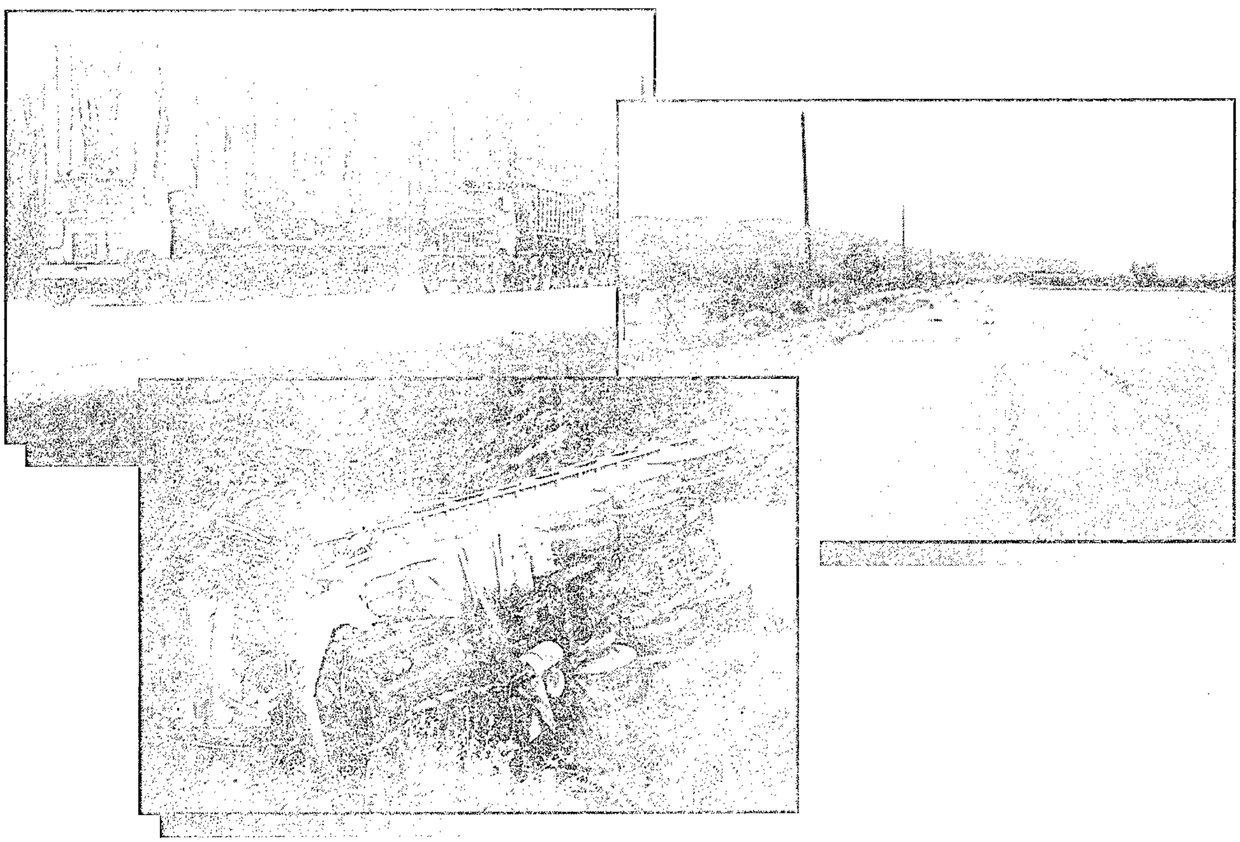

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FOREWORD

This report focuses on the evaluation of typical five- and six-axle tractor/semitrailers in terms of stability and control properties. The behaviors of the vehicles over a wide range of loading conditions, component selection, and operation variables were examined. The results show the safety-related dynamic performance effects of varying a trailer's axle arrangement, suspension type, tire type, and axle loading level.

The results of this study may also assist in understanding the performance trends for other tractor/semitrailer configurations that have different dimensions, suspensions, tires, fifth-wheel settings, tractor parameters, and other component characteristics.

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NOTICE

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16. Abstract

The evaluation of a basic vehicle type relative to another, in terms of stability and control properties, can be done comprehensively only by examining its behavior over a wide range of loading conditions, component selection, and operation variables, such as tire tread wear level, pavement friction, etc. While the scope of this study did not permit an evaluation at such levels of detail, the results show the safety-related dynamic performance effects of varying a trailer's axle arrangement (tandem vs. tridem), suspension type (steel vs. air), tire type (dual vs. wide-base single), and axle loading level. Typical five- and six-axle tractor/semitrailers (483-cm [190-in] tractor and 14.6-m [48-ft] van-semitrailer) were used in this study.

Vehicle safety-related dynamic performance is examined using a recent version of the constant-speed yaw/roll model developed by the University of Michigan Transportation Research Institute (UMTRI). The five- and six-axle tractor/semitrailers are examined using three loading scenarios: (1) loading the trailer with control tractor axle loads at their maximum legal limits, i.e., 5443.2 kg and 15422.4 kg (12 kips and 34 kips) at the steering and tandem drive axles, respectively; (2) loading the trailer without controlling the tractor axle loads; and (3) keeping the payload constant (constant center of gravity height) and varying the trailer axle spacing. It should be noted that the second loading scenario represents the maximum possible gross vehicle weight gain for these vehicle configurations, provided that the load on the steering axle does not exceed the maximum limit of 5443.2 kg (12 kips).

Furthermore, the results of this analysis may assist in understanding the performance trends for other tractor/semitrailer configurations that have different dimensions, suspensions, tires, fifth-wheel settings, tractor parameters, and other component characteristics.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol		Units
A_y	Lateral acceleration	g's
CF	Spring coulomb friction	lb
c.g.	center of gravity	NA
Del, δ	Average front axle steering angle	deg
ESAL	Equivalent Single-Axle Load	NA
F_z	Vertical load at an axle's tires	lb
F_y	Cornering force at an axle's tires	lb
GVW	Gross Vehicle Weight	axle weight [kg (mass)]; lbf
g	Gravitational acceleration	ft/s^2
K_u	Understeer coefficient	deg/g
K_{ucr}	Critical understeer coefficient	deg/g
HOF	High-speed off-tracking	ft
L	Tractor reference wheelbase	ft
LOF	Low-speed off-tracking	ft
LFD	Low-speed friction demand	NA
LTR	Load transfer ratio	NA
RTAC	Roads and Transportation Association of Canada	NA
RWA	Rearward amplification	NA
SRT	Static rollover threshold	g's
TAC	Transportation Association of Canada (succeeded RTAC)	NA
UMTRI	University of Michigan Transportation Research Institute	NA
VWD	Vehicle weights and dimensions	NA

ABSTRACT

The evaluation of a basic vehicle type relative to another, in terms of stability and control properties, can be done comprehensively only by examining its behavior over a wide range of loading conditions, component selection, and operational variables, such as tire tread wear level, pavement friction, etc. While the scope of this study did not permit an evaluation at such levels of detail, the results will show the safety-related dynamic performance effects of varying a trailer's axle arrangement (tandem versus tridem), suspension type (steel versus air), tire type (dual versus wide-base single), and axles loading level. Typical five- and six-axle tractor/semitrailers (483-cm [190-in] tractor and 14.6-m [48-ft] van-semitrailer) were used in this study.

Vehicle safety-related dynamic performance is examined using a recent version of the constant-speed yaw/roll model developed by the University of Michigan Transportation Research Institute (UMTRI). The five- and six-axle tractor/semitrailers are examined using three loading scenarios: (1) loading the trailer with controlled tractor axle loads at their maximum legal limits, i.e., 5443.2 kg and 15422.4 kg (12 kips and 34 kips) at the steering and tandem drive axles, respectively; (2) loading the trailer without controlling the tractor axle loads, while excluding from the stability and control analysis all vehicles exhibiting steering axle loads more than the maximum legal limit of 12k, and (3) keeping the payload constant (constant center of gravity [c.g.] height) and varying the trailer axle spacing. It should be noted that the second loading scenario represents the maximum possible gross vehicle weight (GVW) gain for these vehicle configurations, provided that the load on the steering axle does not exceed the maximum limit of 12k.

Furthermore, the results of this analysis may only assist in understanding the performance trends for other tractor/semitrailer configurations that have different dimensions, suspensions, tires, fifth-wheel settings, tractor parameters, and other component characteristics.

1.0 INTRODUCTION

Heavy-truck regulations in Canada and the United States have an indirect, but important, effect on a large number of vehicle design parameters. Prominent among these are: tractor length; tractor and trailer wheelbase lengths; weights; inertias; axle loads; number of axles and spacing; and fifth-wheel location(s). In addition, the vehicle designer has considerable freedom in determining suspension characteristics (both vertical and roll), engine power (acceleration and hill-climbing capacity), braking and retarding capacity (for controlling hill descents), and tire characteristics. If the designer or manufacturer changes one or more of these variables, even within the limits imposed by current regulations, the vehicle's dynamic properties will become unknown, even if they were known before the change(s). Moreover, performance of heavy vehicles and safety are highly affected by the loading methods and payload densities.

The Canadian Vehicle Weights and Dimensions (VWD) Study, sponsored by the Roads and Transportation Association of Canada (RTAC) (renamed TAC in 1990), was launched in 1984 to provide a technical basis for commercial-vehicle weight and dimension regulatory reform. The study focused on two main areas of research: vehicle stability and pavement response. The stability and control characteristics of various commercial vehicle configurations were evaluated using computer simulations, tilt table tests, and full-scale field testing.

As one of the contractors to the study, the University of Michigan Transportation Research Institute (UMTRI) proposed a tentative set of performance measures to guide the development of regulations and the assessment of proposed vehicle configurations in terms of satisfactory vehicle stability and control behavior. In Canada, these performance measures have come to be referred to as the RTAC Performance Measures.

Ervin and Guy (1986) conducted an extensive study of the dynamics of articulated vehicles, examining the influence of various vehicle parameters on vehicle performance during low- and high-speed path-following maneuvers. This work was a principal part of the Canadian VWD Study. However, the study did not address the effects of varying a tractor design parameter or the payload density on the dynamic performance of a commercial vehicle. Payload density was assumed to be a constant of 544.3 kg/m^3 (34 lb/ft^3) for all vehicle configurations examined in that study.

The research described in this report is part of FHWA's Truck-Pavement Interaction Research Program on Truck Size and Weights. A previous study conducted on B-trains and tractor/semitrailers by El-Gindy et al. (1991) showed that the effect of tractor wheelbase variations on heavy-truck performance was significant. The study further examined the effects of a tractor's fifth-wheel position and tandem-axle spacing on the vehicle's handling, static and dynamic roll stability, friction demand, and off-tracking. Finally, the study presented a novel performance measure for assessing the handling behavior of a vehicle; based on a vehicle's handling diagram, this measure is referred as the "three-point measure."

A study by Fancher et al. (1989) showed that future transportation technology will involve developing heavy commercial vehicles with measurable and predictable levels of performance in safety-related maneuvers. The study concentrated on vehicles weighing more than 36,288 kg (80,000 lb) and applied the same evaluation methods used in the Canadian VWD Study. However, new performance targets were chosen based on accumulated research experience, including knowledge gained from the examination of trucks involved in fatal accidents. Fancher also presented a study (1991) that introduced ideas for developing safety-related performance measures that quantified the dynamic properties of large, heavy trucks. Those performance measures pertained to rollover thresholds, rearward amplification in obstacle-avoidance maneuvers, off-tracking, directional control during braking, speed control for mountain descents, and hill-climbing capability.

Various studies have been conducted to determine the dynamic performance characteristics of heavy-vehicle combinations (e.g., Ervin et al., 1986; El-Gindy et al., 1990, 1991, 1992). These studies resulted in the development of criteria for dynamic performance measures that could be used in evaluating the stability and control properties of heavy vehicles. The influences of a tractor wheelbase and its tandem-axle spacing were examined by El-Gindy et al. (1991). Although a number of vehicle variables were considered in these analyses, the influence of trailer axle spread was not investigated.

Past studies compared safety, productivity, and potential pavement damage attributable to various vehicle configurations with specific design parameters. Gillespie et al. (1993) conducted an extensive study of the influence of vehicle configurations, suspension, pavement (flexible versus rigid), tire, and environmental factors on pavement damage. Also, various aspects of vehicle dynamics, including dynamic loads, cornering, and braking, have been examined. However, this study did not look at economic issues related to productivity or pavement life-cycle costs. Nor did it provide a complete picture of the relationship between safety-related performance and dynamic loads.

The five-axle tractor/semitrailer (3-S2) is the most commonly used heavy truck in North America. In Canada, the six-axle tractor/semitrailer (3-S3) was introduced following the adoption of interprovincial weight limits in 1988. Pioneering work comparing the five- and six-axle tractor/semitrailers (Fekpe, 1995a) concluded that the 3-S3 is becoming increasingly popular relative to the 3-S2. These two configurations exhibit similar dynamic performance characteristics. It was also shown that the 3-S3 is more attractive from the operational efficiency viewpoint, measured by the Equivalent Single-Axle Load (ESAL) per tonne of payload. A further study (Fekpe, 1995b) showed that beyond a certain gross vehicle weight (GVW) limit for the 3-S2, it is potentially more productive and efficient to use the 3-S3, on account of its relatively better operating efficiency. For the same GVW, the 3-S3 is obviously a more efficient truck. In these studies, the effect on safety and potential pavement damage were not investigated.

Fekpe et al. (1994) developed models for estimating truck productivity, from a highway agency's standpoint, in terms of the infrastructure cost and the payload benefit. These models expressed truck productivity as a function of the governing GVW limits and the intensity of their enforcement. Fekpe (1995) then conducted a study on the operating efficiency of heavy vehicles. In this study, a concept for assessing the efficiency of heavy vehicles was presented. The primary variables that defined efficiency were safety-related dynamic performance measures, highway infrastructure damage, and productivity. That study highlighted the importance and the possible role of truck productivity in regulations for the sizes, weights, and operating conditions of heavy vehicles.

This report is part of a Federal Highway Administration (FHWA) truck and size research study on the influence of trailer-axle arrangement (tandem versus tridem) on the safety-related dynamic performance, potential pavement damage, and productivity of a tractor/semitrailer. The range of axle spreads investigated includes the limits stipulated in the governing weight limits across North America. The results are expected to provide a basis for the selection and regulation of axle spreads on semitrailer units, particularly for tridem axles. This study will not assume constant payload density. Previously, such an assumption led to an underestimation of the potential degradation of a heavy vehicle, especially those using van trailers; performance due to lowering the payload density; and increases in the center of gravity (c.g.) height for the same payload weights and axle load distributions.

2.0 VEHICLE CONFIGURATIONS AND LOADING SCENARIOS

Three tractor/semitrailer configurations were selected for this study: (1) four-axle, (2) five-axle, and (3) six-axle. All vehicles had the same tractor (483-cm [190-in] wheelbase) and the same van semitrailer size (14.6-m [48-ft] box length, 2.6-m [8.5-ft] width, and 2.6-m [8.5-ft] height). The reference vehicle configuration is a 36,288-kg (80,000-lb) five-axle tractor/semitrailer. Stability and control analyses are restricted to the tandem- and tridem-axle trailers. The single-axle trailer is used only for the pavement damage analysis. The parameters that are varied are axle spacing and loading, and trailer suspension and tires. Table 1 shows the various types of tires and suspensions used in this study.

Table 1. Suspensions and tires.

Vehicle Unit	Suspension	Tires
Tractor		
Front axle	IH "Reference" 12k front leaf suspension Overall width = 96" Aux. roll stiffness = 3820 (lb-in/deg), Coulomb force (CF) = 475 (lb)	Michelin XZA 11R22.50
Tandem axle	NEWAY ARD-244 air spring (32k). Aux. roll stiffness/leading axle = 15,000 (lb-in/deg) Aux. roll stiffness/trailing axle = 51,000 (lb-in/deg), CF = 275 (lb)	Michelin XZA 11R22.50 (dual)
Trailer		
Tandem and tridem	**Susp. #1:** Reyco 21B trailer spring Aux. roll stiffness/axle = 9,000 (lb-in/deg), CF = 975 (lb)	**Tire #1** Dual-tire Michelin XZA 11R22.50
	Susp #2: NEWAY AR-95-17 air spring (24k). Aux. roll stiffness/axle = 60,000 (lb-in/deg), CF = 362 (lb)	**Tire #2** Wide-base single Goodyear 425/65R22.5J

1 in = 25.4 mm, 1 lbf = 4.448 N, 1 lb-in/deg = 0.1129 N-m/deg

It should be noted that the suspensions used in this simulation represent common types for heavy-duty trucks. They were also used in a previous study conducted by UMTRI (Ervin, 1986). The force-deflection characteristics of these suspensions are given in figure 1. Figures 2 and 3 show the measured characteristics for the dual and wide-base single tires used in this study, respectively.

The loading of a van trailer of a given vehicle configuration is determined by the desired vertical load limits at each axle group. The load distribution of a tractor/semitrailer is also affected by the location of the center of the fifth wheel with respect to the center of the tractor drive-axle group. Axle loads for a specific configuration can be determined using infinite payload densities. The lowest payload density required to achieve a certain axle load distribution is the density for the payload that occupies the volume of a van semitrailer. This is considered to be the worst possible loading condition—the center of gravity of the semitrailer's sprung mass will be at its highest possible location.

In this study, the payload is assumed to uniformly fill a rectangular box whose base is the van's full floor area, and whose height equals twice the payload's relative c.g. height above this floor. The payload moments of inertia about the box's three principal axes are then calculated. When a trailer axle location is varied (i.e., the axles are spread) relative to the cargo bed, the originally computed payload data are changed (i.e., constant volume, different payload density), and either the same axle loads are recalculated. In all cases, the longitudinal location of the payload c.g. and fifth-wheel offset are kept constant. Due to the changes in the payload density, the trailer's overall sprung mass is varied.

Three loading scenarios are employed in this study. They are described as follows:

First loading scenario. In this case, the density of the payload is increased as the axle spread increases (moving the trailer's lead axle(s) forward and maintaining the last axle at its original position). The tractor's steering-axle and drive-axle loads are maintained at their maximum legal limits, i.e., 12k and 34k, respectively. This scenario reflects the maximum possible gain of the payload weight due to the spread of either the tandem or tridem axles. (See table 2, and figures 4 and 5).

Second loading scenario. In this case, the density of the payload is increased, providing controlled trailer axle-group loads at 5k increments at all the examined axle spacings, regardless of the loading level limits for the tractor axles. From this matrix of vehicle configurations, the vehicles with a steering-axle load approximately equal to 12k will be analyzed and compared with those shown in table 1. These vehicles will be heavier than those indicated in table 1 at the same axle spacing, due to the tractor drive-axle being allowed to carry loads greater than 34k. The reason for choosing these vehicles in this analysis is the possibility of increasing a tandem axle-group limit in future legislation in the United States.

The selected vehicles are in the shaded rows in table 3 (see figures 6 and 7). The rest of the vehicles will be used in other analyses, such as pavement and bridge studies. Also, the single-axle trailer configurations will not be included in the stability and control analyses.

Table 2. Matrix of vehicle configurations using first loading scenario.

No. of Vehicle Configur-ations	Trailer Axle	TAS* (in)	c.g. height (in)	GVW (kips)	P1 (kips)	P2 (kips)	P3 (kips)	D (lb/ft^3)
1 (Ref.)	Tandem	48	100.8	80.0	12	34	34	14.50
2	Tandem	72	101.0	81.68	12	34	35.68	15.05
3	Tandem	96	101.3	83.56	12	34	37.56	15.62
4	Tandem	120	101.53	85.67	12	34	39.67	16.26
5	Tridem	48/48	100.9	85.06	12	34	39.06	15.62
6	Tridem	60/60	101.15	87.17	12	34	41.17	16.25
7	Tridem	72/72	101.5	89.56	12	34	43.56	17.00
8	Tridem	96/96	102.12	95.40	12	34	49.40	18.75
9	Tridem	120/120	102.87	103.30	12	34	57.30	21.14

1 in = 25.4 mm, 1 kip = 453.6 kg, 1 lb/ft^3 = 16.01 kg/m^3
*TAS = Trailer-axle spacing.

Table 3. Matrix of vehicle configurations using second loading scenario.

No. of Vehicle Configurations	Truck Configurations	TAS (in)	H (in)	GVW (kips)	P1 (kips)	P2 (kips)	P3 (kips)	D (lb/ft³)
1	four-axle	0	91.34	46.89	10.62	20.27	16	5.26
2	four-axle	0	93.58	50.73	10.76	21.97	18	6.42
3	four-axle	0	95.33	54.56	10.90	23.66	20	7.57
4	four-axle	0	96.74	58.39	11.04	25.35	22	8.73
5	four-axle	0	97.80	62.22	11.18	27.04	24	9.88
6	five-axle	48	99.41	72.34	11.50	30.84	30	12.33
7	five-axle	48	100.75	80.01	11.79	34.22	34	14.63
8	***five-axle***	***48***	***101.30***	***83.84***	***11.93***	***35.91***	***36***	***15.79***
9	five-axle	48	101.78	87.67	12.07	37.61	38	16.94
10	five-axle	48	102.60	95.34	12.35	40.99	42	19.25
11	five-axle	48	103.27	103.01	12.64	42.68	46	21.56
12	five-axle	72	99.14	71.07	11.40	29.66	30	11.94
13	five-axle	72	100.52	78.54	11.67	32.87	34	14.19
14	***five-axle***	***72***	***101.58***	***86.02***	***11.94***	***36.08***	***38***	***16.44***
15	five-axle	72	102.42	93.49	12.21	39.28	42	18.69
16	five-axle	72	103.11	100.97	12.48	42.49	46	20.94

1 in = 25.4 mm, 1 kip = 453.6 kg, 1 lb/ft³ = 16.01 kg/m³

Table 3. Matrix of vehicle configurations using second loading scenario (continued).

No. of Vehicle Configura-tions	Truck Configura-tions	TAS (in)	H (in)	GVW (kips)	P1 (kips)	P2 (kips)	P3 (kips)	D (lb/ft^3)
17	five-axle	96	98.87	69.78	11.30	28.48	30	11.56
18	five-axle	96	100.28	77.08	11.56	31.52	34	13.75
19	five-axle	96	101.36	84.36	11.81	34.55	38	15.94
20	***five-axle***	***96***	***101.82***	***88.01***	***11.94***	***36.07***	***40***	***17.04***
21	five-axle	96	102.23	91.65	12.07	37.58	42	18.14
22	five-axle	96	102.93	98.93	12.32	40.61	46	20.33
23	five-axle	120	98.57	68.51	11.20	27.31	30	11.17
24	five-axle	120	100.02	75.61	11.44	30.16	34	13.31
25	five-axle	120	101.14	82.71	11.68	33.02	38	15.45
26	***five-axle***	***120***	***102.03***	***89.80***	***11.92***	***35.88***	***42***	***17.58***
27	five-axle	120	102.75	96.90	12.16	38.74	46	19.72
28	***six-axle***	***48/48***	***101.56***	***90.41***	***11.97***	***36.44***	***42***	***17.16***
29	six-axle	48/48	102.53	99.53	12.29	40.24	47	19.91
30	six-axle	48/48	103.3	108.63	12.61	44.03	52	22.65
31	six-axle	48/48	103.92	117.74	12.93	47.82	57	23.75
32	six-axle	48/48	104.43	126.85	13.24	51.61	62	28.13

1 in = 25.4 mm, 1 kip = 453.6 kg, 1 lb/ft^3 = 16.01 kg/m^3

Table 3. Matrix of vehicle configurations using second loading scenario (continued).

No. of Vehicle Configura-tions	Truck Configura-tions	TAS (in)	H (in)	GVW (kips)	P1 (kips)	P2 (kips)	P3 (kips)	D (lb/ft^3)
33	six-axle	72/72	101.11	86.87	11.70	33.17	42	16.10
34	***six-axle***	***72/72***	***102.13***	***95.50***	***11.98***	***36.52***	***47***	***18.70***
35	six-axle	72/72	102.94	104.14	12.26	39.88	52	21.30
36	six-axle	72/72	103.59	112.77	12.54	43.38	57	23.90
37	six-axle	72/72	104.13	121.41	12.82	46.24	62	26.49
38	six-axle	96/96	100.61	83.32	11.42	29.90	42	15.03
39	six-axle	96/96	101.69	91.48	11.67	32.81	47	17.48
40	***six-axle***	***96/96***	***102.54***	***99.64***	***11.91***	***35.73***	***52***	***19.94***
41	six-axle	96/96	103.23	107.81	12.16	38.65	57	22.40
42	six-axle	96/96	103.81	115.97	12.40	41.57	62	24.86
43	six-axle	120/120	100.04	79.77	11.15	26.62	42	13.96
44	six-axle	120/120	101.19	87.46	11.36	29.10	47	16.27
45	six-axle	120/120	102.10	95.15	11.56	31.58	52	18.59
46	six-axle	120/120	102.83	102.84	11.77	34.07	57	20.90
47	***six-axle***	***120/120***	***103.44***	***110.53***	***11.98***	***36.54***	***62***	***23.22***

1 in = 25.4 mm, 1 kip = 453.6 kg, 1 lb/ft^3 = 16.01 kg/m^3

It should also be noted that the tandem and tridem vehicle configurations selected for stability and control analyses have approximately the same tractor axle load distributions.

The selected vehicles have approximately 12k at the steering axle and approximately 36k to 36.5k at the drive-axle group. This means that in order not to exceed the maximum steering-axle load limit, the tractor drive-axle (at this particular fifth-wheel setting) cannot exceed the range of 36k to 36.5k, which, in turn, controls the selection of the trailer-axle spacing and loads.

Figures 8 and 9 show the GVW for tandem and tridem trailers for the first and second loading scenarios.

Third loading scenario. In this case, the trailer axle spacing is varied while the GVW payload is kept constant (i.e., constant payload density). The selected tandem- and tridem-axle trailers are based on the results of the first and second loading scenarios, in which the vehicles with the maximum possible GVW and appropriate suspension type are selected. This means that two selected vehicles (tandem and tridem) will be used as reference vehicles for examining the influence of changing the axle spacing and making the corresponding changes in the axle loads. As the trailer-axle spacing is increased by moving the leading axle(s) forward, the trailer-axle load increases slightly and the tractor-axle load decreases slightly, and vice versa. The fifth-wheel location is kept constant (373 mm [14.7 in] ahead of the geometric center of the tractor tandem-axle center). This case represents a good approximation of the effect of trailer-axle spacing on vehicle performance, where the c.g. height and GVW are kept constant while the axle spacing is varied.

3.0 DYNAMIC PERFORMANCE MEASURES

The objective of this study was to evaluate various vehicle configurations and conduct limited sensitivity analyses. The comparison between vehicle configurations was based on the following assumptions: (1) the tractor parameters are kept constant and (2) the payload of 544.3 kg/m^3 (34 lb/ft^3) is uniformly distributed in the trailers for all configurations. This loading scenario resulted in a maximum c.g. height of 203 cm (80 in) for the payload. The performance evaluation of these vehicles does not represent the worst possible loading case, where filling the trailers with a lower uniform payload density would result in a 267-cm (105-in) c.g. height for the payload.

The dynamic performance characteristics are indirectly determined by the regulations relating to size and weight limits, vehicle manufacturing technology, load characteristics, and operating practices in the trucking industry. The dynamic performance of heavy vehicles also has implications for the road system. The performance measures used in this study are as follows:

- Handling performance.
- Static rollover threshold.
- Load transfer ratio.

- Rearward amplification.
- Low-speed friction demand.
- Off-tracking (low, high-speed, and transient).

Detailed descriptions are presented elsewhere (e.g., El-Gindy, 1992 and 1995; Fekpe et al., 1995b).

Each of these measures is a specific, quantifiable, heavy-truck performance characteristic that can theoretically be measured while the vehicle is conducting a specified maneuver, and can be used to quantitatively assess the relative performance of a particular vehicle combination. In addition, the value of each measure for a given vehicle can be compared with the minimum level of performance developed initially in the Canadian VWD Study and subsequently used in the development of the national "Memorandum of Understanding on Vehicle Weights and Dimensions."

Also, some of the measures are routinely evaluated by physical testing (e.g., static rollover threshold, rearward amplification), while others have never been successfully evaluated in this manner (e.g., load transfer ratio).

A definition, a method for evaluation, and a passing criterion for each of the TAC performance measures are described in the following sections. The influences of the trailer loading scenario, axle spacing, axle loads, suspension type, and tire type are all examined.

3.1 Handling Performance: Understeer Coefficient

Handling performance is evaluated at steady-state conditions by calculating the understeer coefficient at a centripetal (lateral) acceleration of 0.25 g. The understeer coefficient is determined from the slope of the difference between two steering-related angles, as influenced by the centripetal acceleration. The slope is found on a handling diagram. The angles in question are: the Ackerman angle (L/R), which is the ideal front-axle steer angle needed for a simple two-axle vehicle of wheelbase L to negotiate a turn of radius R at near-zero speed; and the nominal front-axle steer angle (steering wheel angle to steering box gear ratio), taking into account the compliance of the steering system.

The understeer coefficient is calculated during a ramp-steer maneuver at a vehicle speed of 100 km/h (62.1 mi/h). The ramp-steer rate is 2.0 deg/s, measured at the steering wheel, which yields an approximate rate of increase in lateral acceleration of between 0.01 and 0.02 g/s, depending on the vehicle. The calculations needed to evaluate the understeer coefficient used in the construction of the handling diagram are based upon a constant vehicle speed of 100 km/h (62.1 mi/h), using $\{(L/R - d_{sw}/N_g), A_y\}$, where d_{sw} is the steering wheel angle and N_g is the steering box gear ratio. Using the nominal front axle steering angle (d_{sw}/N_g) instead of the actual front-axle steer angle, d, accounts for the understeer attributable to steering system compliance. Accordingly, the understeer coefficient of interest, K_u, expressed in units of degrees/g, is defined by the equation:

$$K_u = d(d_{sw}/N_g - L/R)/d(A_y) \qquad (1)$$

The pass/fail criterion is addressed by comparing K_u with the critical understeer coefficient, K_{ucr}, which can be expressed as $-Lg/U^2$, where U is the vehicle speed (U = 100 km/h [62.1 mi/h]), L is the tractor or truck wheelbase, and g is acceleration due to gravity. If the value of K_u is greater than the target value K_{ucr}, the vehicle will pass the criterion and will therefore satisfy this performance measure.

3.2 Static Rollover Threshold (SRT)

The traditional definition of static rollover threshold has been "the level of lateral acceleration, in units of g, beyond which overturn occurs in a steady turn." A strict interpretation of this definition does not permit the assessment of rollover threshold when the vehicle exhibits yaw divergence at a lateral acceleration that is less than the rollover threshold. A more universally applicable definition of static rollover threshold has therefore come into common use—"the maximum lateral acceleration level, in g's, beyond which static rollover of a vehicle occurs."

Two methods for evaluating a vehicle's static rollover threshold are: (1) using a tilt table to measure it, or (2) calculating it using a validated static roll or yaw/roll model. The latter method is used in this study.

There is a profound relationship between the low level of SRT and rollover accidents. Based on accident statistics in the United States (Ervin, 1980 and 1983), 2,000 rollovers involved five-axle tractor/semitrailer combinations with van-type trailer bodies, carrying general freight, and being operated by interstate carriers. Therefore, a minimum acceptable level of 0.4 g has been suggested in the Canadian VWD study.

It is very difficult to achieve this SRT level for fully-loaded and fully-filled van-type trailers, even with very high levels of suspension stiffness. Another target value of 0.35 g was considered to be the minimum acceptable value in a study conducted by UMTRI (Winker and Fancher, 1992). In our study, with the proposed loading scenarios (i.e., high payload c.g.), an SRT value of 0.3 g is assumed to be the minimum acceptable value.

3.3 Load Transfer Ratio (LTR) and Rearward Amplification (RWA)

Load transfer ratio (LTR). LTR is defined as the ratio of the absolute value of the difference between the sum of the right-wheel loads and the sum of the left-wheel loads to the sum of all wheel loads. For vehicles with trailer units that are decoupled in roll, LTR calculations apply only within the independent units. The front steering axle is usually excluded from the calculations because of its relatively high roll compliance.

Rearward amplification (RWA). RWA, a frequency-dependent measure, is defined as the ratio of the peak (positive or negative) lateral acceleration at the center of gravity of the rearmost trailer to the amplitude of controlled lateral acceleration of 0.15 g at the center of the front axle of the lead unit.

LTR and RWA are evaluated with a time-series simulation model, such as the UMTRI yaw/roll model. They are assessed during a rapid, high-speed, path-change maneuver conducted at 100 km/h (62.1 mi/h), yielding a lateral acceleration amplitude of 0.15 g at the center of the steer axle within a time period of 3.0 s. The maximum allowable values for rearward amplification and load transfer ratio are 2.2 and 0.6, respectively. The path-following lane-change method, which allows for a complete assessment of vehicle performance, was used in preference to the path-following method.

3.4 Low-Speed Friction Demand (LFD)

This friction demand performance measure describes the tire friction levels required at the tractor drive-axle during a tight-radius, low-speed, path-following turn. Excessive friction demand is a contributing factor to jackknife and also results in excessive tire wear. This performance measure is particularly useful for evaluating the effects of trailer lift-axles on the maneuvering characteristics of combination vehicles (Fancher, 1989).

It should be noted that on slippery surfaces, the friction demand at a tractor's rear axles may exceed that which is available from the road surface, especially if the trailer has a widely spread axle group. The LFD is evaluated in a 90-degree turn at a vehicle speed of 8.25 km/h (5.1 mi/h). During the maneuver, the center of the front steer-axle tracks an arc with a 9.8-m (32.2-ft) radius (approximately an 11-m (36.1-ft) outside wheelpath radius). The target maximum allowable value for LFD is 0.10.

3.5 Off-Tracking Measures

The three TAC off-tracking measures are:

- Low-speed off-tracking.
- Steady-state high-speed off-tracking.
- Transient high-speed off-tracking.

Low-speed off-tracking (LOF). LOF is defined as the peak offset in wheelpath, measured from the outside of the outer front tire on the tractor to the inside of the innermost trailing tire on the trailer. The path constraint used for measuring LOF is a 90-degree turn with a 9.8-m (32.2-ft) radius, referenced to the center of the front axle, with the vehicle exiting along a tangent to this curve. This maneuver is conducted at a speed of 8.25 km/h (5.1 mi/h). The TAC target value for low-speed off-tracking is 6.0 m (19.7 ft). Greater off-tracking would constitute a failure to comply with the criterion.

Steady-state high-speed off-tracking (HOF). HOF is defined as the extent to which any trailing axle(s) in a vehicle combination tracks outside the path of the tractor steering axle in a steady turn. High-speed off-tracking is determined at a vehicle speed of 100 km/h (62.1 mi/h) through a constant-radius curve of 393 m (1289.4 ft). The lateral acceleration experienced under these conditions is 0.2 g. This maneuver is represented by the closed-loop (path-following) portion of the maneuver used to evaluate the SRT measures.

The TAC target value for HOF is 0.46 m (1.5 ft), which requires that a minimal clearance of 0.15 m (0.5 ft) remains between the trailer tires and the outside of a 3.66-m- (12.0-ft-) wide conventional traffic lane, with a 2.44-m- (8.0-ft-) wide tractor following a path down the center of the lane. Off-tracking of more than 0.46 m (1.5 ft) represents a failure to comply with the HOF criterion.

Transient high-speed off-tracking (TOF). TOF is defined as the peak lateral offset in a direction normal to the path traveled by the outside front tire of the tractor and the path of the most outboard trailing axle, in response to a transient steering maneuver.

Transient high-speed off-tracking is computed using the same rapid path-change maneuver required for the dynamic roll stability measures. The value of 0.8 m (2.6 ft) represents the nominal midrange of performance for the vehicles examined in the Canadian VWD Study (Ervin et al., 1986).

4.0 COMPUTER SIMULATION MODEL AND POST-PROCESSOR

The task of evaluating the various stability and control performance measures was supported by the constant-speed yaw/roll vehicle model developed by UMTRI. The outputs from the model were evaluated with a post-processor developed specifically for this purpose.

4.1 Yaw/Roll Model

The first version of the yaw/roll model was developed in 1980 by Dr. C. Mallikarjunarao at UMTRI. Since then, every effort has been made to ensure that program statements are correct and results are at a reasonable level of accuracy and precision. The yaw/roll model has been subjected to constant revision by UMTRI for more than 12 years. It has also been validated several times—by UMTRI (Gillespie, 1981), Carleton University of Canada (Wong, 1993), the National Research Council (NRC) of Canada (Tong, 1995), and perhaps others unknown to the authors.

The UMTRI yaw/roll model (Mallikarjunarao and Segel, 1981) was developed to predict the directional and roll response of single and multiple articulated vehicles engaged in steering maneuvers that may approach the critical limits of stability. In this model, the forward speed of the lead unit is assumed to remain constant during a maneuver; therefore, the longitudinal motion of each articulated unit cannot vary. Each unit is treated as a rigid body with five degrees of freedom: lateral, vertical, yaw, roll, and pitch. The axles are treated as beam axles that are free to roll and to deflect vertically with respect to the sprung mass of the vehicle. This simulation model was used to compute the stability control and off-tracking performance measures deemed important for a thorough assessment of a vehicle's behavior.

4.2 Post-Processor

For a study of vehicle behavior, it is necessary, but not sufficient, to obtain numerical values from a simulation model. Also needed are criteria by which to judge whether or not the vehicle's behavior is in a desirable range. The criteria and thresholds emerging from this study are embodied in a post-processor program that analyzes various performance parameters. The yaw/roll simulation program produces an output file known as an ERD file, in a format developed at UMTRI (Sayers, 1989). The ERD file contains all the important simulation output data, together with some data describing the vehicle and the maneuvers.

The post-processor identifies which maneuver was simulated and calls the relevant subroutine where calculations appropriate to that maneuver are carried out. The relevant channels in the ERD file are read, the analysis is performed, and the results are written to a summary file. An inspection file is also produced to verify that the correct data have been used. The post-processor was modified by NRC in 1991 to deal with new and modified performance measures and their relevant maneuvers.

4.3 Model Validation

The validity of the computer simulation program depends on the accuracy and execution of the program statements, the capabilities of the simulation models, the quality of the measured vehicle-design parameters, and the maneuver descriptions defined by the input data. It is well known that the ultimate determinants of validity are the user-supplied input data and the interpretation applied to the results. Properly used, the program is capable of validly predicting most aspects of directional response in maneuvers up to wheel liftoff. In the special case where a direct comparison between vehicle and simulation (i.e., validation) is intended, an iterative process is often performed, revealing unexpected differences, which, when carefully examined, are related to errors in the experimental measurements or program input. Furthermore, in most applications, the user can assume a given component characteristic and can investigate vehicle performance with that component, knowing that it is typical, but not precisely equivalent to any specific component at hand. Much of the utility of computer simulation programs derives not from an absolute prediction of vehicle/test-maneuver situations (as required for validation), but from studying the generalized performance and the sensitivity of performance to vehicle parameters.

The yaw/roll model was found to accurately predict the directional and roll response of tractor/semitrailers and double-trailer-type vehicles. The first validation of the yaw/roll model was presented by Gillespie (1982) using directional response data collected during a double-tanker study (Ervin, 1978). The match between test data and simulated response was found to be good even for severe maneuvers that resulted in wheel lift-off. However, in this validation, tractor front-wheel measurements were not made.

The yaw/roll model used in our study is a revized and updated version of the model used in the Canadian VWD Study (Ervin, 1986). This version has been subjected to extensive validation by the Ontario Ministry of Transportation of Canada and Carleton University of Canada (Wang, 1986, and El-Gindy, 1987). The validation of the model was extended to cover not only severe lane-change maneuvers, but steady-state turns at different levels of lateral acceleration up to the rollover limits. This steady-state validation is quite challenging; the accuracy of the measured nonlinear characteristics of vehicle components (such as tires and suspension), as well as the mathematical representation of these components in the model, can be tested. The results of this extensive validation showed that the yaw/roll model version used in the Canadian VWD Study is very accurate and that it confirmed Ervin's findings in 1982. Furthermore, the yaw/roll model was modified by UMTRI in 1990 to include more features, such as stabilized dolly arms and self-steering axles, as well as a post-processor to analyze the performance measures. This version was tested by the NRC of Canada in 1991. It was then validated using NRC-measured responses of two types of logging trucks obtained from field tests in 1995 (Tong, 1995), and it has proven to be the most accurate available computer simulation model developed in North America for predicting the yaw/roll response of heavy vehicles. The latest version of the yaw/roll model is used in this FHWA study.

5.0 STABILITY AND CONTROL ANALYSES

In this study, the performance characteristics of tractor/semitrailer configurations equipped with 259-cm (102-in) trailer axles and loaded according to the first and second loading scenarios (tables 2 and 3) are examined, as are the effects of tire type (dual versus super single). The tractor design parameters and fifth-wheel location are kept constant, while the trailer-axle suspensions are varied (steel versus air springs).

In this analysis, each vehicle is loaded with a uniform payload density, and the trailer box is assumed to be completely filled. The weight and axle loads are changed by modifying the payload density. This method of loading results in placing the c.g. at its highest position for a given density.

The results show a much-reduced range of some important performance measures relative to the TAC-recommended target values. For the tractor/semitrailer, the performance measures most affected were the SRT and the LTR. The low-speed friction demand (LFD) was highly sensitive to the axle spacing and the level of the axle loads. These results are discussed in the following sections.

5.1 Handling Performance

As described in section 3, the pass/fail criterion is addressed by comparing the understeer coefficient, K_u, with the critical understeer coefficient, K_{ucr}, which can be expressed as $-Lg/U^2$. If the value of K_u is greater than the target value K_{ucr}, the vehicle will pass the criterion and will therefore satisfy this performance measure. For the tractor used in this study, the critical value was -3.5 (deg/g).

Figures 10 and 11 show the handling characteristics of various vehicle configurations, where S and A refer to steel and air spring suspensions, respectively. From these figures, it can be noted that:

- Increasing both trailer-axle spacing and axle loads reduces the understeer level of the tractor and may lead to an unstable situation in which the understeer coefficient exceeds the critical value. This unstable situation is clearly shown in the second loading scenario, at an axle spacing of 305 cm (120 in) with a steel suspension.

- All configurations equipped with a trailer steel suspension exhibit oversteer characteristics, while the vehicles equipped with air suspension exhibit understeer characteristics. The reason is that the air suspension used in this study has a higher roll stiffness than that of the steel suspension used. This leads to a more stable (understeer) tractor and vehicle combination, at all axle loads and spacings.

- The tractor/semitrailer combination loaded according to the second loading scenario (heavier than those in the first scenario) exhibits better performance for vehicles equipped with air suspension. They exhibit better stability and only a moderate understeer level, compared to vehicles with steel suspensions.

5.2 Static Rollover Threshold (SRT)

The static rollover threshold (SRT) of a roll-coupled combination vehicle, such as a tractor/semitrailer combination, is defined as the lateral acceleration at which rollover of both vehicle units occurs. Figures 12 and 13 show the variation of the SRT versus axle spacing, for all vehicle combinations.

All of the tractor/semitrailer configurations examined exhibited a rollover threshold of less than 0.35 g. Furthermore, it was observed that:

- The first loading scenario results in a higher SRT than the second scenario. Vehicles equipped with air suspension exhibited a higher SRT than those with steel suspension, due to the higher roll stiffness of the air suspension.

- As the axle spacing and load increases, the SRT decreases slightly. The steel-suspension vehicles loaded according to the second scenario showed a critical SRT at 183 cm (72 in) of tandem-axle spacing. Due to the increased suspension roll-resistance of the tridem-axle trailer, compared to that of the tandem-axle trailer, the SRT is higher for tridem-axle trailers, in spite of a higher payload.

According to these results, the SRT can be improved by using stiffer suspension in roll, especially the steel spring for tandem-axle trailers. To reach the minimum SRT requirement of 0.35 g, it would also be beneficial to increase the effective track width of the trailer axles and the suspension lateral spread.

It should be recognized that the height of the payload mass c.g. plays a powerful role in determining the vehicle's roll stability. Changes in weight and dimension allowances that result in a higher c.g. will result in a higher rate of accidents for the vehicles involved (Ervin et al., 1980).

5.3 Load Transfer Ratio (LTR) and Rearward Amplification (RWA)

Load transfer ratio. The load transfer ratios of the various tractor/semitrailer configurations examined for this study were all sensitive to the variation of suspension type. Figures 14 and 15 show the results obtained:

- In general, the steel suspension (S) has a lower load transfer ratio than the air suspension (A). The reason is that during this maneuver (small roll angle), the effective roll stiffness of the air suspension is less than that of the steel suspension. However, the lateral shift of the trailer c.g. is larger in the case of air suspension, which produces a higher axle-load transfer from one side to the other.

- Increasing axle spacing and loads result in an increase in the load transfer ratio, due to an increase in vehicle weight and c.g. height. This effect is more significant in tridem-axle trailers.

- The values of LTR are below the maximum allowable level of 0.6 (as recommended by Ervin et al., 1984) in the case of a tandem-axle trailer equipped with steel suspension, with axle spacings less than or equal to 183 cm (72 in) for both loading scenarios. For the tridem-axle trailer, the LTR is higher than 0.6 for all axle spacings and loads. This constitutes a problem that can be resolved by increasing the air suspension auxiliary stiffness from 6774 N-m/deg to 9032 N-m/deg (60,000 lb-in/deg to 80,000 lb-in/deg). This stiffness increase will also improve the SRT.

Rearward amplification. The rearward amplifications of the various tandem and tridem trailer configurations examined in this study varied slightly, in the range of 1.2 to 1.5, but they all remained comfortably below the maximum recommended level of 2.2. Figures 16 and 17 show these results. It should be noted that:

- In general, the tridem-axle trailers exhibited less RWA than the tandem-axle trailers at a given axle spacing.

- As the axle spacing increased (payload was also increased), the RWA increased for both the tandem- and tridem-axle trailers.

- Trailers equipped with air suspension systems exhibited higher RWA than those equipped with steel suspensions. The main reason is the higher LTR (higher roll stiffness) associated with the air suspension.

- The second loading scenario resulted in a slightly higher RWA, due to the higher payload compared to the first scenario.

5.4 Low-Speed Friction Demand (LFD)

The low-speed friction demand (LFD) measure was initially developed and applied in the Canadian VWD Study to estimate the extent to which a short tractor would have difficulty pulling a long trailer around a corner when the trailer is equipped with a significant number of nonsteerable axles. The recommended target value is 0.1. This is very difficult to measure, but it is theoretically a good indication of the influence of trailer-axle spacing and number on driving performance during low-speed tight-turn maneuvers on slippery roads.

The results obtained (figures 18 and 19) show that the LFD is a very sensitive performance measure of trailer-axle spacing and number (tandem or tridem). From these figures, it can be observed that:

- The LFD sharply increases as axle spacing increases. This result is valid for both tandem- and tridem-axle trailers.

- The LFD for the tridem-axle trailer is higher than that of a tandem-axle trailer, due to an increase in the required turning moment of the tractor during the tight-turn maneuver.

- Trailer suspension type, especially its roll characteristics, has some influence on the LFD. The air suspension with high roll stiffness shows a lower LFD, especially at a large axle spacing (305 cm [120 in]). This holds true for both tandem and tridem trailers.

- For the steel suspension, trailer loading scenarios have some effect on the LFD. For air suspension, the effect is insignificant.

The results indicate that the interaxle spacing for both tandem-axle and tridem-axle trailers should not exceed 183 cm (72 in).

5.5 Off-Tracking Measures

Low-speed off-tracking. The TAC procedure requires that the vehicle negotiate a tight-turn maneuver with a radius of 9.8 m (32.2 ft), measured to the center of the steer axle. The TAC target value for low-speed off-tracking is 6.0 m (19.7 ft). Greater off-tracking constitutes a worst-case scenario and failure to comply with this criterion.

Figures 20 and 21 show the results obtained for the vehicles equipped with tandem- and tridem-axle trailers. It can be noted that:

- LOF improves as the trailer axle spread increases. The effect of the tridem-axle spread is much greater than that of the tandem axle. The reason is the increase in the trailer's yaw resistance as either its axle spread or the number of axles increases.

- The suspension type and loading scenario have only a minor effect on the LOF performance measure.

Steady-state high-speed off-tracking. The negative values shown for steady-state high-speed off-tracking in figures 22 and 23 are indicative of a situation in which the trailer track is outside the path taken by the steer axle of the vehicle. The high-speed off-tracking maximum allowable magnitude is 0.46 m (1.6 ft). The results of the simulation show that:

- The trailer's suspension system characteristics have a significant effect on HOF. Air suspension with high roll stiffness results in better HOF performance (lower values) at all the examined axle spacings, for both tandem and tridem axles.

- Increasing the axle spacing for both tandem and tridem axles results in an increase in the HOF (worse). This effect is more significant for the tridem axle.

- The second loading scenario (heavier trailer) has a slightly increased HOF.

These results indicate that a trailer with air suspension and either a tandem axle with 183-cm (72-in) spacing or a tridem axle with 183-cm (72-in)/183-cm (72-in) axle spacings comfortably pass this measure.

Transient high-speed off-tracking (TOF). The transient high-speed off-tracking of all tandem-axle trailer configurations varied from approximately 0.37 m to 0.64 m (1.2 ft to 2.1 ft), while that for the tridem-axle trailer varied from approximately 0.24 m to 0.73 m (0.8 ft to 2.4 ft). All vehicles' TOF remained well below the maximum allowable level of 0.78 m (2.55 ft). It should also be noted, from figures 24 and 25, that:

- An increase in trailer axle spacing will result in an increase in the TOF. This increase is very significant for tridem-axle trailers.

- Trailers equipped with air suspensions exhibit lower TOF than trailers equipped with steel suspensions. This is indirectly related to the higher roll stiffness of the air suspension.

- The second loading scenario (heavier trailer) results in a slight increase in the TOF compared to that of the first loading scenario.

6.0 THIRD LOADING SCENARIO

In this case, the density of the payload is kept constant for the selected vehicle configurations of 86.02k (tandem) and 95.5k (tridem), while the axle spacing for both vehicles changes from 122 cm to 305 cm (48 in to 120 in). This scenario reflects the maximum possible axle spacing for both tandem- and tridem-axle vehicles (see table 4 and figures 26 and 27), without violating the maximum legal load limit of 5443 kg (12,000 lb) at the steering axle of the tractor.

Table 4. Matrix of vehicle configurations using third loading scenario.

No. of Vehicle Configurations	Trailer Axle	TAS (in)	c.g. height (in)	GVW (kips)	P1 (kips)	P2 (kips)	P3 (kips)	D (lb/ft^3)
1	Tandem	48	101.58	86.02	12	36.88	37.14	16.44
2 (Ref.)	***Tandem***	***72***	***101.58***	***86.02***	***11.94***	***36.08***	***38***	***16.44***
3	Tandem	96	101.58	86.02	11.87	35.24	38.91	16.44
4	Tandem	120	101.58	86.02	11.79	34.36	39.87	16.44
5	Tridem	48/48	102.13	95.50	12.15	38.56	44.79	18.70
7 (Ref.)	***Tridem***	***72/72***	***102.13***	***95.50***	***11.98***	***36.52***	***47***	***18.70***
8	Tridem	96/96	102.13	95.50	11.79	34.25	49.46	18.70
9	Tridem	120/120	102.13	95.50	11.57	31.70	52.23	18.70

1 in = 25.4 mm, 1 kip = 453.6 kg, 1 lb/ft^3 = 16.01 kg/m^3

With a constant payload for both tandem-axle and tridem-axle trailers, independently altering the lead axle(s) location relative to the cargo bed changes both the tractor and trailer axle loads. As the trailer axle spread is increased, the vertical load also increases, while the tractor axle load decreases. This scenario presents the likely regulatory scenario that ties the axle spread and load together. However, the results of this analysis will lead to the final recommendations for axle spread and loads for both tandem-axle and tridem-axle vehicles.

The results obtained for tandem-axle and tridem-axle trailers are shown in tables 5 and 6, respectively. It was found that:

- Increasing the axle spacing of either tandem- or tridem-axle trailers will result in a shorter effective trailer wheelbase, which will affect the off-tracking measures as follows:

  -Greater outboard off-tracking excursion at a given high-speed cornering condition (higher HOF).

  - Less tracking inboard for low-speed maneuvers (less LOF).

  - Greater overshot of the trailer axles during high-speed lane-change maneuvers (higher TOF).

Table 5. Comparison of the dynamic performance of an 86.02k GVW tandem-axle trailers with different axle spacings.

Performance Measure	Tandem-Axle Spacing = 48 in	Tandem-Axle Spacing = 72 in (38k)	Tandem-Axle Spacing = 96 in	Tandem-Axle Spacing = 120 in
K_u (deg/g)	0.92	1.26	1.57	1.49
SRT (g's)	0.32	0.32	0.32	0.32
LTR (-)	0.69	0.70	0.71	0.74
RWA (-)	1.37	1.38	1.45	1.49
HOF (ft)	-0.91	-0.95	-1.09	-1.11
TOF (ft)	1.38	1.45	1.51	1.57
LOF (ft)	19.38	18.84	18.38	17.96
LFD (-)	0.03	0.07	0.17	0.25

1 in = 25.4 mm, 1 ft = 0.305 m

Table 6. Comparison of the dynamic performance of 95.5k GVW tridem-axle trailers with different axle spacings.

Performance Measure	Tridem-Axle Spacing = 48 in/48 in	Tridem-Axle Spacing = 72 in/72 in (47k)	Tridem-Axle Spacing = 96 in/96 in	Tridem-Axle Spacing = 120 in/120 in
K_u (deg/g)	0.20	1.09	2.57	4.04
SRT (g's)	0.32	0.32	0.33	0.34
LTR (-)	0.572	0.59	0.635	0.70
RWA (-)	1.06	1.11	1.20	1.26
HOF (ft)	-0.83	-0.86	-1.00	-1.08
TOF (ft)	1.07	1.22	1.39	1.59
LOF (ft)	18.20	17.11	16.30	15.26
LFD (-)	0.08	0.10	0.21	0.35

1 in = 25.4 mm, 1 ft = 0.305 m

- Increasing the axle spacing (i.e., reducing the trailer effective wheelbase) effects the dynamic roll stability measures as follows:

  - There is a significant increase (deterioration) in the rearward amplification (RWA).

  - There is a significant increase (deterioration) of the load transfer ratio (LTR), resulting from the increase in the RWA. It is well known that the c.g. height has a first-order effect on LTR, but in this case, the c.g. height is kept constant.

  - The static rollover threshold (SRT) is significantly increased (improved) for the tridem-axle trailer, but it is only insignificantly increased for the tandem-axle trailer.

- Axle spacing has a first-order effect on the low-speed friction demand (LFD) on the tractor drive-axles. It is considered to be one of the most important measures for determining the maximum allowable trailer-axle spacing or number. The maximum recommended LFD limit is 0.1; however, as noted in the tables, the tandem-axle spacing of 183 cm (72 in) (38k load) and the tridem-axle spacing of 183 cm (72 in)/183 cm (72 in) (47k load) are considered to be the maximum values for these vehicle configurations (shaded columns in tables 5 and 6).

- As the axle spacing is increased, the understeer coefficient, K_u, increases. This means that the tractor becomes more stable at 0.25 g lateral acceleration. It should also be noted that increasing the understeer level of the tractor (within reasonable limits) will result in better directional stability.

The results obtained from the third scenario confirm the findings from the first and second senarios—the tandem-axle spacing should not exceed 183 cm (72 in) for loads of 38k. The maximum recommended tridem-axle spacing is 183 cm (72 in)/183 cm (72 in) for loads of 47k.

The recommended tandem-axle spacing and loads will result in a GVW of 86k and a tractor-axle load distribution of 11.94k at the steering axle, and 36.06k at the tandem drive-axle for an axle spacing of 152 cm (60 in). The recommended tridem-axle spacing and loads will result in a GVW of 95.5k and a tractor-axle load distribution of 11.98k at the steering axle and 36.52k at the tractor drive-axle. Both the tandem and tridem configurations have a 14.6-m (48-ft) trailer and a 483-cm (190-in) tractor wheelbase. Also, both were equipped with the same suspension systems and tires. The fifth-wheel location for all vehicle configurations was kept at 373 mm (14.7 in) ahead of the geometric center of the tractor tandem drive-axle.

It should be mentioned that the recommended vehicles need further improvement in directional and roll stability. This is due to the fact that these vehicles were selected based on the maximum allowable performance limits. For safety, a reasonable margin is recommended. Replacing the dual tires of the selected vehicles may provide some performance improvement and may increase the safety margin. This approach is examined in the next section.

7.0 INFLUENCE OF TIRE TYPE (DUAL VERSUS SUPER SINGLE)

In this section, the selected vehicles (i.e., an 86k GVW tractor/semitrailer with a tandem axle and an air suspension with a 6774 N-m/deg/axle (60,000 lb-in/deg/axle) auxiliary roll stiffness, and a 95.5k GVW tractor/semitrailer with a tridem-axle trailer and the same air suspension) represented the maximum possible GVW for these types of tractors/semitrailers. The performance analysis of these vehicles showed that they marginally satisfy most of the performance criteria. To improve their stability and control without changing their design parameters, the trailer dual tire was replaced with a wide-base single (super single) tire. This was expected to increase the trailer axle track and suspension spread. Also, the super single tires are slightly lower in weight than the dual tires and they have less vertical stiffness (approximately 20 percent less). This means that there are some benefits with respect to the dynamic tire load. Table 7 shows the results obtained when dual tires are replaced with super single tires (see figures 2 and 3).

Table 7. Comparison of the dynamic performance of 86k GVW tandem-axle trailers with dual or super-single tires.

Performance Measure	Trailer With Dual Tires	Trailer With Super-Single Tires	Percent Improvement	Percent Degradation
K_u (deg/g)	1.07	0.727	N/A	N/A
SRT (g's)	0.32	0.35	9.4%	-
LTR (-)	0.70	0.56	25%	-
RWA (-)	1.38	1.21	14%	-
HOF (ft)	-1.05	-0.84	25%	-
TOF (ft)	1.46	1.12	30%	-
LOF (ft)	18.84	18.85	-	0.5%
LFD (-)	0.06	0.04	50%	-

1 ft = 0.305 m

Table 8. Comparison of the dynamic performance of 95.5k GVW tridem-axle trailers with dual or super-single tires.

Performance Measure	Trailer With Dual Tires	Trailer With Super-Single Tires	Percent Improvement	Percent Degradation
K_u (deg/g)	0.87	1.56	N/A	N/A
SRT (g's)	0.32	0.35	9.4%	
LTR (-)	0.59	0.48	23%	
RWA (-)	1.11	1.04	6.7%	
HOF (ft)	-0.93	-0.83	12%	
TOF (ft)	1.22	1.01	20.8%	
LOF (ft)	17.11	18.85	-	10%
LFD (-)	0.11	0.04	64%	

1 ft = 0.305 m

8.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to examine the safety-related effects of varying the trailer axle arrangement, axle load levels, axle spacing, suspension type, and tire type of a typical five- and six-axle tractor/semitrailer. This vehicle consisted of a 483-cm (15.83-ft or 190-in) tractor and a 14.6-m (48-ft or 576-in) van-semitrailer.

The safety-related dynamic performance was examined using a recent version of the UMTRI constant-speed yaw/roll model. The vehicles were examined using three loading scenarios: (1) loading the trailer while controlling the tractor's axle loads at their maximum legal limits, i.e., 12k and 34k at the steering and tandem drive-axles, respectively; (2) loading the trailer without controlling the tractor axle loads, but not allowing the steering axle loads to exceed 12k; and (3) varying trailer axle spacing, while keeping the GVW constant and consequently keeping the c.g. height constant. In this case, the trailer tandem-axle and tridem-axle, and tractor-axle loads were changed as the spacing was modified.

The dynamic performance characteristics of the vehicles under examination were evaluated according to UMTRI's performance measures:

- Handling performance.
- Static rollover threshold.
- Load transfer ratio.
- Rearward amplification.

- Low-speed friction demand.
- Off-tracking (low, steady-state high-speed, and transient high-speed).

The tandem-axle and tridem-axle trailer vehicle configurations selected for stability and control analyses had approximately the same tractor-axle load distribution; i.e., approximately 12k at the steering axle and 36k to 36.5k at the drive-axle group. This means that in order not to exceed the maximum steering-axle load limit, the tractor drive-axle load (at this particular setting of the fifth wheel) cannot exceed the range of 36k to 36.5k, which, in turn, controls the selection of the trailer-axle spacing and loads.

The following conclusions can be drawn from the findings of this study:

Tandem-axle trailer. The stability and control analyses of the two loading scenarios and trailer-axle suspension types resulted in several recommendations:

- The GVW of an 80k tractor/semitrailer (483-cm [190-in] wheelbase tractor and 14.6-m [48-ft] trailer) equipped with 122-cm (48-in) (axle spread) tandem-axle spacing may increase to 86k, provided that the following conditions are satisfied:

  - The trailer suspension characteristics should be equivalent or close to those of the air suspension used in this study, especially its auxiliary roll stiffness.

  - The axle spread should not exceed 183 cm (72 in).

- The tractor tandem-axle with a 152-cm (60-in) axle spread may carry a 36k load, provided it has similar (or close) design parameters.

- The axle load distribution should be maintained as close as possible to 12k (steering axle), 36k (drive axle), and 38k (trailer axle).

Tridem-axle trailer. The stability and control analyses of the two loading scenarios and trailer-axle suspension types resulted in several recommendations:

- The GVW of an 80k tractor/semitrailer (483-cm [190-in] wheelbase tractor and 14.6-m [48-ft] trailer) may increase to 95.5k if it is equipped with 183-cm (72-in)/183-cm (72-in) tridem-axle spacing and if the following conditions are satisfied:

  - The trailer suspension characteristics should be equivalent or close to those of the air suspension used in this study, especially its auxiliary roll stiffness.

  - In this case, the axle spread should not exceed 183 cm (72 in)/183 cm (72 in).

- The tractor tandem-axle with a 153-cm (60-in) axle spread may carry a 36.5k load, provided it has similar (or close) design parameters.

- The axle load distribution should be maintained as close as possible to 12k (steering axle), 36.5k (drive axle), and 47k (trailer axle).

For both tandem-axle and tridem-axle trailers, it should also be mentioned that:

- Trailers longer than 14.6 m (48 ft) will perform better if they are carrying approximately the same payload weight and density, or if a higher density is balanced by a lower c.g. height.

- To maintain adequate handling performance, the fifth-wheel location must remain as specified in this study.

It can also be concluded that replacing the trailer tridem-axle dual tires with wide-base single tires is recommended for improving the dynamic performance of the selected vehicle configurations. However, replacement of the dual tires with wide-base singles should be restricted to the tridem axles and should not be followed by an additional increase in the recommended maximum GVW (95.5k) for the tridem-axle trailer.

It is recommended that a complete study be initiated on the influence of wide-base single tires on pavement response, dynamic performance (stability, control, and vertical dynamics), and braking performance, for various vehicle configurations at different operating and design conditions.

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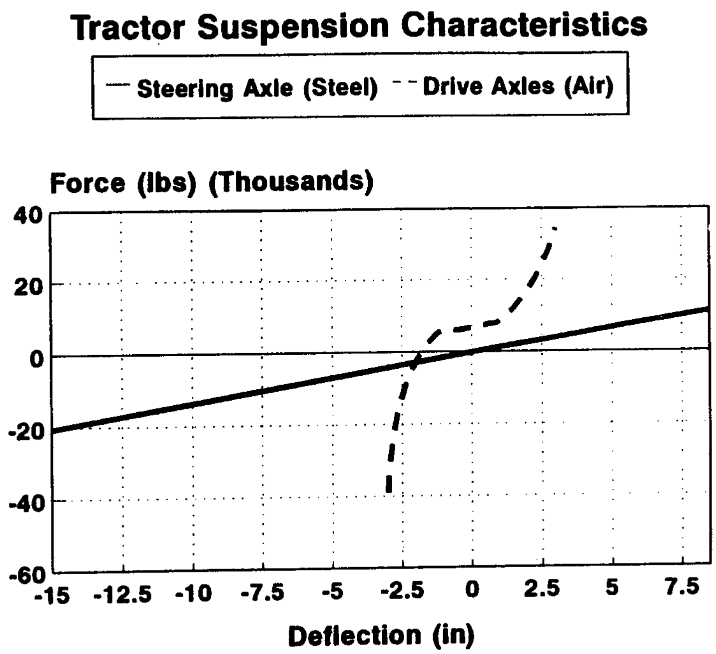
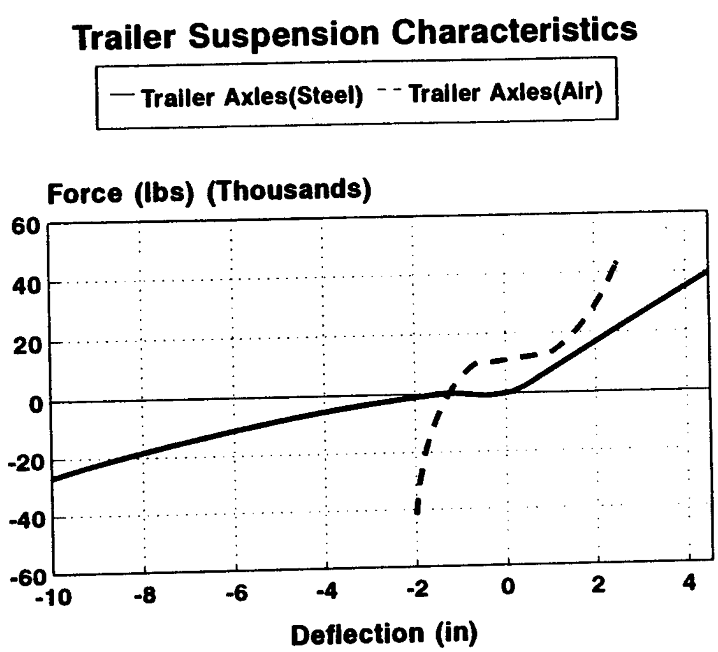
10.0 FIGURES



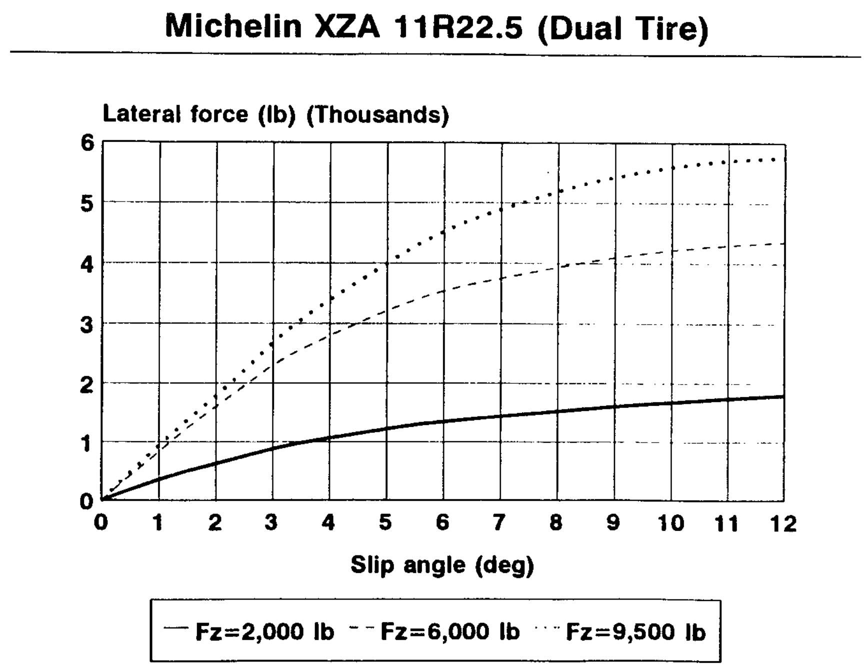
(a) Tractor.



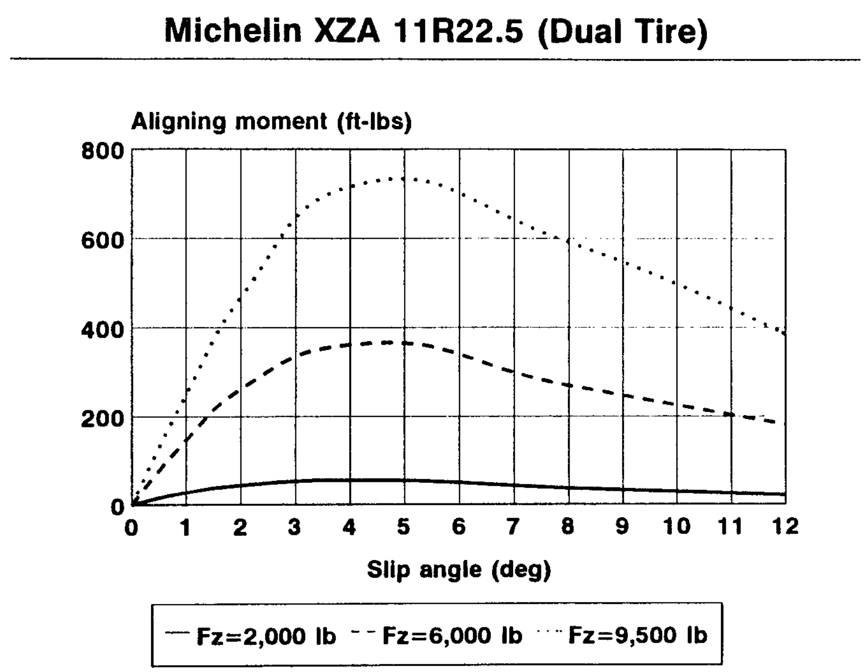
(b) Trailer.

1 in = 25.4 mm, 1 lbf = 4.448 N

Figure 1. Suspension characteristics: (a) tractor and (b) trailer.



(a) Lateral force.

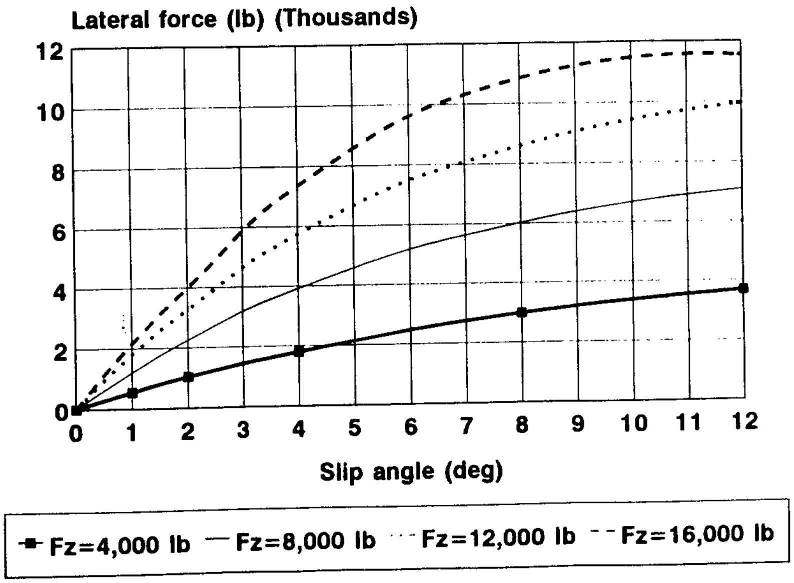


(b) Aligning moment.

1 lbf = 4.448 N, 1 lb-ft = 1.356 N-m

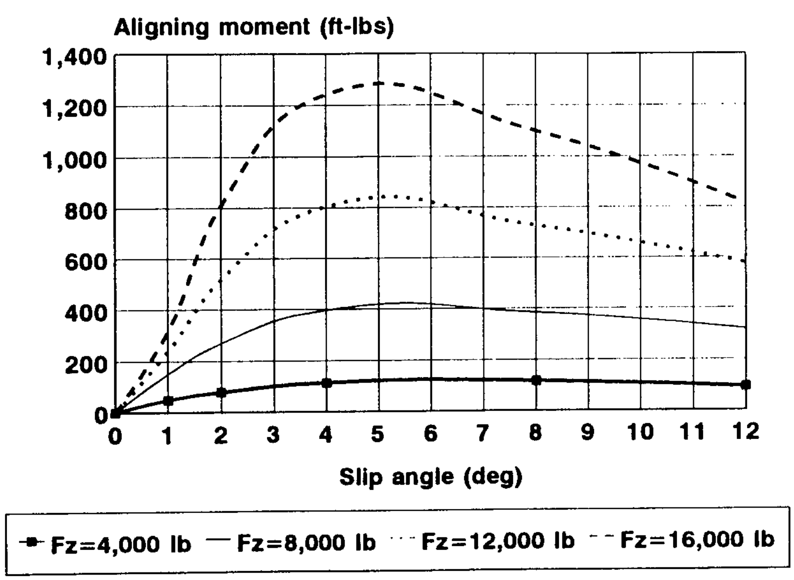
Figure 2. Dual-tire characteristics: (a) lateral force and (b) aligning moment.

Good Year G286 425/65R22.5J (Super Single)



(a) Lateral force.

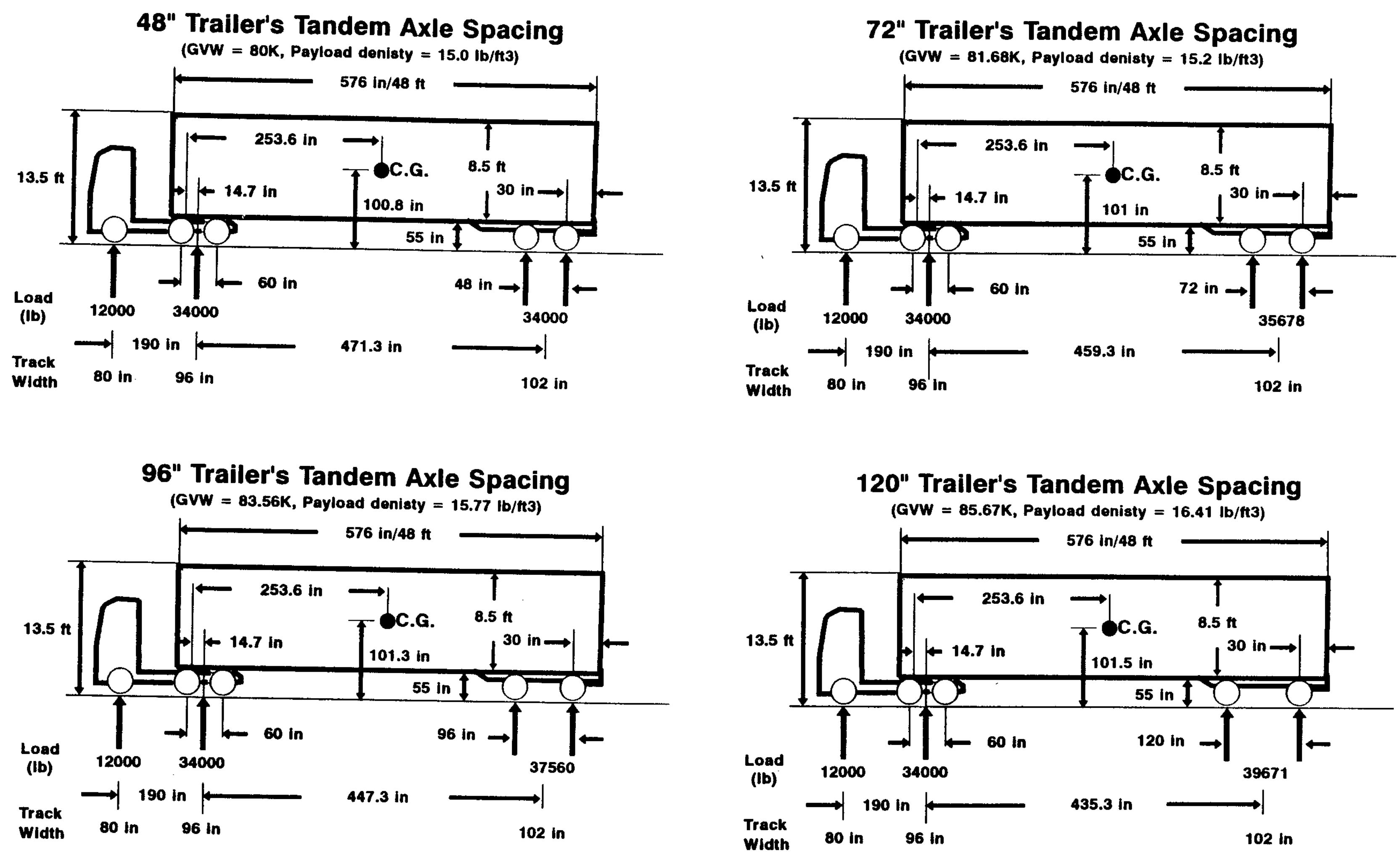
Good Year G286 425/65R22.5J (Super Single)



(b) Aligning moment.

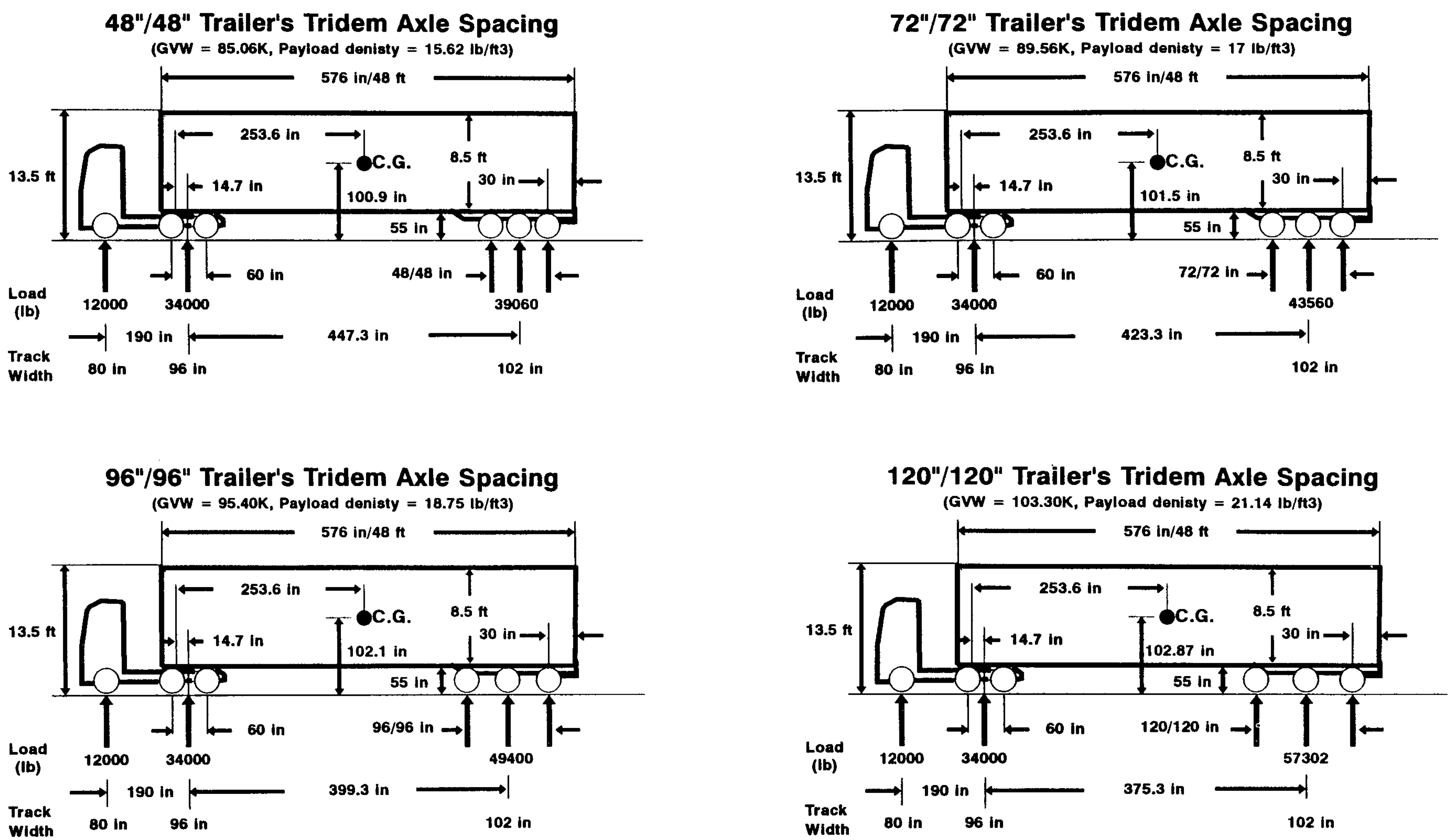
1 lbf = 4.448 N, 1 lb-ft = 1.356 N-m

Figure 3. Wide-base single-tire characteristics: (a) lateral force and (b) aligning moment.



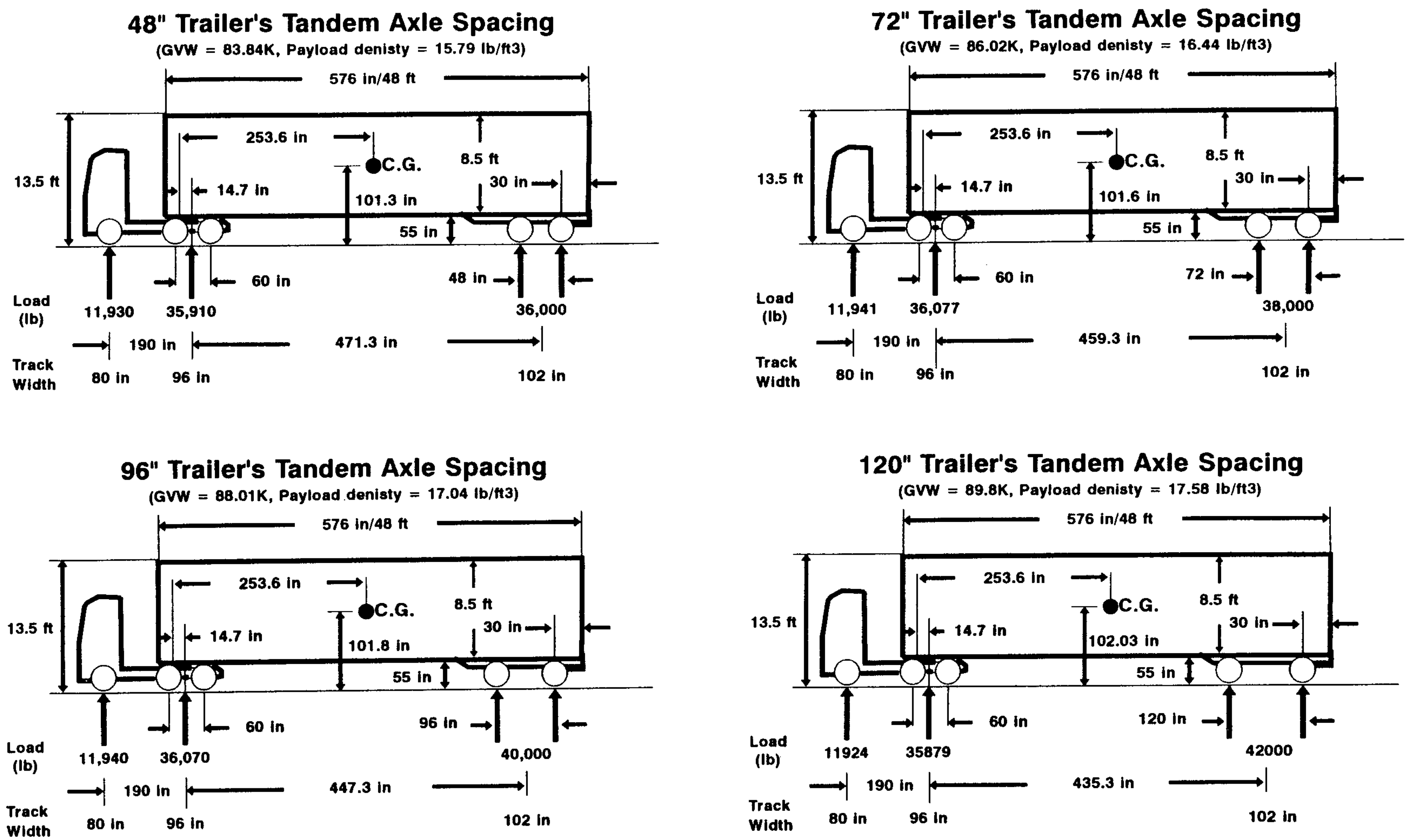
1 in = 25.4 mm, 1 ft = 0.305 m, 1 lb/ft^3 = 16.01 kg/m^3, 1 lbf = 4.448 N

Figure 4. Schematic of tandem-axle-trailer vehicle configurations under the first loading scenario.



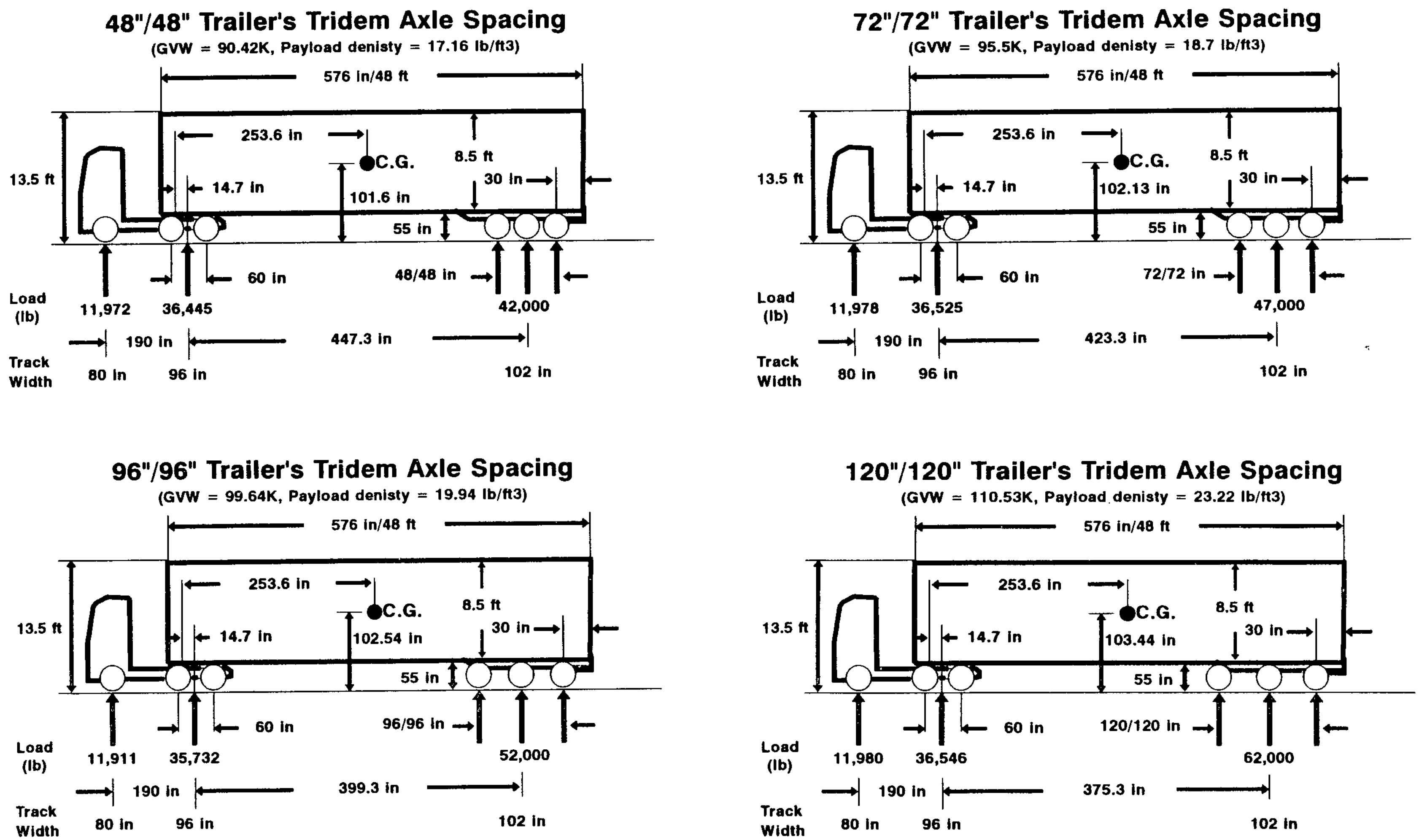
1 in = 25.4 mm, 1 ft = 0.305 m, 1 lb/ft^3 = 16.01 kg/m^3, 1 lbf = 4.448 N

Figure 5. Schematic of tridem-axle-trailer vehicle configurations under the first loading scenario.



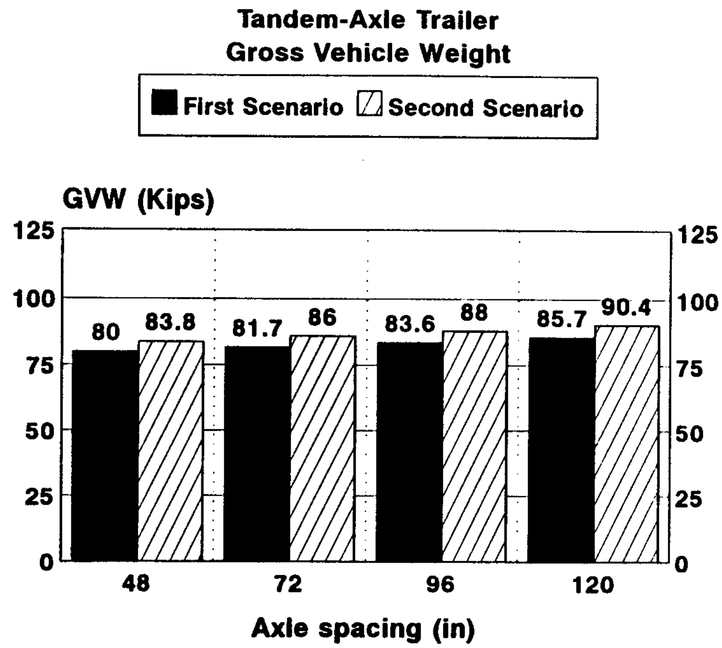
1 in = 25.4 mm, 1 ft = 0.305 m, 1 lb/ft^3 = 16.01 kg/m^3, 1 lbf = 4.448 N

Figure 6. Schematic of tandem-axle-trailer vehicle configurations under the second loading scenario.



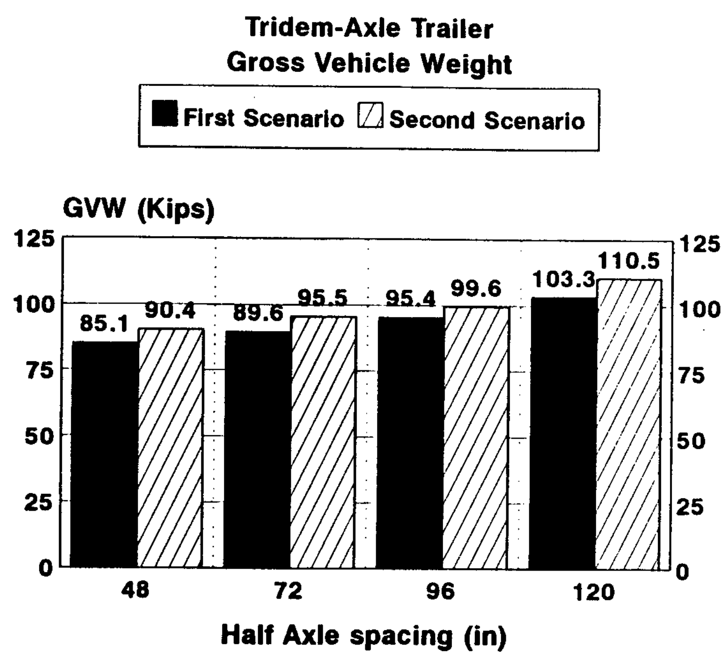
1 in = 25.4 mm, 1 ft = 0.305 m, 1 lb/ft^3 = 16.01 kg/m^3, 1 lbf = 4.448 N

Figure 7. Schematic of tridem-axle-trailer vehicle configurations under the second loading scenario.



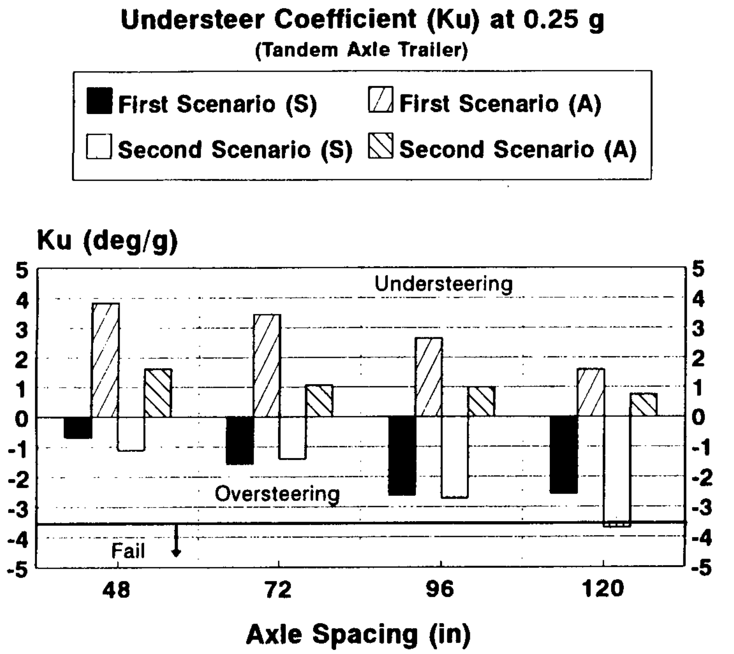
1 in = 25.4 mm, 1 kip = 453.6 kg

Figure 8. GVW of tandem-axle trailer for first and second loading scenarios.



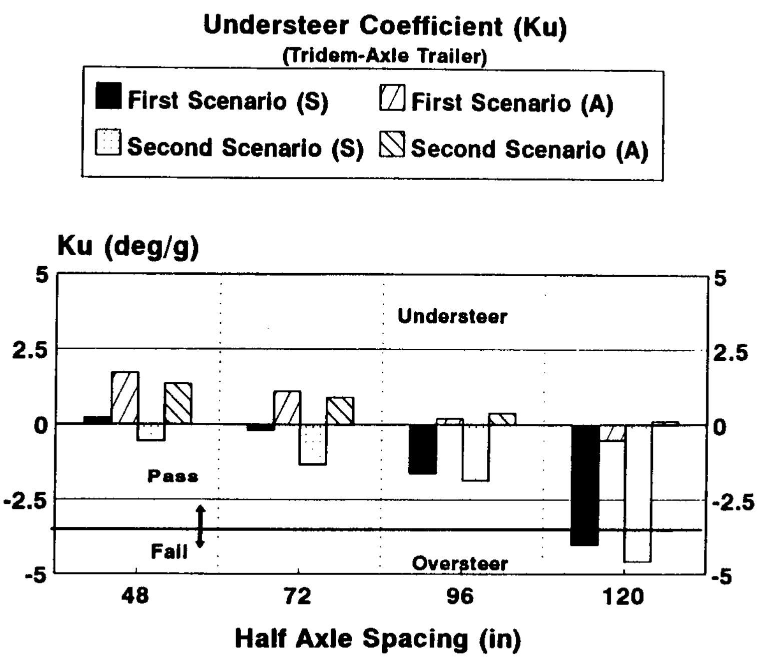
1 in = 25.4 mm, 1 kip = 453.6 kg

Figure 9. GVW of tridem-axle trailer for first and second loading scenarios.



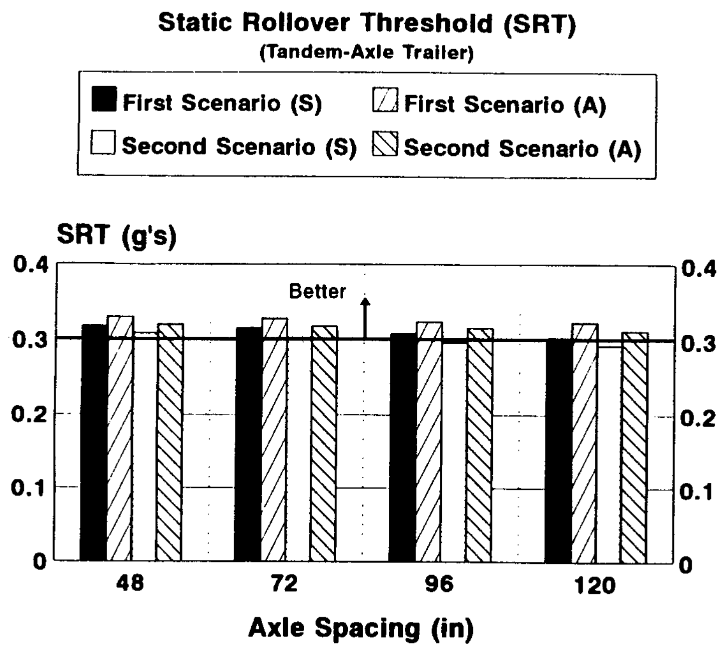
1 in = 25.4 mm

Figure 10. Handling characteristics of various tractor/semitrailer combinations with tandem-axle trailers.



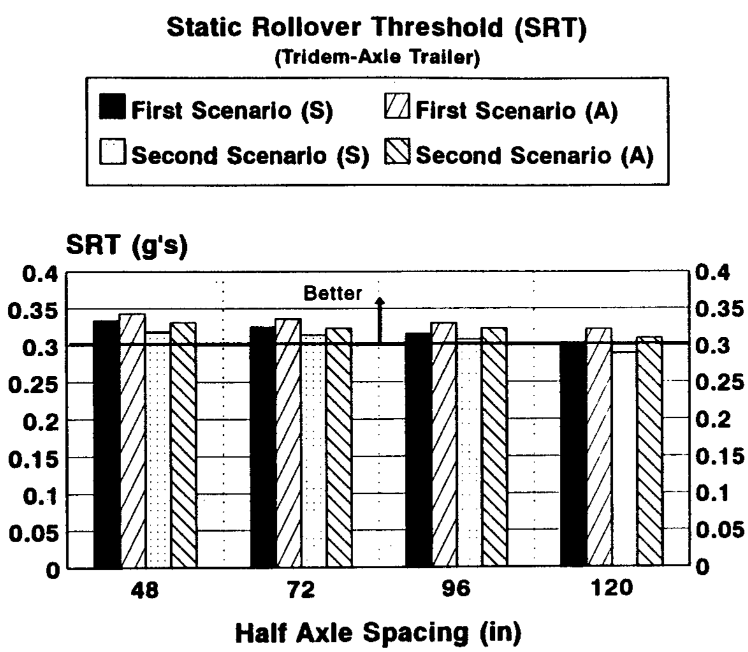
1 in = 25.4 mm

Figure 11. Handling characteristics of various tractor/semitrailer combinations with tridem-axle trailers.



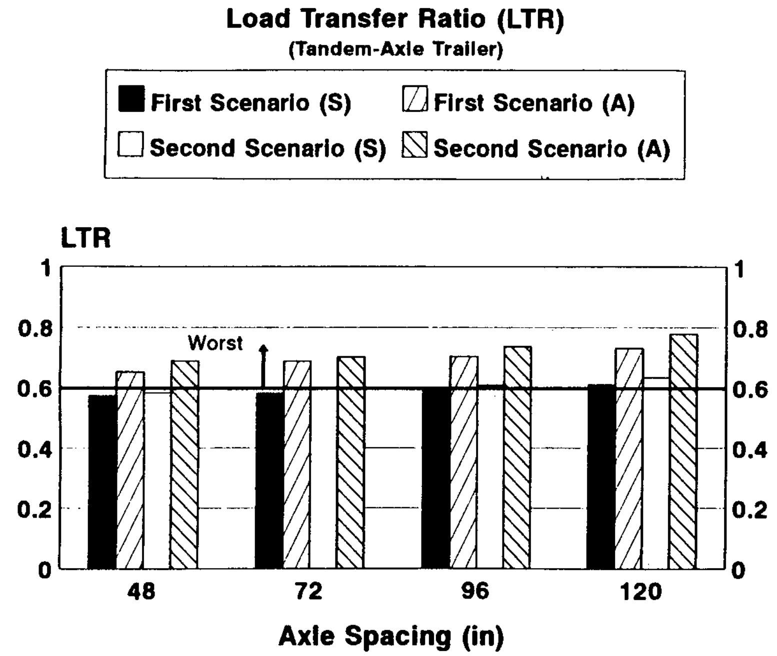
1 in = 25.4 mm

Figure 12. Static rollover characteristics of various tractor/semitrailer combinations with tandem-axle trailers.



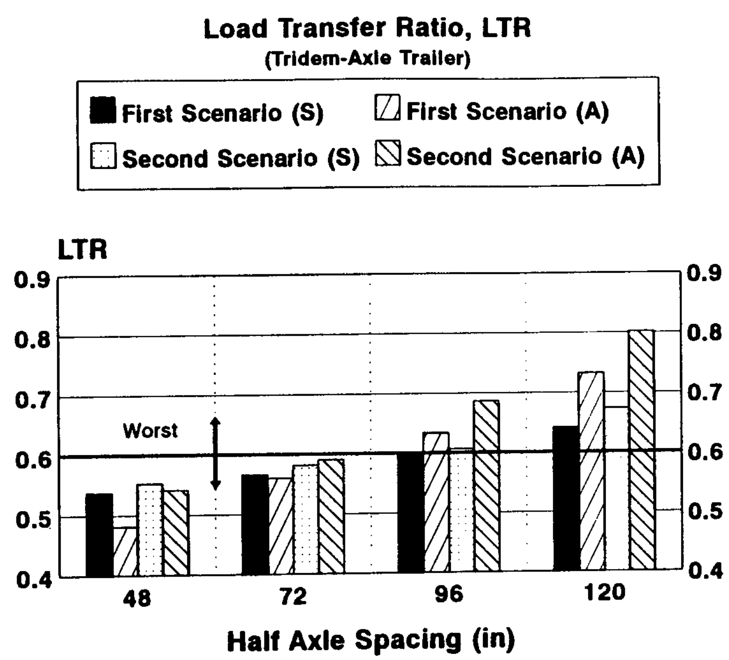
1 in = 25.4 mm

Figure 13. Static rollover characteristics of various tractor/semitrailer combinations with tridem-axle trailers.



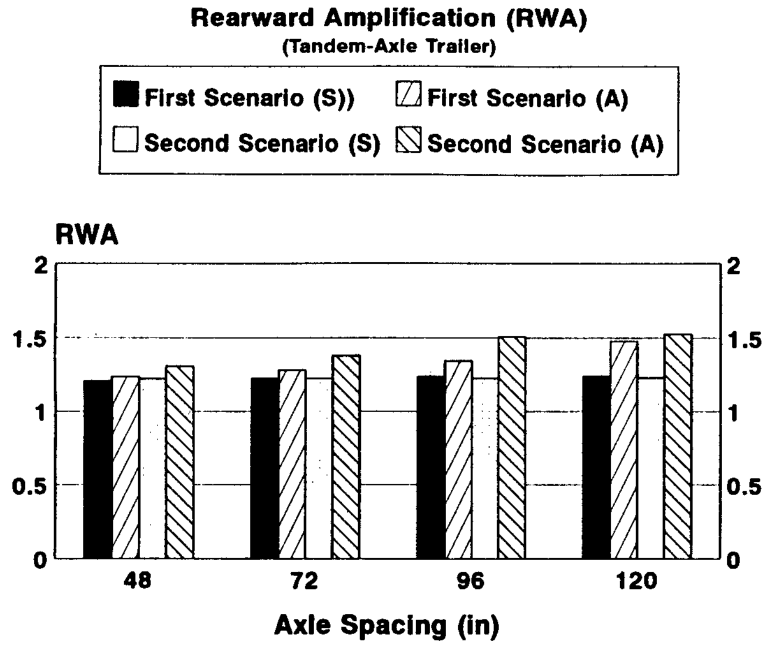
1 in = 25.4 mm

Figure 14. Load transfer ratio of various tractor/semitrailer combinations with tandem-axle trailers.



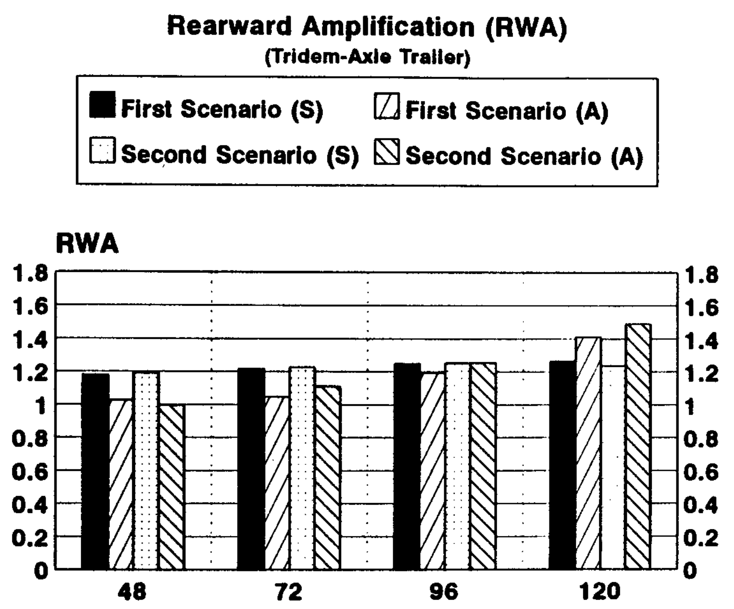
1 in = 25.4 mm

Figure 15. Load transfer ratio of various tractor/semitrailer combinations with tridem-axle trailers.



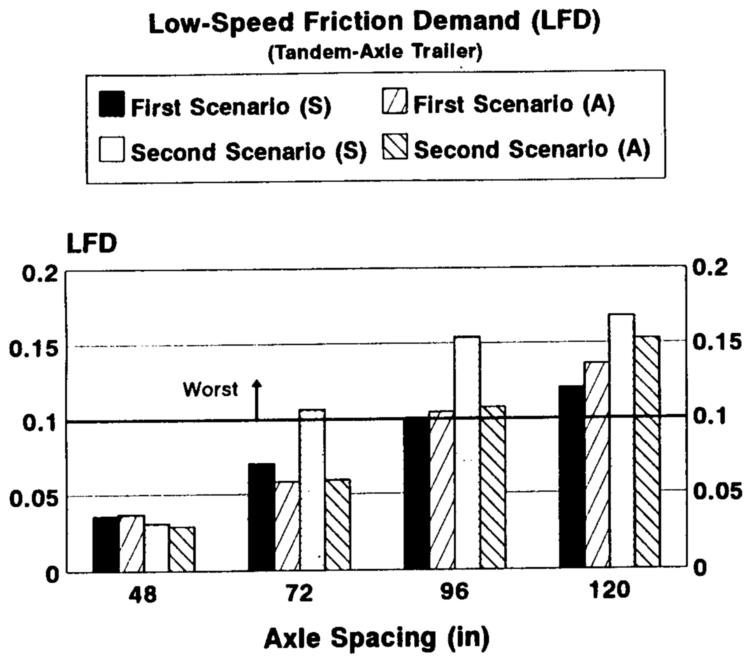
1 in = 25.4 mm

Figure 16. Rearward amplification of various tractor/semitrailer combinations with tandem-axle trailers.



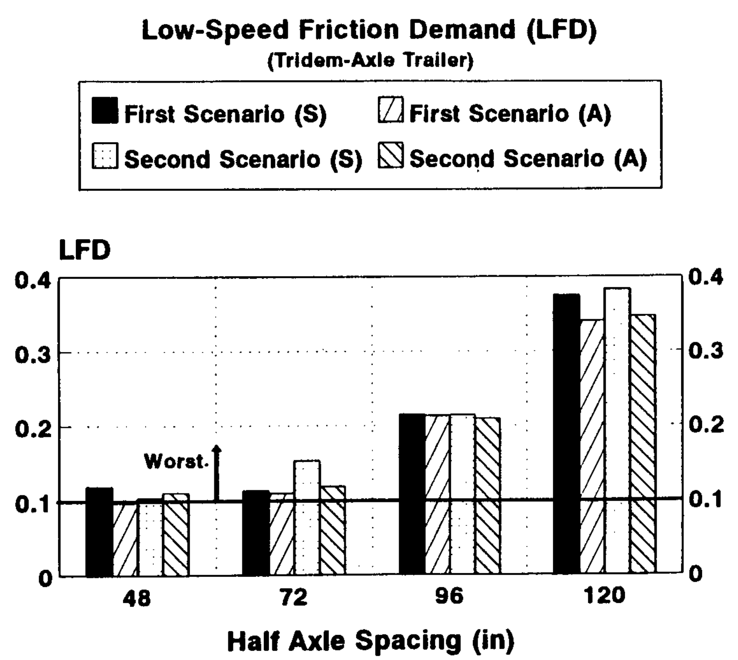
1 in = 25.4 mm

Figure 17. Rearward amplification of various tractor/semitrailer combinations with tridem-axle trailers.



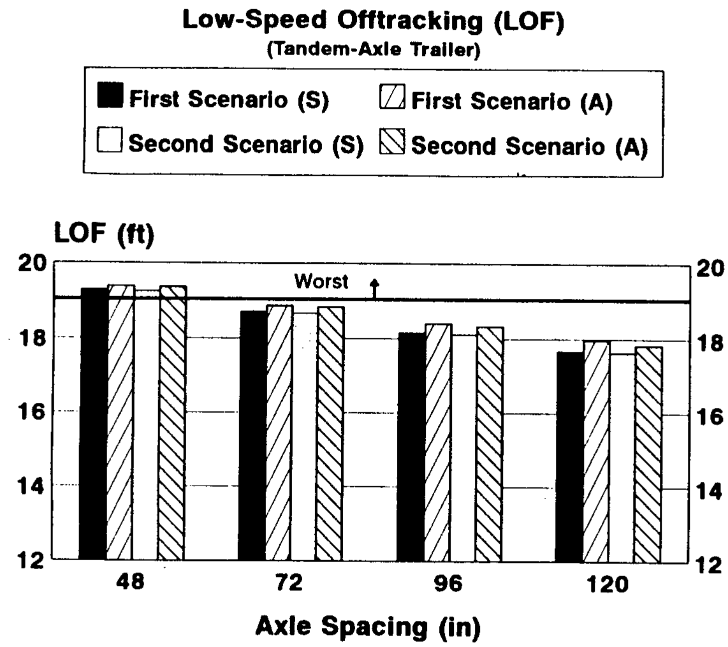
1 in = 25.4 mm

Figure 18. Low-speed friction demand of various tractor/semitrailer combinations with tandem-axle trailers.



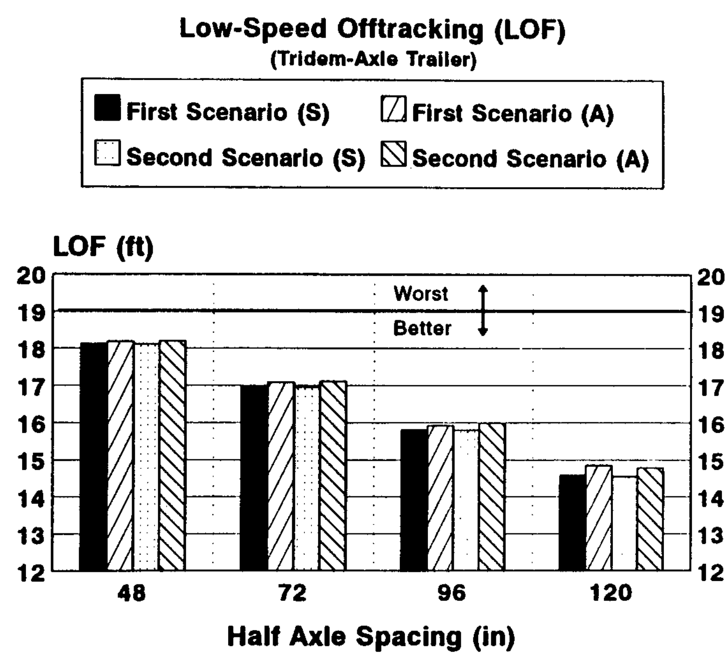
1 in = 25.4 mm

Figure 19. Low-speed friction demand of various tractor/semitrailer combinations with tridem-axle trailers.



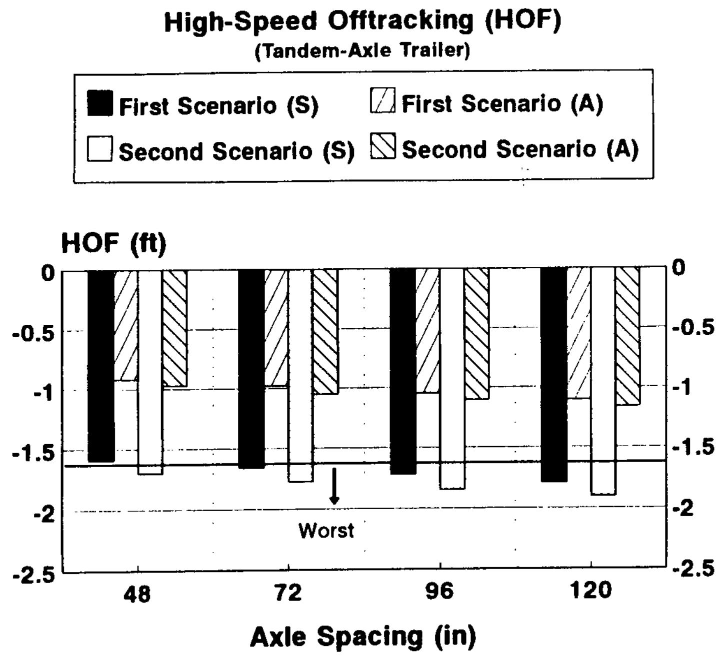
1 in = 25.4 mm, 1 ft = 0.305 m

Figure 20. Low-speed off-tracking of various tractor/semitrailer combinations with tandem-axle trailers.



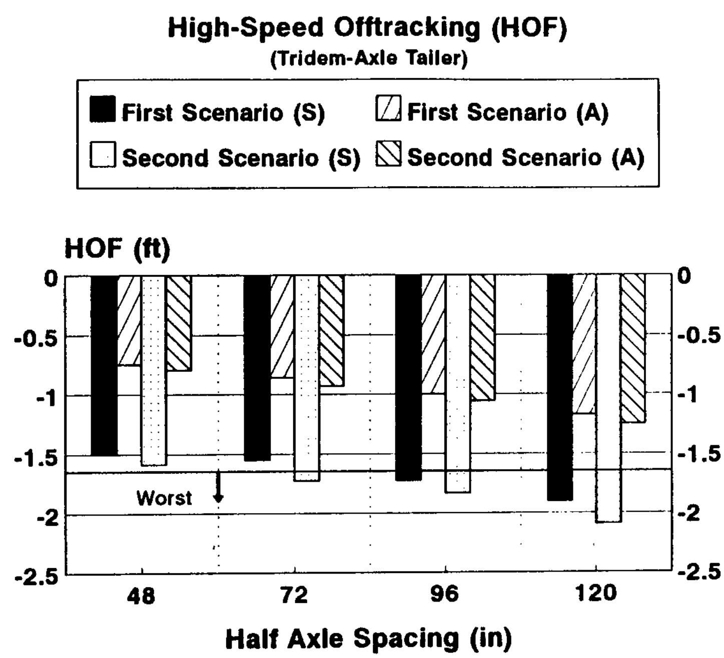
1 in = 25.4 mm, 1 ft = 0.305 m

Figure 21. Low-speed off-tracking of various tractor/semitrailer combinations with tridem-axle trailers.



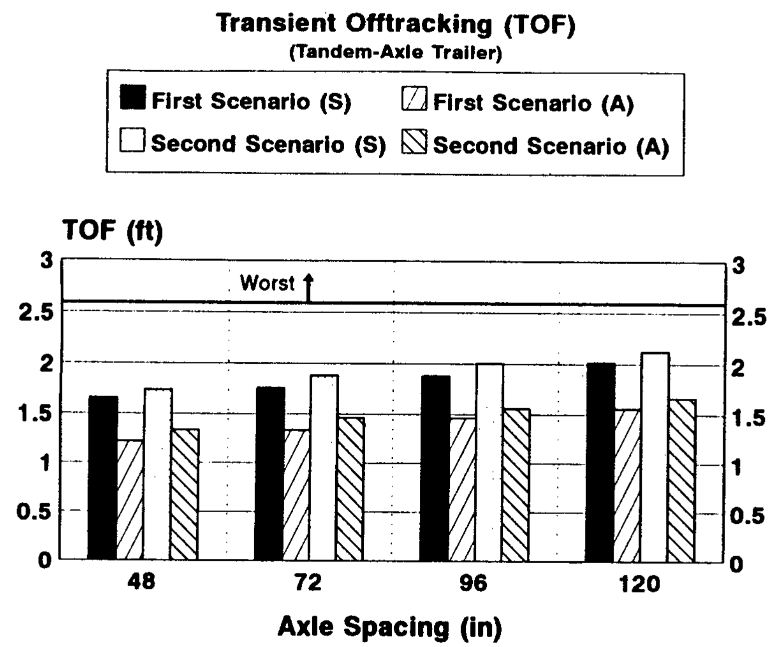
1 in = 25.4 mm, 1 ft = 0.305 m

Figure 22. High-speed off-tracking of various tractor/semitrailer combinations with tandem-axle trailers.



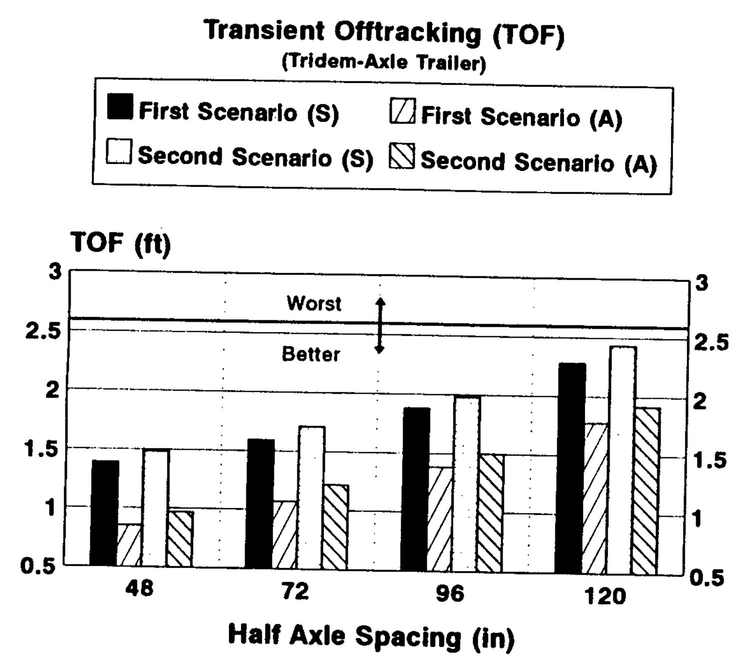
1 in = 25.4 mm, 1 ft = 0.305 m

Figure 23. High-speed off-tracking of various tractor/semitrailer combinations with tridem-axle trailers.



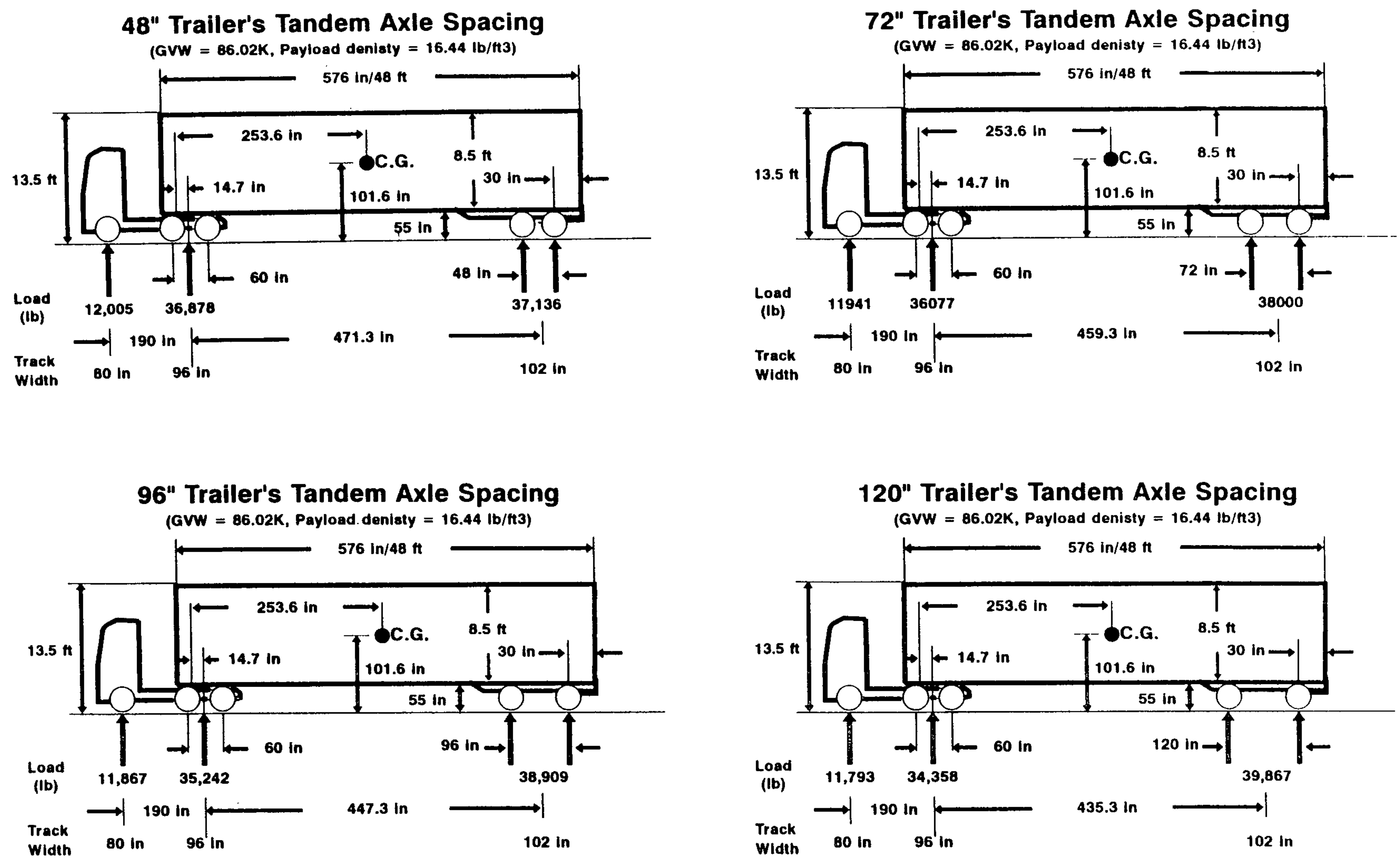
1 in = 25.4 mm, 1 ft = 0.305 m

Figure 24. Transient off-tracking of various tractor/semitrailer combinations with tandem-axle trailers.



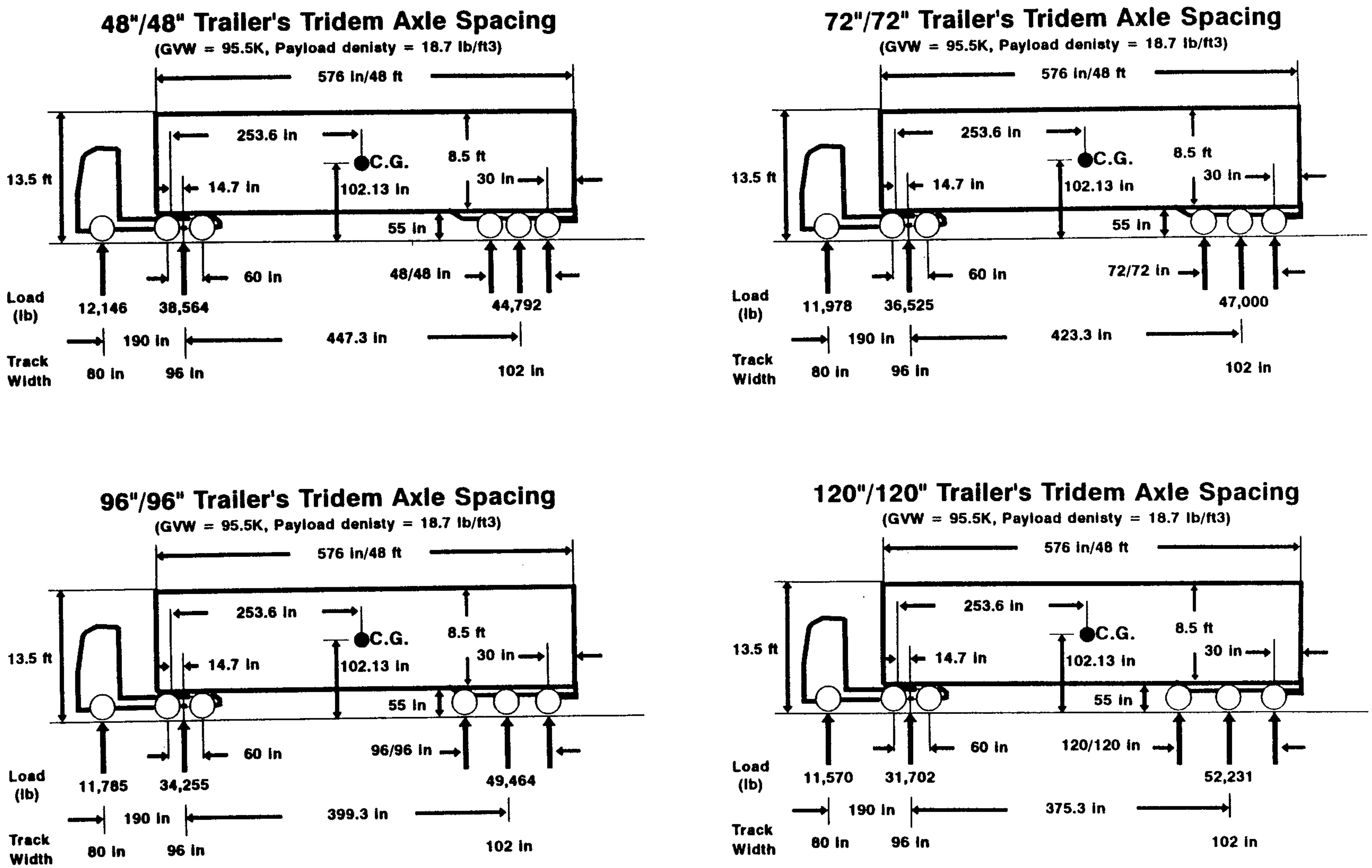
1 in = 25.4 mm, 1 ft = 0.305 m

Figure 25. Transient off-tracking of various tractor/semitrailer combinations with tridem-axle trailers.



1 in = 25.4 mm, 1 ft = 0.305 m, 1 lb/ft^3 = 16.01 kg/m^3, 1 lbf = 4.448 N

Figure 26. Schematic of tandem-axle-trailer vehicle configurations using the third loading scenario.



1 in = 25.4 mm, 1 ft = 0.305 m, 1 lb/ft^3 = 16.01 kg/m^3, 1 lbf = 4.448 N

Figure 27. Schematic of tridem-axle-trailer vehicle configurations using the third loading scenario.

APPENDIX A. VEHICLE PARAMETERS FOR TANDEM-AXLE TRAILER (FIRST LOADING SCENARIO)

5-Axle tractor/semi (GVW = 80,000 lb, Steel/34 kips, 48 in, 3s2-rsa) (A)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 80000.00 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	56.80		

LINKED ARTICULATION: GAIN: 0 .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT:
- 01 CONVENTIONAL 5TH WHEEL
- 02 INVERTED 5TH WHEEL
- 03 PINTLE HOOK
- 04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
5000.00	996.41

1 5-Axle tractor/semi (GVW = 80000 lb, Steel/34 Kips, 48 in, 3s2-Rsa) (A)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	************************************		
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15 .50	15 .50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 80000 lb, Steel/34 Kips, 48 in, 3s2-Rsa)
(A)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 59400.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 226026.90 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 4991688.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5050943.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 100.80 INCHES

	AXLE # 4	AXLE # 5
	**************************	
LOAD ON EACH AXLE (LB.)	17000.00	17000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	19.50	19.50
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	28.00	28.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.23	.23
AUX ROLL STIFFNESS (IN.LB/DEG)	9000.00	9000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	975.00	975.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	.00	.00
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(A)
1 SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-26660.15	-10.00
-97.65	-1.50
-50.00	.00
1150.00	.25
3000.00	.50
5375.00	.75
39542.00	4.50

(A)
1 CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 80,000 lb,Air/34 Kips, 48 in, 3s2-raa) (A)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 80000.00 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	56.80		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN(RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
5000.00	996.41

1 5-Axle tractor/semi (GVW = 80,000 lb, Air/34 Kips, 48 in, 3s2-Raa)
(A)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	**************************************		
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 80,000 lb, Air/34 Kips, 48 in, 3s2-Raa)
(A)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 59400.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 226026.90 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 4991688.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5050943.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 100.80 INCHES

	AXLE # 4	AXLE # 5
	************************	
LOAD ON EACH AXLE (LB.)	17000.00	17000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00

X DIST FROM SP MASS CG (IN)	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(A) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00

7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(A)
1 CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
	1983.00	356.94	634.56	1070.82	1526.91	1804.53
	5967.00	835.38	1611.09	2804.49	3938.22	4355.91
	9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
	2000.00	336.00	528.00	660.00	444.00	252.00
	3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
	5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
	7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
	9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 81,680 lb, Air/35, 68 Kips, 72 in, 3s2-25aa) (A)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 81678.00 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.00		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT : 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 5-Axle tractor/semi (GVW = 81,680 lb, Air/35, 68 Kips, 72 in, 3s2-25aa)
(A)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 81,680 lb, Air/35, 68 Kips, 72 in, 3s2-25aa)
(A)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 61078.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 232378.70 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5131963.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5192883.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.00 INCHES

	AXLE # 4	AXLE # 5
	**************************	
LOAD ON EACH AXLE (LB.)	17840.00	17840.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-184.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(A) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2

****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(A)

1 CORNERING FORCE TABLE # 1

****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1

****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

5-Axle Tractor/Semi (GVW=83,559.69lb, Air/37.56Kips, 96 in, 3s2-26aa) (A)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 83559.69 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.30		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
5000.00	996.41

1 5-Axle tractor/semi (GVW = 83559.69 lb, Air/37.56 Kips, 96 in, 3s2-26aa)
(A)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	********	********	********
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 83559.69 lb, Air/37.56 Kips, 96 in, 3s2-26aa)
(A)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 62959.69 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 239537.80 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5290069.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5352866.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.30 INCHES

	AXLE # 4	AXLE # 5
	************************	
LOAD ON EACH AXLE (LB.)	18779.85	18779.85
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(A) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(A)
1 CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle Tractor/Semi (GVW=85,671.28lb,Air/39.67Kips, 120in, 3s2-27aa) (A)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 85671.28 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.53		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT : 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 5-Axle tractor/semi (GVW = 85671.28 lb, Air/39.67 Kips, 120 in, 3s2-27aa)
(A)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 85671.28 lb, Air/39.67 Kips, 120 in, 3s2-27aa)
(A)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 65071.28 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 247571.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5467491.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5532394.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.53 INCHES

	AXLE # 4	AXLE # 5
	************************	
LOAD ON EACH AXLE (LB.)	19835.64	19835.64
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(A) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2

****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(A) CORNERING FORCE TABLE # 1

****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1

****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW = 85,059.69 lb, Air/39.06 Kips, 48/48 in, 3s3-25aa)
(B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 85059.69 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	56.90		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 85059.69 lb, Air/39.06 Kips, 48/48 in, 3s3-25aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 85059.69 lb, Air/39.06 Kips, 48/48 in, 3s3-25aa) (B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 62959.69 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 239537.80 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5290069.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5352866.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 100.90 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	13020.00	13020.00	13020.00
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW=87171.28lb,Air/41.17Kips,60/60in,3s3-26aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 87171.28 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.15		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 87171.28 lb, Air/41.17 Kips, 60/60 in, 3s3-26aa) (B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	**************************************		
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 87171.28 lb, Air/41.17 Kips, 60/60 in, 3s3-26aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 65071.28 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 247571.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5467491.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5532394.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.15 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	13723.76	13723.76	13723.76
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-136.40	-196.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B)

CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW=89557.7lb,Air/43.56Kips,72/72in,3s3-27aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 89557.70 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.50		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 89557.7 lb, Air/43.56 Kips, 72/72 in, 3s3-27aa) (B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 89557.7 lb, Air/43.56 Kips, 72/72 in, 3s3-27aa)
(B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 67457.70 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 256651.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5668005.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5735289.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.50 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	14519.23	14519.23	14519.23
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-112.40	-184.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW=95,402 lb, Air/49.4 Kips, 96/96 in, 3s3-28aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95402.00 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	58.12		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95402 lb, Air/49.4 Kips, 96/96 in, 3s3-28aa) (B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	***		
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95402 lb, Air/49.4 Kips, 96/96 in, 3s3-28aa)
(B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73302.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 278886.40 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6159061.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6232174.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.12 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**************************************		
LOAD ON EACH AXLE (LB.)	16467.25	16467.25	16467.25
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-64.40	-160.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW = 103,302.4 lb, Air/57.3 Kips, 120/120 in, 3s3-29aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 103302.40 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	58.87		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT : 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
1429.59	987.54
1431.71	996.41
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 103,302.35 lb, Air/57.3 Kips, 120/120 in, 3s3-29aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 103,302.35 lb, Air/57.3 Kips, 120/120 in, 3s3-29aa) (B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 81202.35 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 308944.30 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6822873.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6903866.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.87 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	***		
LOAD ON EACH AXLE (LB.)	19100.78	19100.78	19100.78
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-16.40	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
	1983.00	356.94	634.56	1070.82	1526.91	1804.53
	5967.00	835.38	1611.09	2804.49	3938.22	4355.91
	9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
	2000.00	336.00	528.00	660.00	444.00	252.00
	3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
	5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
	7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
	9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

APPENDIX B. VEHICLE PARAMETERS FOR TRIDEM-AXLE TRAILER (FIRST LOADING SCENARIO)

6-Axle Tractor/Semi (GVW = 85,059.69 lb, Air/39.06 Kips, 48/48 in, 3s3-25aa)
(B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 85059.69 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	56.90		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 85059.69 lb, Air/39.06 Kips, 48/48 in, 3s3-25aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 85059.69 lb, Air/39.06 Kips, 48/48 in, 3s3-25aa)
(B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 62959.69 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 239537.80 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5290069.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5352866.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 100.90 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
LOAD ON EACH AXLE (LB.)	13020.00	13020.00	13020.00
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

6-Axle Tractor/Semi(GVW=87171.28lb,Air/41.17Kips,60/60in,3s3-26aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 87171.28 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.15		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 87171.28 lb, Air/41.17 Kips, 60/60 in, 3s3-26aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	********	********	********
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 87171.28 lb, Air/41.17 Kips, 60/60 in, 3s3-26aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 65071.28 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 247571.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5467491.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5532394.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.15 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	13723.76	13723.76	13723.76
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-136.40	-196.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B)

CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

6-Axle Tractor/Semi (GVW=89557.7lb,Air/43.56Kips,72/72in,3s3-27aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 89557.70 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.50		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 89557.7 lb, Air/43.56 Kips, 72/72 in, 3s3-27aa) (B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 89557.7 lb, Air/43.56 Kips, 72/72 in, 3s3-27aa)
(B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 67457.70 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 256651.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5668005.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5735289.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.50 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	14519.23	14519.23	14519.23
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-112.40	-184.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW=95,402lb, Air/49.4Kips,96/96in,3s3-28aa) (B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95402.00 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	58.12		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95402lb, Air/49.4 Kips, 96/96in, 3s3-28aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	**************************************		
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95402 lb, Air/49.4 Kips, 96/96 in, 3s3-28aa)
(B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73302.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 278886.40 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6159061.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6232174.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.12 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**************************************		
LOAD ON EACH AXLE (LB.)	16467.25	16467.25	16467.25
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-64.40	-160.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
	1983.00	356.94	634.56	1070.82	1526.91	1804.53
	5967.00	835.38	1611.09	2804.49	3938.22	4355.91
	9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
	2000.00	336.00	528.00	660.00	444.00	252.00
	3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
	5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
	7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
	9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW = 103,302.4 lb, Air/57.3 Kips, 120/120 in, 3s3-29aa)
(B)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 103302.40 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	58.87		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
1429.59	987.54
1431.71	996.41
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 103,302.35 lb, Air/57.3 Kips, 120/120 in, 3s3-29aa)
(B)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12000.00	17000.00	17000.00
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 103,302.35 lb, Air/57.3 Kips, 120/120 in, 3s3-29aa) (B)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 81202.35 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 308944.30 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6822873.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6903866.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.87 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	19100.78	19100.78	19100.78
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-16.40	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(B) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2

****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(B) CORNERING FORCE TABLE # 1

****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1

****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

APPENDIX C. VEHICLE PARAMETERS FOR TANDEM-AXLE TRAILER (SECOND LOADING SCENARIO)

6-Axle tractor/semi (GVW = 83841.32 lb, Air/36 Kips, 48 in, 3s2-28aa) (C)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 83841.32 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.30		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
5000.00	996.41

1 5-Axle tractor/semi (GVW = 83841.32 lb, Steel/36 Kips, 48 in, 3s2-28sa)
(C)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11927.12	17957.10	17957.10
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.26	.00	.00
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 83841.32 lb, Air/36 Kips, 48 in, 3s2-28aa)
(C)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 63241.32 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 240609.30 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5313732.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5376810.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.30 INCHES

	AXLE # 4	AXLE # 5
	*************************	
LOAD ON EACH AXLE (LB.)	18000.00	18000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(C) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(C)
1 CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

5-Axle tractor/semi (GVW = 86,018 lb, Air/38 Kips, 72 in, 3s2-29aa) (C)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 86017.98 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.58		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
5000.00	996.41

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/38 Kips, 72 in, 3s2-29aa) (C)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	**		
LOAD ON EACH AXLE (LB.)	11940.80	18038.59	18038.59
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.26	.00	.00
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 86,018 lb, Steel/38 Kips, 72 in, 3s2-29sa)
(C)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 65417.98 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 248890.70 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5496621.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5561870.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.58 INCHES

	AXLE # 4	AXLE # 5
	**************************	
LOAD ON EACH AXLE (LB.)	19000.00	19000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-184.40	-256.40

HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(C) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00

34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(C) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 88005.36 lb, Air/40 Kips, 96 in, 3s2-30aa) (C)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 88005.36 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.82		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
5000.00	996.41

1 5-Axle tractor/semi (GVW = 88005.36 lb, Air/40 Kips, 96 in, 3s2-30aa)
(C)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	******	******	******
LOAD ON EACH AXLE (LB.)	11939.83	18032.77	18032.77
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 88005.36 lb, Air/40 Kips, 96 in, 3s2-30aa)
(C)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 67405.36 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 256451.90 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5663607.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5730839.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.82 INCHES

	AXLE # 4	AXLE # 5
	*************************	
LOAD ON EACH AXLE (LB.)	20000.00	20000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(C) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00

5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(C) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 89803.47 lb, Air/42 Kips, 120 in, 3s2-31aa) (C)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 89803.47 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	58.03		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 5-Axle tractor/semi (GVW = 89803.47 lb, Air/42 Kips, 120 in, 3s2-31aa) (C)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	*******	*******	*******
LOAD ON EACH AXLE (LB.)	11924.19	17939.64	17939.64
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 89803.47 lb, Air/42 Kips, 120 in, 3s2-31aa)
(C)

UNIT # 2
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 69203.47 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 263293.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5814690.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5883715.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.03 INCHES

	AXLE # 4	AXLE # 5
	************************	
LOAD ON EACH AXLE (LB.)	21000.00	21000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(C) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(C) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

APPENDIX D. VEHICLE PARAMETERS FOR TRIDEM-AXLE TRAILER (SECOND LOADING SCENARIO)

6-Axle Tractor/Semi (GVW = 90416.24 lb, Air/42 Kips, 48/48 in, 3s3-30aa) (D)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 90416.24 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.56		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 90416.24 lb, Air/42 Kips, 48/48 in, 3s3-30aa)
(D)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11971.66	18222.29	18222.29
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 90416.24 lb, Air/42 Kips, 48/48 in, 3s3-30aa)
(D)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 68316.24 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 259917.50 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5740143.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5808283.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.56 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
LOAD ON EACH AXLE (LB.)	14000.00	14000.00	14000.00
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(D) SPRING TABLE # 1

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(D) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/47 Kips, 72/72 in, 3s3-31aa)
(D)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95502.99 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	58.13		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/47 Kips, 72/72 in, 3s3-31aa)
(D)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	********	********	********
LOAD ON EACH AXLE (LB.)	11978.38	18262.30	18262.30
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/47 Kips, 72/72 in, 3s3-31aa)
(D)

Semitrailer
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73402.99 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 279270.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6167547.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6240761.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.13 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	***		
LOAD ON EACH AXLE (LB.)	15666.67	15666.67	15666.67
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-112.40	-184.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(D) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(D) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW = 110526.65 lb, Air/62 Kips, 120/120 in, 3s3-33aa)
(D)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 110526.60 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-119.72	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	59.44		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 110526.65 lb, Air/P3=62 Kips, 120/120 in, 3s3-33aa)
(D)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	*************	*************	*************
LOAD ON EACH AXLE (LB.)	11980.21	18273.22	18273.22
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3824.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 110526.65 lb, Air/P3=62 Kips, 120/120 in, 3s3-33aa) (D)

UNIT # 2
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 88426.65 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 336430.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 7429881.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 7518080.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 103.44 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	***************************************		
LOAD ON EACH AXLE (LB.)	20666.67	20666.67	20666.67
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-16.40	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(D) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2

****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(D) CORNERING FORCE TABLE # 1

****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1

****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

APPENDIX E. VEHICLE PARAMETERS FOR TANDEM-AXLE TRAILER (THIRD LOADING SCENARIO)

5-Axle tractor/semi (GVW = 86,018 lb, Air/37.136 Kips, 48 in, 3s2-32aa) (E)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 86017.98 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1				
ON UNIT # 2	253.60	57.58		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/37.136 Kips, 48 in, 3s2-32aa)
(E)

Tractor
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12004.46	18438.85	18438.85
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/37.136 Kips, 48 in, 3s2-32aa)

Semitrailer
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 65417.98 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 248890.70 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5496621.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5561870.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.58 INCHES

	AXLE # 4	AXLE # 5
	**********	**********
LOAD ON EACH AXLE (LB.)	18567.90	18567.90
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(E) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(E) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 86,018 lb, Air/38 Kips, 72 in, 3s2-33aa) (E)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 86017.98 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.58		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/38 Kips, 72 in, 3s2-33aa) (E)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11940.80	18038.59	18038.59
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/38 Kips, 72 in, 3s2-33aa)
(E)

UNIT # 2
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 65417.98 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 248890.70 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5496621.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5561870.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.58 INCHES

	AXLE # 4	AXLE # 5
LOAD ON EACH AXLE (LB.)	19000.00	19000.00
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00

X DIST FROM SP MASS CG (IN)	-184.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(E) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50

8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(E) CORNERING FORCE TABLE # 1

****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1

****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 86,018 lb, Air/38.91 Kips, 96 in, 3s2-34aa) (E)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 86017.98 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.58		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
5000.00	996.41

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/38.91 Kips, 96 in, 3s2-34aa) (E)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11867.26	17620.80	17620.80
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/38.91 Kips, 96 in, 3s2-34aa)
(E)

UNIT # 2
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 65417.98 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 248890.70 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5496621.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5561870.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.58 INCHES

	AXLE # 4	AXLE # 5
	**************************	
LOAD ON EACH AXLE (LB.)	19454.55	19454.55
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(E) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2

****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3

****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(E) CORNERING FORCE TABLE # 1

****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1

****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

5-Axle tractor/semi (GVW = 86,018 lb, Air/39.871 Kips, 120 in, 3s2-35aa) (E)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 5

GROSS VEHICLE WEIGHT = 86017.98 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	57.58		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
5000.00	996.41

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/39.871 Kips, 120 in, 3s2-35aa) (E)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11793.18	17179.10	17179.10
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 5-Axle tractor/semi (GVW = 86,018 lb, Air/39.871 Kips, 120 in, 3s2-35aa) (E)

UNIT # 2
****

OF AXLES ON THIS UNIT = 2

WEIGHT OF SPRUNG MASS = 65417.98 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 248890.70 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 5496621.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 5561870.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 101.58 INCHES

	AXLE # 4	AXLE # 5
LOAD ON EACH AXLE (LB.)	19933.33	19933.33
AXLE WEIGHT (LB.)	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30
SPRING TABLE #	3	3
CORNERING FORCE TABLE #	1	1
ALIGNING TORQUE TABLE #	1	1

(E) SPRING TABLE # 1

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(E) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

APPENDIX F. VEHICLE PARAMETERS FOR TRIDEM-AXLE TRAILER (THIRD LOADING SCENARIO)

6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/44.79 Kips, 48/48 in, 3s3-34aa) (F)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95502.99 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	58.13		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
154.94	.09
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/44.79 Kips, 48/48 in, 3s3-34aa) (F)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	12145.94	19282.43	19282.43
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/44.79 Kips, 48/48 in, 3s3-34aa) (F)

UNIT # 2
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73402.99 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 279270.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6167547.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6240761.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.13 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
LOAD ON EACH AXLE (LB.)	14930.74	14930.74	14930.74
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-160.40	-208.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(F) SPRING TABLE # 1

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(F) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/47 Kips, 72/72 in, 3s3-35aa)
(F)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95502.99 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	58.13		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
1429.59	987.54
1431.71	996.41
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/47 Kips, 72/72 in, 3s3-35aa)
(F)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11978.38	18262.30	18262.30
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/47 Kips, 72/72 in, 3s3-35aa)
(F)

UNIT # 2
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73402.99 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 279270.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6167547.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6240761.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.13 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	15666.67	15666.67	15666.67
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-112.40	-184.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(F) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(F) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00

6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/49.46 Kips, 96/96 in, 3s3-36aa)
(F)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95502.99 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	253.60	58.13		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
154.94	.09
164.05	.14
182.28	.34
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/49.46 Kips, 96/96 in, 3s3-36aa)
(F)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
LOAD ON EACH AXLE (LB.)	11784.51	17127.36	17127.36
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/49.46 Kips, 96/96 in, 3s3-36aa)
(F)

UNIT # 2
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73402.99 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 279270.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6167547.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6240761.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.13 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	16487.92	16487.92	16487.92
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-64.40	-160.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(F) SPRING TABLE # 1

****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(F) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53	
5967.00	835.38	1611.09	2804.49	3938.22	4355.91	
9441.00	944.00	1793.79	3398.76	5192.55	5759.01	

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

	.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00	
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00	
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00	
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00	
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00	

6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/52.23 Kips, 120/120 in, 3s3-37aa)
(F)

OF SPRUNG MASSES = 2

TOTAL # OF AXLES = 6

GROSS VEHICLE WEIGHT = 95502.99 LB.

FORWARD VELOCITY = 62.15 M.P.H.

PEAK FRICTIONAL COEFFICIENT = .90

	DISTANCE AHEAD OF SPRUNG MASS C.G. (INCHES)	HEIGHT BELOW SPRUNG MASS C.G. (INCHES)	ROLL STIFFNESS (IN.LB/DEG)	TYPE OF CONSTRAINT
ON UNIT # 1	-120.30	.00	1000000.00	1
ARTICULATION PT # 1 ON UNIT # 2	.253.60	58.13		

LINKED ARTICULATION: GAIN: .000 STIFFNESS: 1.000 (IN-LB/DEG GAMMA2)

TYPE OF CONSTRAINT: 01 CONVENTIONAL 5TH WHEEL
02 INVERTED 5TH WHEEL
03 PINTLE HOOK
04 KING PIN (RIGID IN ROLL & PITCH)

CLOSED LOOP PATH FOLLOWER INPUT
****

DRIVER LAG = .00 SEC
PREVIEW INTERVAL = .30 SEC
CLOSED LOOP TIME = 20.00 SEC
RAMP-STEER RATE = 2.00 DEG/SEC

STEERING GEAR RATIO = 30.00

STEERING STIFFNESS (IN.LB/DEG) = 11000.00
TIE ROD STIFFNESS (IN.LB/DEG) = 11000.00
MECHANICAL TRAIL (IN) = 1.00

1 # OF POINTS IN PATH TABLE = 206

X (FEET)	Y (FEET)
.00	.00
54.69	.00
63.78	.00
72.91	.00
82.01	.00
91.13	.01
100.25	.00
109.36	.01
118.48	.01
127.59	.02
136.70	.03
145.82	.05
154.94	.09
164.05	.14
5000.00	996.41

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/52.23 Kips, 120/120 in, 3s3-37aa)
(F)

UNIT # 1
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 11800.00 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 26000.00 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 170000.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 44.00 INCHES

	AXLE # 1	AXLE # 2	AXLE # 3
	******	******	******
LOAD ON EACH AXLE (LB.)	11470.43	15410.90	15850.90
AXLE WEIGHT (LB.)	1200.00	2300.00	2300.00
AXLE ROLL M.I (LB.IN.SEC**2)	3700.00	4458.00	4458.00
X DIST FROM SP MASS CG (IN)	55.00	-105.00	-165.00
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	18.25	29.50	29.50
HALF SPRING SPACING (IN)	16.00	19.00	19.00
HALF TRACK - INNER TIRES (IN)	40.00	29.50	29.50
DUAL TIRE SPACING (IN)	.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.17	.17
AUX ROLL STIFFNESS (IN.LB/DEG)	3820.00	15000.00	51000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	475.00	275.00	275.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	22.43	15.50	15.50
SPRING TABLE #	1	2	2
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

1 6-Axle Tractor/Semi (GVW = 95502.99 lb, Air/52.23 Kips, 120/120 in, 3s3-37aa)
(F)

UNIT # 2
****

OF AXLES ON THIS UNIT = 3

WEIGHT OF SPRUNG MASS = 73402.99 LB.

ROLL MOMENT OF INERTIA OF SPRUNG MASS = 279270.60 LB.IN.SEC**2

PITCH MOMENT OF INERTIA OF SPRUNG MASS = 6167547.00 LB.IN.SEC**2

YAW MOMENT OF INERTIA OF SPRUNG MASS = 6240761.00 LB.IN.SEC**2

HEIGHT OF SPRUNG MASS CG ABOVE GROUND = 102.13 INCHES

	AXLE # 4	AXLE # 5	AXLE # 6
	**		
LOAD ON EACH AXLE (LB.)	17410.26	17410.26	17410.26
AXLE WEIGHT (LB.)	1500.00	1500.00	1500.00
AXLE ROLL M.I (LB.IN.SEC**2)	4100.00	4100.00	4100.00
X DIST FROM SP MASS CG (IN)	-16.40	-136.40	-256.40
HEIGHT OF AXLE C.G. ABOVE GROUND (INCHES)	20.00	20.00	20.00
HEIGHT OF ROLL CENTER ABOVE GROUND (INCHES)	29.00	29.00	29.00
HALF SPRING SPACING (IN)	22.00	22.00	22.00
HALF TRACK - INNER TIRES (IN)	32.50	32.50	32.50
DUAL TIRE SPACING (IN)	13.00	13.00	13.00
STIFFNESS OF EACH TIRE (LB/IN)	4500.00	4500.00	4500.00
ROLL STEER COEFFICIENT	.00	.00	.00
AUX ROLL STIFFNESS (IN.LB/DEG)	60000.00	60000.00	60000.00
SPRING COULOMB FRICTION - PER SPRING (LB)	362.00	362.00	362.00
VISCOUS DAMPING PER SPRING (LB.SEC/IN)	17.30	17.30	17.30
SPRING TABLE #	3	3	3
CORNERING FORCE TABLE #	1	1	1
ALIGNING TORQUE TABLE #	1	1	1

(F) SPRING TABLE # 1
****

FORCE LB	DEFLECTION INCHES
-20550.00	-15.00
-1170.00	-.75
-150.00	.00
1250.00	1.00
2550.00	2.00
3825.00	3.00
7240.00	5.50
11127.50	8.50
20076.50	15.50

1 SPRING TABLE # 2
****

FORCE LB	DEFLECTION INCHES
-38775.00	-3.00
5100.00	-1.25
6012.50	-.50
6725.00	.00
7537.50	.50
8537.50	1.00
34387.50	3.00

1 SPRING TABLE # 3
****

FORCE LB	DEFLECTION INCHES
-41675.00	-2.00
9300.00	-.75
10600.00	-.25
11137.50	.00
11662.50	.25
12775.00	.75
13387.00	1.00
43406.20	2.50

(F) CORNERING FORCE TABLE # 1
****

LATERAL FORCE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
1983.00	356.94	634.56	1070.82	1526.91	1804.53
5967.00	835.38	1611.09	2804.49	3938.22	4355.91
9441.00	944.00	1793.79	3398.76	5192.55	5759.01

1 ALIGNING TORQUE TABLE # 1
****

ALIGNING TORQUE VS. SLIP ANGLE

.00	1.00	2.00	4.00	8.00	12.00
2000.00	336.00	528.00	660.00	444.00	252.00
3980.00	1020.00	1716.00	2256.00	1728.00	1092.00
5970.00	1764.00	3156.00	4344.00	3240.00	2184.00
7950.00	2484.00	4608.00	6720.00	5304.00	3576.00
9440.00	3000.00	5616.00	8604.00	7104.00	4620.00